Hydro Aluminium Kurri Kurri Pty Ltd

Containment Cell Design

Design Report

August 2018

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1. Introduction

1.1 General

Hydro Aluminium Kurri Kurri Pty Ltd (herein referred to as 'Hydro') maintains the former Hydro Aluminium Kurri Kurri Aluminium Smelter (herein referred to as the 'site'), which is located on Hart Road, Loxford, NSW. The site operated as an aluminium smelter and formally shut down in May 2014.

The site currently operates under the following approvals/licences

- Environment Protection Licence 1548

GHD was engaged by Hydro to undertake the detailed design of the proposed Containment Cell for the HAKK Demolition and Remediation Project (the project). This report presents documentation of the engineered design providing the basis, computations and a rationale for various components of the design.

1.2 Purpose of this report

The purpose of this report is to:

- Present the basis for the design and future construction of the future containment cell at the site
- Demonstrate compliance of the cell design with relevant consent conditions and relevant regulatory guidelines
- Document the design process for the future containment cell at the site
  - Refer to Figure 1 for the preliminary works undertaken
  - Refer to Figure 2 for the development of the design basis
  - Refer to Figure 3 for the development of the detailed design

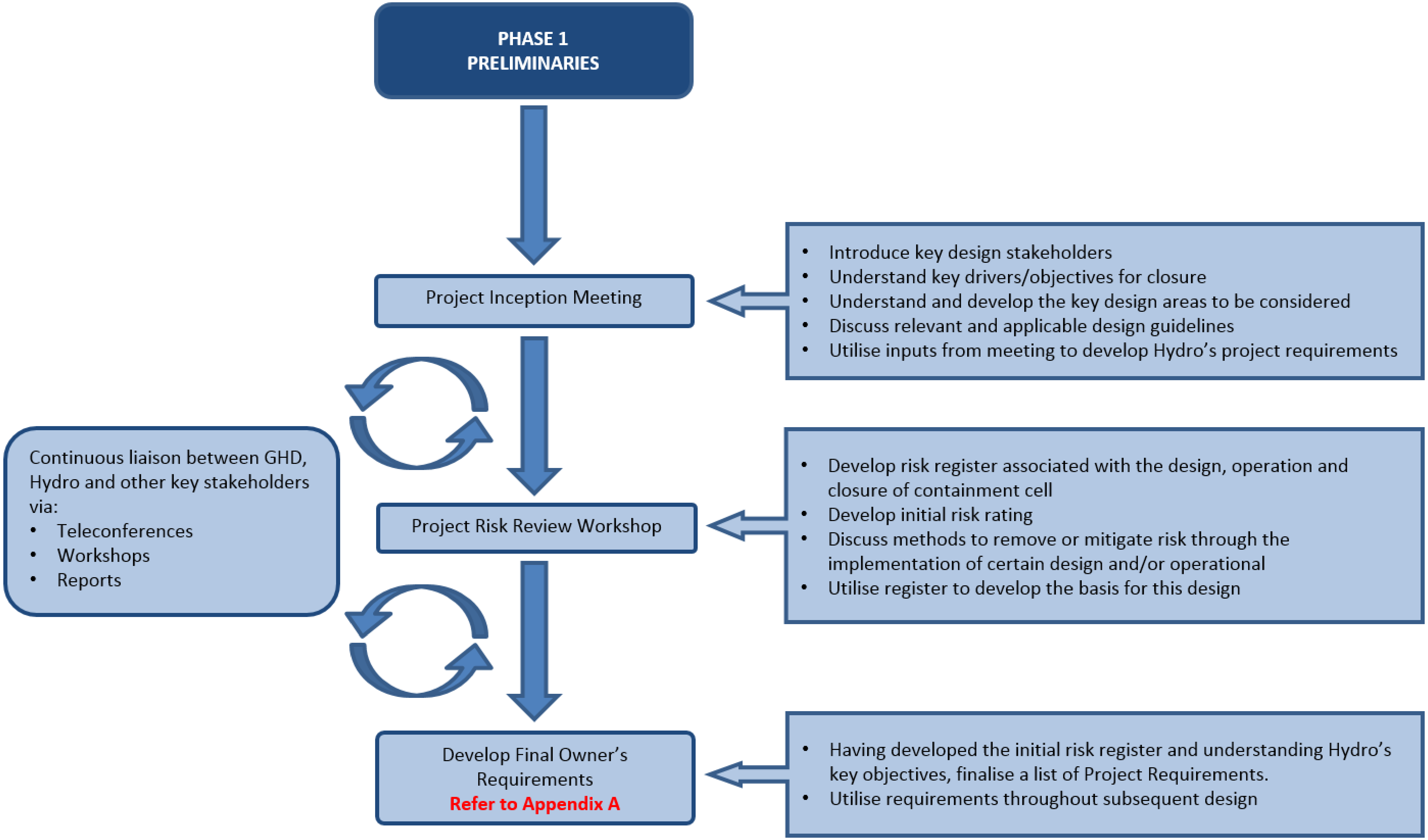

Figure 1 Preliminary works

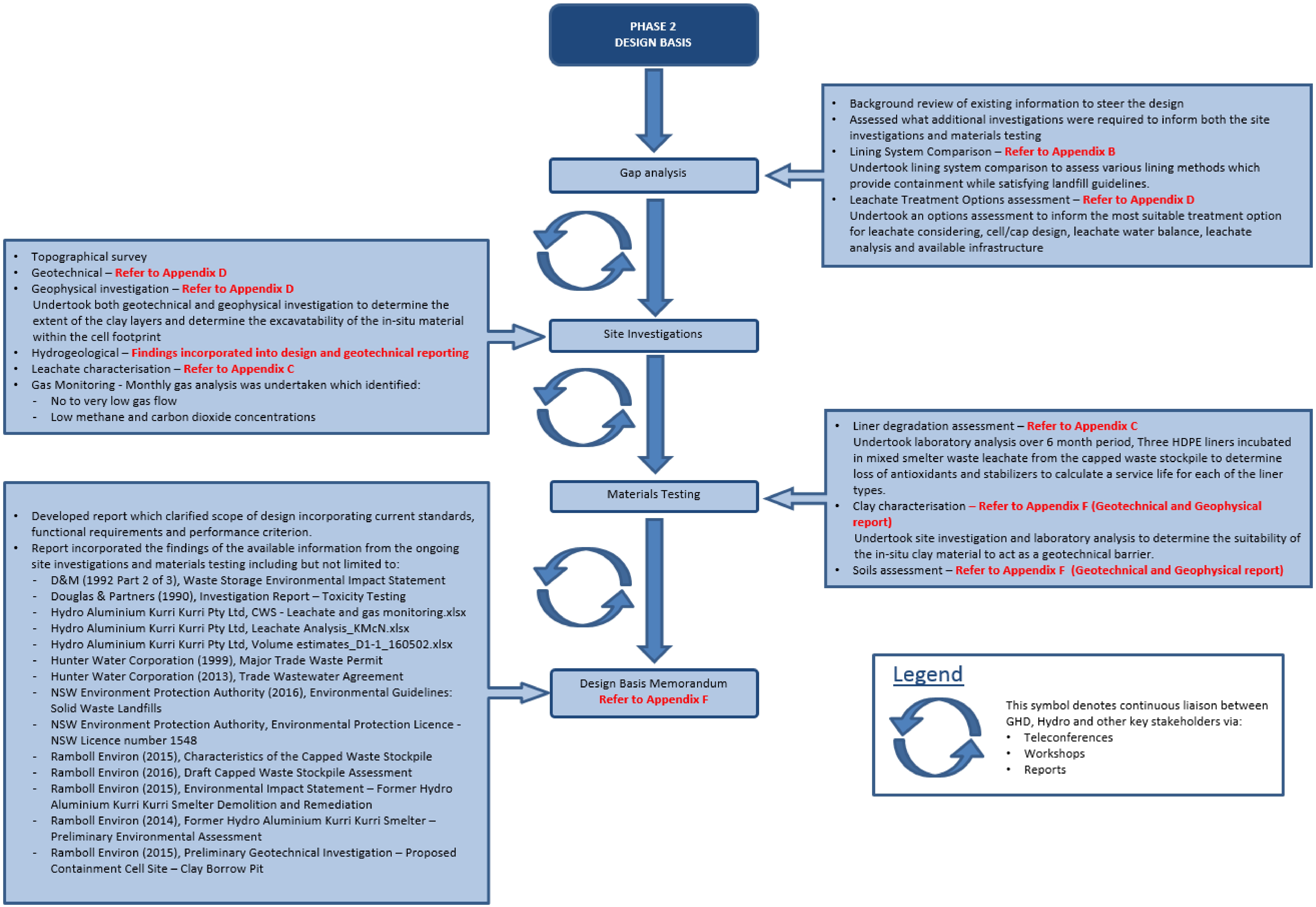

Figure 2 Design basis development

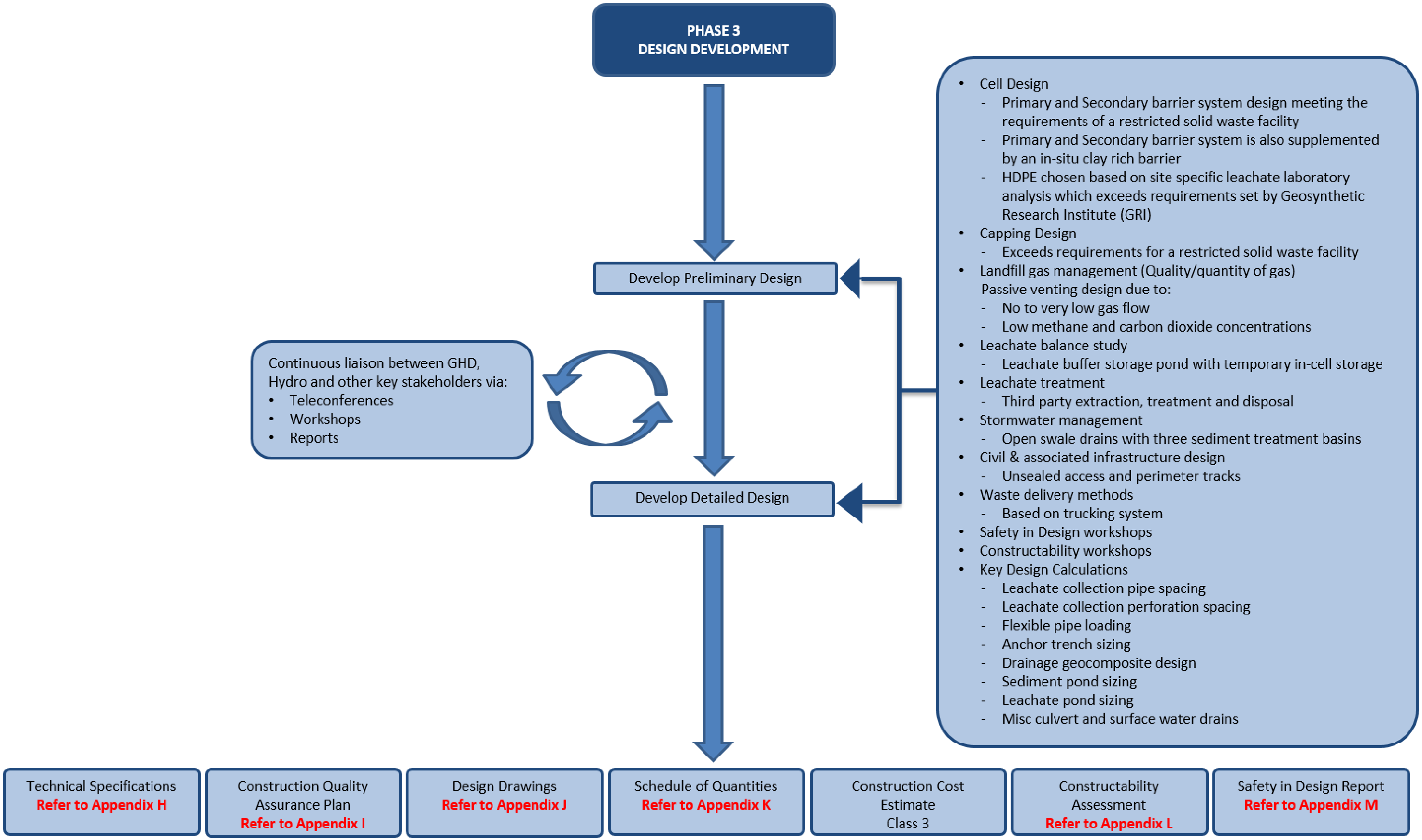

Figure 3 Detailed design development

1.3 Reliance

In preparation of this design report, GHD has referenced the following documents:

- D&M (1992 Part 2 of 3), Waste Storage Environmental Impact Statement.
- Douglas & Partners (1990), Investigation Report – Toxicity Testing.
- GHD Pty Ltd (2016), Design Basis for Containment Cell.
- GHD Pty Ltd (2016), Preliminary design drawings 21-18015-C001-C046-RB.
- GHD Pty Ltd (2016), Supplementary Geotechnical Investigation Factual Report.
- Hydro Aluminium Kurri Kurri Pty Ltd, CWS - Leachate and gas monitoring.xlsx.
- Hydro Aluminium Kurri Kurri Pty Ltd, Leachate Analysis_KMcN.xlsx.
- Hydro Aluminium Kurri Kurri Pty Ltd, Volume estimates_D1-1_160502.xlsx.
- Hunter Water Corporation (1999), Major Trade Waste Permit.
- Hunter Water Corporation (2013), Trade Wastewater Agreement.
- NSW Environment Protection Authority (2016), Environmental Guidelines: Solid Waste Landfills.
- NSW Environment Protection Authority, Environmental Protection Licence - NSW Licence number 1548.
- Ramboll Environ (2015), Characteristics of the Capped Waste Stockpile.
- Ramboll Environ (2016), Draft Capped Waste Stockpile Assessment.
- Ramboll Environ (2015), Environmental Impact Statement – Former Hydro Aluminium Kurri Kurri Smelter Demolition and Remediation.
- Ramboll Environ (2014), Former Hydro Aluminium Kurri Kurri Smelter – Preliminary Environmental Assessment.
- Ramboll Environ (2015), Preliminary Geotechnical Investigation – Proposed Containment Cell Site – Clay Borrow Pit.

GHD has prepared this report based on information provided by others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report, which were caused by errors, or omissions in that information.

1.4 Limitations

This report:

- Has been prepared by GHD for Hydro Aluminium Kurri Kurri Pty Ltd.
- May be used and relied on by Hydro Aluminium Kurri Kurri Pty Ltd.
- May be used by and relied upon by the New South Wales Environment Protection Authority in its capacity as the regulatory authority.
- May be used by and relied upon by the Department of Planning and Environment in its capacity as the consent authority.
- may be copied to relevant consultants carrying out approval works for information purposes.

- Must not be copied to, used by, or relied on (as relevant) by any person other than those listed in 1-4 above without prior written consent of those listed in 1 above.
- May only be used for the purpose specifically detailed in section 1.2 of this report (and must not be used for any other purpose).

GHD otherwise disclaims responsibility to any person other than Hydro Aluminium Kurri Kurri Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

1.5 Definitions

The following definitions are relevant throughout the report.

Site – The entire site owned by Hydro Aluminium at Kurri Kurri.

Containment Cell Site - the site works area, the extent of which is defined within the detailed design drawings.

'ENM' – Excavated natural material. As defined in the NSW EPA excavated natural material exemption 2014 (http://www.epa.nsw.gov.au/resources/waste/rre14-excavated-natural-material.pdf).

'Geosynthetic' – Synthetic material (man-made plastic and fabric) used in geotechnical and construction applications.

'PE' – Polyethylene.

SBS Bitumen mix -- Styrene-butadiene-styrene: a polymer modifier added to improve the mechanical properties of the bitumen.

'VENM' – Virgin excavated natural material. As defined in Schedule 1 of the *Protection of the Environment Operations Act 1997.*

'Waste' – Material identified by the Superintendent to be placed in the containment cell.

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2. Site characteristics

2.1 General

Hydro maintains the former site located on Hart Road, Loxford, NSW. The site covers approximately 80 ha, within approximately 1,940 ha of Hydro owned buffer zone land (herein referred to as ‘Hydro land’).

The large areas in Hydro land that are not used by the site consist of flora in the northwest and south, rural in the northeast, and leased rural residential in the southeast. Hydro land also consists of The Kurri Kurri Speedway and the Kurri Kurri Junior Motorcycle Club, which are located 200 m from site.

Hydro land is located within the Cessnock City Council and Maitland City Council local government areas, and is approximately situated three kilometres north of the Kurri Kurri central business district (CBD), 10 km south of the Maitland CBD and 33 km to the northwest of the Newcastle CBD.

The land uses surrounding the site include industrial, residential, rural and rural residential areas. The industrial areas consist of small to medium businesses in the north of Kurri Kurri to the south of the site. The residential areas are located in south Kurri Kurri, Weston and Heddon Greta south of site and in Gillieston heights and Cliftleigh to the northeast and east of site. Rural and rural residential areas reside to the north, east and west of site. Two educational institutions, the Kurri Kurri TAFE and the Kurri Kurri High School are located approximately 1.5 km and 1.9 km to the southeast of the site respectively.

A private rail line known as the South Maitland Railway travels through the eastern portion of Hydro Land.

2.2 Site access

The site is accessed via Hart Road in Loxford, which is reached via the Hunter Expressway in the southwestern edge of Hydro Land. The Hunter Expressway is a large freeway within the Lower Hunter Region that connects to the Pacific Motorway and Newcastle Link Road in the south and New England Highway in the north.

Another main road of access is John Renshaw Drive, which joins the Hunter Expressway towards the south of site. John Renshaw Drive leads towards the Port of Newcastle and nearby industrial areas.

2.3 History and future use

The site operated as an aluminium smelter from 1969 until September 2012, and shut down formally in May 2014. Hydro has since been assessing the future use of the site, particularly ensuring that a combination of employment, residential and rural conservation areas are included within Hydro land. Hydro aims to remain aligned with the NSW Government *NSW State Plan 2021*, which encourages positive economic, employment and environmental activity.

2.4 Climate

A meteorological tower has been operating at the site from 1996 in order to provide information concerning the climate of the area. Information was collected from 10 m and 30 m above ground level (AGL). These measurements were analysed from January 2010 recordings to December 2014.

2.4.1 Temperature

Temperature records from 1968 to date were acquired from the Bureau of Meteorology (BoM) Automatic Weather Station (AWS) 061242 located at Cessnock Airport approximately 12 km west of site. The data showed that the average monthly temperatures for the area are from 4 °C to 17 °C and the average maximum monthly temperature between 17 °C to 30 °C. The highest temperatures occur during the months of November and February, while the lowest temperatures occur during June and August.

2.4.2 Rainfall

Rainfall data was acquired from both BoM at AWS 061242 and the meteorological tower at the site. The data was analogous and showed that the area receives average yearly precipitation of 730 mm, with an average range of 460 mm to 1040 mm. The majority of the rainfall occurred between November and March and the area received a yearly average of 112 days of rain.

2.4.3 Evaporation

Information from the BoM AWS 061242 informed that the site experienced an annual evaporation mean of 1350 mm. The majority of this occurred during the summer months.

2.4.4 Wind

Wind records from the meteorological tower on site were taken at 10 m AGL and at 30 m AGL. The records informed that wind speeds were higher at 30 metres AGL and calm winds of 0.5 m/s occurred more frequently at 10 m AGL. Largest wind speeds travelled from west to north at both levels.

The 10 m AGL readings informed that the main yearly wind flow was south easterly with some southwest and northwest components. The yearly mean speed is 1.5 m/s.

The 30 m AGL readings informed that the main yearly wind was a more balanced circulation from east to southwest. The yearly mean speed is 2.7 m/s.

2.5 Topography

The terrain in this area is predominantly flat sloping mildly from south to north and west to east.

The future Containment Cell site is proposed for a location in the western portion of the site, within the Clay Borrow Pit at an elevation of 25 m AHD, which increases in elevation towards the west.

The site is surrounded by low hills, consisting of residential housing, in the west and low lying swampy land in the north and east. Fill was added to raise the low-lying areas to approximately 16 m AHD to create a balanced foundation for the creation of the Smelter.

2.6 Hydrology

The site is located within the Hunter River catchment. The Hunter River flows to the north of the site in a southeasterly direction and ultimately enters the Pacific Ocean in Newcastle south-east of the site.

The site is further surrounded by Swamp Creek to the south and east and Black Waterholes Creek to the north west of site. Both creeks belong to the Wentworth Swamps. Swamp Creek is located approximately 180 m to the east of the southeast corner of site. Black Waterholes Creek is located 280 m to the Northwest. Swamp Creek and Black Waterholes Creek flow in a northerly direction, ultimately connecting to Hunter River, see Figure 4.

An unnamed tributary to Black Waterholes Creek is within the containment cell site, see Figure 4 below.

Figure 4 Existing watercourses around site

2.6.1 Flooding

The site is located above the 1% Annual Exceedance Probability (AEP) flood level.

2.7 Geology and soils

2.7.1 Regional geology

The site is located within the Sydney Basin. The Sydney Basin begins at Newcastle in the north and ends in Batemans Bay in the south. The length of the basin extends to Lithgow in the west.

The Sydney Basin Geological Sheet informs that the site is located within an area of siltstone, marl and minor sandstone from the Permian aged Rutherford Formation (Dalwood Group) in the Sydney Basin. The basin consists primarily of sedimentary rock known as Permian and Triassic rocks. These involve closely horizontal layers of sandstones and shales with a number of igneous dykes. Minor folding and faulting of the rocks allowed the Great Dividing Range to develop in the west. Beneath the sedimentary rocks lies the Lachlan Fold belt consisting of older basement rock. Below the Lachlan Ford Belt lie the Greta Coal Measures and Newcastle Coal Measures, and then the Dalwood Group situated in a marine environment.

Reference to the relevant soils maps and data shows that the site is located within the Neath soil landscape located on gently undulating rises and swamps of the Permian siltstone, sandstone and coal units with local relief up to 30 m and slopes up to 3%. Surface soils shown to be are solodic, with a strong textural contrast between the A (topsoil) and strongly acid B (subsoil) horizons. At least one of the subsoil horizons (B2) within the soil landscape has been shown to be sodic (i.e. dispersive).

2.7.2 Soils

The soils surrounding the containment cell site consist of quaternary sediment, to the east, and complex interbedded fluvial and marine sands and estuarine muds to the west. The former sediment comes from Swamp Creek and the latter from Wentworth Swamps and the Hunter River, having been deposited during period of sea level rise and fall. There are no known occurrences of acid sulfate soils at the site.

A geotechnical investigation by GHD at the site showed the general subsurface profile of an upper layer of residual clay soil, overlying weathered siltstone bedrock. At some locations the residual clay was overlain by fill or topsoil material.

The geotechnical investigation by GHD at the site is contained in Appendix D. The following extract is taken from Supplementary Geotechnical Investigation Factual Report (GHD Pty Ltd 2016):

The more pertinent aspects of general occurrences of these strata are summarised as follows

Topsoil - *comprising sandy clay with some roots, encountered in boreholes BH01 and BH03 only and extending to depths of 0.15 m and 0.3 m respectively.*

Fill - *identified in BH02 only to a depth of 0.4 m, comprising clayey sand.*

Residual Clay - *comprising an upper layer of red-brown and orange brown medium to high plasticity clay, encountered from the surface or underlying the fill or topsoil strata to depths ranging from 0.4 m to 2.4 m; underlain by pale grey medium to high plasticity clay layer.*

Bedrock - *encountered underlying the predominantly medium plasticity residual clay layer, at depths ranging from 3.7 m to 7 m and comprising extremely to highly weathered, very low to low strength siltstone. A 1.5 m thick bed of extremely to completely weathered, very low to low strength sandstone layer was encountered above the siltstone bedrock in BH01.*

The following extract is taken from Preliminary Geotechnical Investigation – Proposed Containment Cell Site – Clay Borrow Pit (Ramboll Environ, 2015):

The following generalised soil profile was encountered across the clay borrow pit (CPB) site (as observed within the boreholes and test pits):

A veneer of topsoil and/or slope wash/colluvial soils comprising silty sands/sandy silts with some gravel (and in one case, clayey sand fill), was encountered, overlying a profile of weathered in-place siltstone/shale/sandstone as residual, sandy silty clays, and gravelly clays becoming extremely weathered rock. The clays had low to medium plasticity, with occasional higher plasticity and were generally very stiff to hard.

In general, the rock comprised massively-bedded sandstones, or more thinly bedded siltstones, down to laminated shales. The rock profiles exposed in the cored sections were generally tight, with few defects visible.

2.8 Hydrogeology

2.8.1 Containment cell site

Groundwater ranges between 1 m and 5 m below ground surface (bgs) in the estuarine sands in the eastern portion of the site. At the containment cell site, the groundwater occurs within the residual clay at RL 16.1 to RL 18.2 m AHD. The shallow groundwater travels north and northeast towards the Wentworth Swamps.

2.8.2 Capped waste stockpile

Testing showed fluoride leachate, from the smelting works, within the groundwater. Fluoride was found at concentrations ranging from 0.22 mg/L to 43 mg/L.

Leachate from the Capped Waste Stockpile has also affected the shallow groundwater (0.3 m to 2.5 m bgs). The leachate plume is 350 m in lengths and travels approximately 350 m northeast of the eastern corner of the Capped Waste Stockpile. The depth of the leachate is limited by the low permeability of the high plasticity clays situated beneath the coarse-grained sands. Increased concentrations of fluoride, cyanide and sodium exist within the leachate plume at pH>9. The water affected is identified as an unsuitable water source due to its impermanent nature, having insufficient yield, and being within unconsolidated estuarine deposits.

Actions to decrease the effect of the waste stockpile on groundwater included the capping of the stockpile in 1995 and the introduction of two interception trenches to capture and direct leachate to ultimately discharge to the North Dam. Ongoing monitoring showed that the capping and the trenches improved groundwater quality significantly.

Fate and transport modelling was conducted on the leachate plume to predict its effect on the nearby Swamp Creek. The modelling was a conservative representation of worst-case scenario and concluded that fluoride would reach the creek at concentration of 5 mg/L. The modelling however considered the plume as an infinite source, which is not a representation of the leachate mitigation once the stockpile is moved and leachate is treated.

2.9 Air emissions

Potential air emission sources in the area include vehicle emissions from the nearby rail lines and Hunter Expressway, and coal mining emissions from the Bloomfield Open Cut, Donaldson Open Cut, Abel Underground and Tasman Underground mines. The mines are situated approximately 7 to 12 kilometres east to southeast of site.

2.10 Flora and fauna

Ten threatened fauna species, six listed migratory fauna species and two threatened flora species have been identified within Hydro land. No species have been identified within the proposed location of the Containment Cell. Refer to Environmental Impact Statement, October 2005, Ramboll Environ (Ref AS130401) for further details.

2.11 Indigenous heritage

An Aboriginal Cultural Heritage Assessment conducted with the support of Aboriginal stakeholders revealed an Aboriginal stone artefact and potential archaeological deposit in the northern section of the site. If required, Hydro proposes to salvage and relocate the artefact in consultation with Aboriginal stakeholders. The area of potential archaeological importance is to be avoided during ongoing works, and any stockpiles within the area will need to be placed on a geo-matting surface.

No areas of indigenous importance were identified within the proposed location of the Containment Cell. Refer to Environmental Impact Statement, October 2005, Ramboll Environ (Ref AS130401) for further details.

3. Basis of design

3.1 General

This section this outlines the design criteria which was used for the detailed design.

3.2 Works

The proposed works for the detailed design of the future containment cell include:

- The leachate barrier system
- The excavation and preparation of subgrade
- The groundwater and surface water management systems
- The sidewall liner system
- Leachate extraction and collection system
- Final cap

3.3 Regulatory requirements

3.3.1 Environmental Planning Instruments

The Project has been identified as a State Significant Development. Schedule 1 of the S&RD SEPP, accompanying the ‘waste and resource management facility’, further identifies the development as:

- *“(5) Development for the purpose of hazardous waste facilities that transfer, store or dispose of solid or liquid waste classified in the Australian Dangerous Goods Code or medical, cytotoxic or quarantine waste that handles more than 1,000 tonnes per year of waste.”*

The Australian Dangerous Goods Code (‘Australian Code for the Transport of Dangerous Goods by Road & Rail’, Seventh Edition prepared by the National Transport Commission, 2011) recognises ‘Aluminium smelting by product’ to be currently located within the Capped Waste Stockpile, which will be relocated to the proposed Containment Cell. ‘Aluminium smelting by product’ is identified to include *‘aluminium dross, aluminium skimmings, spent cathodes, spent pot lining, and aluminium salt slags.’*

Cessnock Local Environmental Plan 2011

During the operation of the Smelter, the site was categorised as ‘RU2 Rural Landscape’ under Cessnock Local Environmental Plan 2011(the LEP). The primary objective of RU2 Rural Landscape is for the protection of rural land and activities, and is not aligned with the previous manufacturing processes of the Smelter. The operation of the site was permitted under existing use rights under the EP&A Act.

Development of a waste disposal facility can be approved with consent within the RU2 Rural Landscape zone. The operations of the proposed Containment Cell do not align with the objectives of the RU2 Rural Landscape zone, however they are consistent with the previously approved industrial activities under existing use rights and developments consents granted under the EP&A Act.

Hydro has applied to change the current zone of Hydro land to IN1 General Industrial for the Smelter Site and IN3 Heavy Industrial for the proposed Containment Cell under the Cessnock City Council. A Gateway Determination by the NSW Department of Planning and Environment (DPE) has been received by Hydro. The primary objective of the IN1 General Industrial Zone is for the protection and encouragement of sustainable industrial development, and the primary objective of the IN3 Heavy Industrial zone is for the provision of appropriate area for industries that require separation from other land uses.

The proposed Containment Cell will be within the IN3 Heavy Industrial zone and the demolition and remediation of the site will be within the IN1 General Industrial zone and the IN3 Heavy Industrial zone.

3.3.2 Other Environmental Planning Instruments

Under the State Environmental Planning Policy No 33—Hazardous and Offensive Development (SEPP 33), a preliminary hazard analysis has been prepared for approval. A preliminary hazard analysis is required for developments with potential for hazardous work and materials.

Protection of the Environment Operations Act 1997

Under the Protection of the Environment Operations Act 1997 (POEO Act), Hydro is required to acquire an Environmental Protection Licence (EPL) to allow for works, which are labelled scheduled activities in Schedule 1 of the POEO Act to proceed.

The site is regulated by the EPL 1548, which allows Hydro to store hazardous, restricted solid, liquid, clinical and related waste materials, asbestos, and other wastes.

The application of the proposed Containment Cell may require scheduled activities, which are not included in the EPL 1548. Once approved, an application to update Hydro’s EPL will be submitted the EPA to update the scheduled activities. These scheduled activities may include: contaminated soil treatment (for the removal of the Capped Waste Stockpile and the remediation of affected soils), and chemical storage (for the storage of chemicals within the proposed Containment Cell.

Protection of the Environment Operations (Waste) Regulation 2014

Under Clause 98 of the Protection of the Environment Operations (Waste) Regulation 2014 (POEO Regulation), an immobilised contaminants approval is required from the EPA for the reclassification of waste to allow its displacement in the proposed Containment Cell. This allows the EPA to place other restrictions on the waste according to its chemical properties.

Hydro is submitting an application for an immobilised contaminants approval.

Environmentally Hazardous Chemical Act 1985

The EPA issues a Chemical Control Order for hazardous chemical wastes, which have been identified as per the Environmentally Hazardous Chemical Act 1985 (EHC Act). A Chemical Control Order has been delivered for the management of aluminium smelter waste, which contains fluoride and/or cyanide.

The Chemical Control Order requires a number of actions to be undertaken by Hydro. These include:

- The control and security of aluminium smelter wastes on site, including the prohibition of the spreading of leachate, the security of a holding facility, and the prohibition of unauthorised access.
- Aluminium smelter waste that does not contain leachable fluoride or leachable cyanide and is in accordance with the POEO Act can be disposed.

- Waste can be conveyed for the reduction of leachable fluoride and leachable cyanide levels if EPA approval is given.
- Waste can be processed for the purpose of researching environmentally acceptable methods of fluoride and/or cyanide leachate reduction and for the reduction of fluoride and/or cyanide leaching.

License Number 05, under the EHC Act, is currently applied to the aluminium smelter waste at the site. This includes relocation to an approved receiving facility. The spent pot lining and all other waste materials located within the Capped Waste Stockpile is to be contained within the proposed Containment Cell, categorised as approved aluminium smelter waste. The proposed Containment Cell will address the immobilisation of the leachable fluoride and cyanide.

3.4 Existing services and site infrastructure

3.4.1 Electricity

The electricity infrastructure on site includes overhead power lines situated in the north, west, southwest and northwest portions of the site.

3.4.2 Water supply

The water supply for the site is sourced from the Hunter Water Corporation. The works within the site will rely on this source as long as is feasible. Additional sources are planned to support the works, including water from the North Dam, which is presently used for irrigation purposes.

3.4.3 Infrastructure

The site consists of electricity, telecommunications, water, sewer and gas services infrastructure, most of which is terminated. Hydro has created a program that focuses on the disconnection of these services, ensuring the security of works, decreasing negative environmental impacts, and enhancing efficiency.

3.5 Site access and internal traffic requirements

The following extract is taken from, Former Hydro Aluminium Kurri Kurri Smelter – Preliminary Environmental Assessment (Ramboll Environ, 2014):

The Project site would continue to be accessed via Hart Road. Vehicles would use the following routes:

- *Vehicles travelling to the south would travel on the Hunter Expressway via the Hart Road exit.*
- *Vehicles travelling to Maitland and surrounds would travel on the Hunter Expressway via the Hart Road interchange before exiting at the Main Road interchange and continuing on Main Road/Cessnock Road.*
- *Vehicles travelling to the northwest would use the same route to the Main Road interchange, before using it as a roundabout and continuing northwest on the Hunter Expressway.*
- *Vehicles transporting municipal waste to the Cessnock Waste and Reuse Centre would travel along Sawyers Gully Road and then Old Maitland Road.*

As such, project vehicles would avoid residential areas. Project vehicles would include personal vehicles of Works personnel, trucks for the delivery and removal of construction machinery and works compound components, removal of recyclable and reusable materials, transport of municipal wastes and delivery of materials.

Access and haul roads would be built within the Project site to connect the Smelter with the Containment Cell and ancillary facilities. These roads would be constructed of suitable materials sourced from within the Hydro land, generated during demolition activities or potentially transported from licensed facilities.

At the completion of the Works, the access road to the Containment Cell would be graded to be used for the operational phase. An access track would be maintained around the perimeter of the Containment Cell.

3.6 Waste volumes

An analysis of the waste data provided by Hydro:

- Hydro Aluminium Kurri Kurri Pty Ltd, Volume estimates_D1-1_160502.xls
- Ramboll Environ (2016), Capped Waste Stockpile Assessment

The review included:

- Reviewing and updating the assumed waste densities where relevant
- Addition of an additional contingency volume of 10%
- Review and updating the CWS volume based on survey information
- 2 m depth of contaminated soil beneath the CWS based on the bore logs included Ramboll Environ assessment

Based on the review, GHD will allow for a required landfill airspace of 345,000 m^3 (rounding up to the nearest 1,000 m^3) and an in place density in the cell of 1.6 t/m^3 (refer Table 1).

Table 1 Waste Volumes

Waste type	m^3	tonnes
Capped Waste Stockpile	183,491	326,816
Process Wastes	26,330	27,050
Smelter Contaminated Soils	34,328	58,492
Hydro Land Contaminated Soils:		
Dickson Road Landfill	14,150	21,225
Former Municipal Landfill	8,400	16,800
Asbestos Contaminated Soils	6,700	13,400
Stockpiled Hydro Land Soils	6,622	12,611
Kline Street Wastes and Soils	3,074	6,149
Non-Recyclable Demolition and Smelter Wastes		
Non-Leachable/Non-Hazardous	21,000	14,000
Leachable/Hazardous	9,000	6,000
TOTAL	**313,096**	**502,543**
Contingency	**10%**	**50,254**
TOTAL (incl. contingency)	**345,000**	**553,000**

3.7 Opportunities

- An area exists adjacent to the creek to allow for a laydown area and stockpiling
- A suitably sized un-vegetated area exists on site for placement of the containment cell
- The slope of the site allows for natural grades to ponds
- Material (both excavated and recovered) may be used in the design
- Recycled aggregate can be sourced as part of demolition works
- Existing site surface requires minor grading to construct perimeter road and drainage slopes
- A creek is located downstream for disposal of clean surface waters

3.8 Constraints

- Dense vegetation limits the footprint of the containment cell.
- Groundwater has been recorded in sub-strata.
- An electrical easement runs through the proposed works area running northeast and north.
- Existing stockpiles will need to be removed as part of the site works.
- The containment cell needs to be located above the 1% Annual Exceedance Probability (AEP) flood level and be more than 100 metres from a watercourse.
- The containment cell needs to be located more than 500 metres from the nearest residence, within 500 metres of the Smelter and on the northern side of the Hunter Expressway.

3.9 Amenities requirements

The proposed Containment Cell has a proposed height, which will enable its visibility. Hence, the flora, which will be used on the cap of the proposed Containment Cell should complement the existing nearby native vegetation. A vegetation cover will also aid in offsetting the carbon footprint and reducing long-term maintenance.

4. Detailed design development

4.1 Introduction

The Containment Cell is a key element of the project as it is to be used for long-term storage of varied wastes.

They need to fulfil a number of requirements that have been developed specifically for the project, including minimising rainwater and surface water from entering the cells during filling operations, closure or post closure, and minimising cell aftercare and post closure maintenance requirements.

The Containment Cell has been designed to prevent the impact on the surrounding by:

- Minimising the clearing of existing vegetation
- Putting in place management structures to minimise contamination of adjacent lands and water bodies and underlying aquifers
- Surrounding the containment cell with perimeter bunding to minimise ingress of floodwaters
- Optimising the cap design to keep a low visual impact and vegetating with flora to minimise maintenance and provide additional screening.

The cell has been designed to allow progressive capping and closure as well as environmental monitoring and maintenance.

4.2 Design approach

The design was developed by adopting a risk based approach in accordance with the standards for design, operation and rehabilitation for landfill facilities in New South Wales, and addressing additional risk areas, by utilising Australian and International regulations and best practice where applicable.

The approach to environmental management has been hierarchically categorised as follows:

- Preventative measures - aim to eliminate or reduce an environmental aspect that is likely to cause a negative impact if released to the environment.
- Mitigation measures - aim to pre-emptively minimise the negative impact caused by the environmental aspect released to the environment.
- Rectification measures - aim to retrospectively control the negative impact caused by the environmental aspect released to the environment.

This approach will minimise the risks associated with the operation of the containment cells, support the defined containment cell management strategies and enable the necessary environmental approvals to be obtained.

4.3 Key assumptions and references

This section outlines the key assumptions, risks, findings and references identified for the design of the containment cells.

4.3.1 Key criteria

Key references to establish the criteria for the design include:

- Key outcomes are summarised in the Design basis report contained in Appendix F.

- Failure mechanisms and liner system comparison identified and documented throughout the project are detailed in the Liner system comparison report (GHD-2218015-1987) contained in Appendix B
- Findings from geosynthetics testing are described in the Degradation Testing of HDPE Liners (ExcelPlas #5644 – dated 8 January 2016) contained in Appendix H.

In addition, Table 2 provides a summary of key parameters adopted for the containment cell.

Table 2 Summary of key parameters

Key Design Parameter	Containment cell
Design life	Operation – 2 yrs Post closure – 98 yrs Total – 100 years
Number of stages	4
Capacity requirement	~345,000 m^3
Total excavation	~100,000 m^3
Location of storage capacity	Predominately above ground storage
Intermediate waste batter slopes	1 in 2
Internal batter slopes	1 in 4
External batter slopes	1 in 4 (maximum slope) 1 in 20 (minimum slope to crest)
Nominal cell depth (below ground level)	Bottom of Waste Design Subgrade ~5 m
Nominal cap height (above ground level)	Top of waste ~ 13 m Top of cap ~ 15 m
Access	Via lined access ramp incorporated into design. 1 in 10 (maximum slope)
Leachate extraction	Leachate extraction by pump from two sumps located in the east of the containment
Gas collection system	Passive collection and venting system
Density of in-place materials	1.6 t/m^3 (typical)

4.4 Design drawings

This report should be real in conjunction with the design drawings. Refer to Appendix J.

4.5 Design description

Consistent with the design approach (refer Section 4.2) a multi-layered soil/geosynthetic basal barrier and final capping system was developed for the containment cell to provide for safe, long-term disposal.

The basal barrier system profile consists of a primary and secondary lining system including a leak detection system as well as a groundwater diversion system (refer section 0).

The final capping system consists of a multi-layered soil/geosynthetic cap including a sub-surface drainage system (refer section 4.7).

4.5.1 Project risks, failure mechanisms and safety in design

Various risks and issues for the design, construction, operation, filling and closure of the containment cell has been identified and documented in the following associated documents:

- A failure mechanism assessment for the containment cell has been compiled in the Liner Comparison Report. Risks identified have been addressed by the design.
- A project specific Safety in Design register for the containment cell has been compiled and updated as the project progresses and is contained in Appendix M.

4.5.2 Capacity requirement

The capacity requirement of the containment cells has been calculated based on analysis of the waste data provided by Hydro:

- Hydro Aluminium Kurri Kurri Pty Ltd, Volume estimates_D1-1_160502.xls
- Ramboll Environ (2016), Draft Capped Waste Stockpile Assessment

Based on the review, the containment cell provides landfill airspace of 345,000 m^3 (rounding up to the nearest 1,000 m^3) and an in place density in the cell of 1.6 t/m^3 (refer Table 1).

4.5.3 Cell dimensions

A comprehensive process has been undertaken to optimise the containment cell size and dimensions, including slopes of the batters to investigate the implications on cost, constructability and safety.

The dimensions of the containment cell have been designed in accordance with the following:

- Perimeter bund of 3 m height with a crest width of 3 m (including barrier system).
- All internal batter grades 1(V) in 4(H).
- Basal liner grades:
  - 3% transverse cross-fall
  - 1% longitudinal cross-fall
- All external grades:
  - 1 in 4 (maximum) to minimise erosion
  - 1 in 20 (minimum) to minimise pooling, promote surface water runoff and allow access for maintenance
- Overall footprint minimised (as practicable) to reduce the environmental footprint (minimise clearing, water infiltration etc.).
- Maximise ease of excavation and beneficial reuse of all excavated material based on geotechnical and soil investigations (refer to *Containment Cell Detailed Design and Associated Services – Supplementary Geotechnical Investigation Factual Report* – GHD 22-18015 dated 03.05.2016).
- A final landform that minimises pooling, promotes surface water runoff, provides access for maintenance and is aesthetically sympathetic to the surrounding lands.

4.6 Barrier system design

4.6.1 Leachate containment and collection

A multi-barrier system has been developed, to provide safe, long-term containment of the waste consisting of (from top to bottom) the following systems:

- Primary leachate collection and extraction system
- Primary liner protection system to minimise damage and/or degradation to ALARP
- Primary liner system
- Primary leak detection and extraction system
- Secondary liner system
- Groundwater diversion system (including extraction system)

The containment system design follows the guides as set out below with an enhanced subgrade of clay rich fill. Subsequent sections will detail the primary and secondary components. Refer to Figure 5 and Figure 6.

> *“Restricted solid waste landfills*
>
> *For restricted solid waste cells, the design of the leachate barrier system should be a dual barrier system addressing the following requirements:*
>
> *☐ The leachate barrier system should consist of a primary barrier and a secondary barrier. The secondary barrier is installed below or outside the primary barrier. Its purpose is to detect and remove any leakage through the primary barrier.*
>
> *☐ The primary barrier should contain a composite liner, comprising a lower geosynthetic clay liner and an upper geomembrane liner. The primary leachate collection layer above the liner should be a 300-millimetre-thick gravel layer containing collection pipework. Protection and separation geotextiles should be installed as for the design for general solid waste landfills. A geonet drainage geocomposite may be used as an alternative to the gravel drainage layer for wall drainage.*
>
> *☐ The secondary barrier should contain either a single compacted clay liner 1000 millimetres thick with a saturated hydraulic conductivity less than 1 x 10–9 metres/second, or a composite geomembrane/geosynthetic clay liner. The secondary leachate collection layer should be a gravel drainage layer or a drainage geocomposite with a minimum hydraulic transmissivity of 0.3 x 10–3 square metres/second.*
>
> *☐ The leakage rate through the dual barrier system should be less than 1 litre/hectare/day of leachate for a maximum level of leachate of 300 millimetres over the upper liner.*
>
> *☐ Material properties and specifications should be as for general solid waste landfills. In the case of restricted solid waste leachate barriers, materials should be used that will not be compromised by chemicals in the leachate.*
>
> *☐ Restricted solid waste cells should have a base gradient of greater than 2% in the longitudinal direction and greater than 3% in transverse directions.*
>
> *☐ Restricted solid waste cells should be wholly above the highest historically recorded groundwater table at all times. Alternatively, the cell can be sited partly or wholly above ground.”*

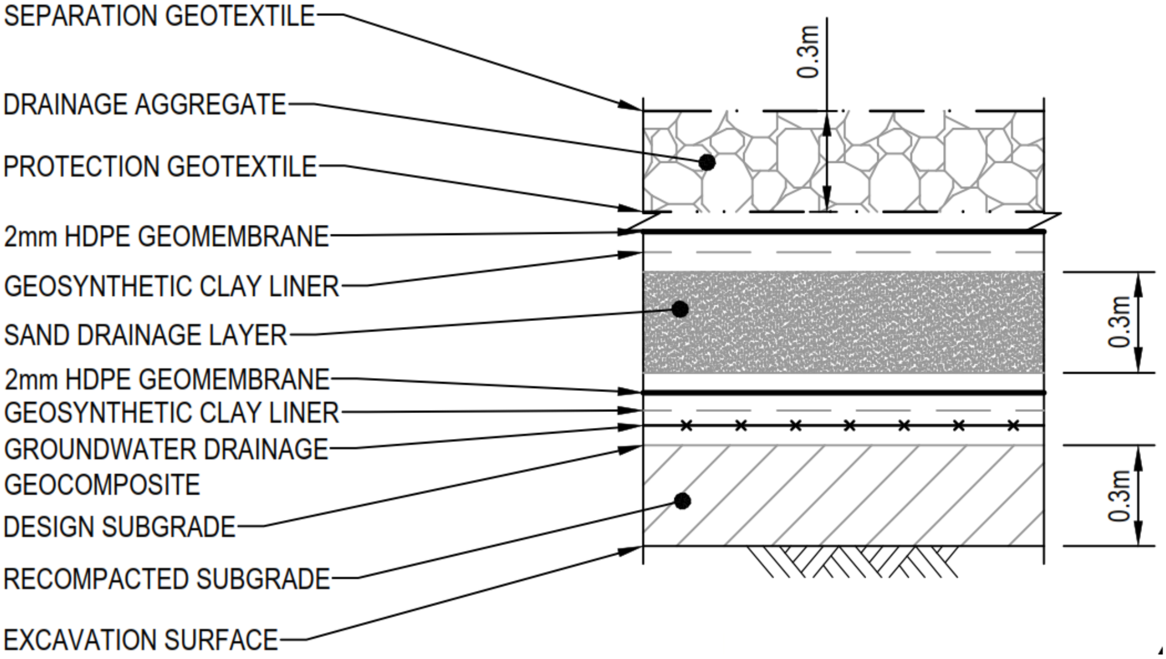

Figure 5 Leachate containment and collection system (base)

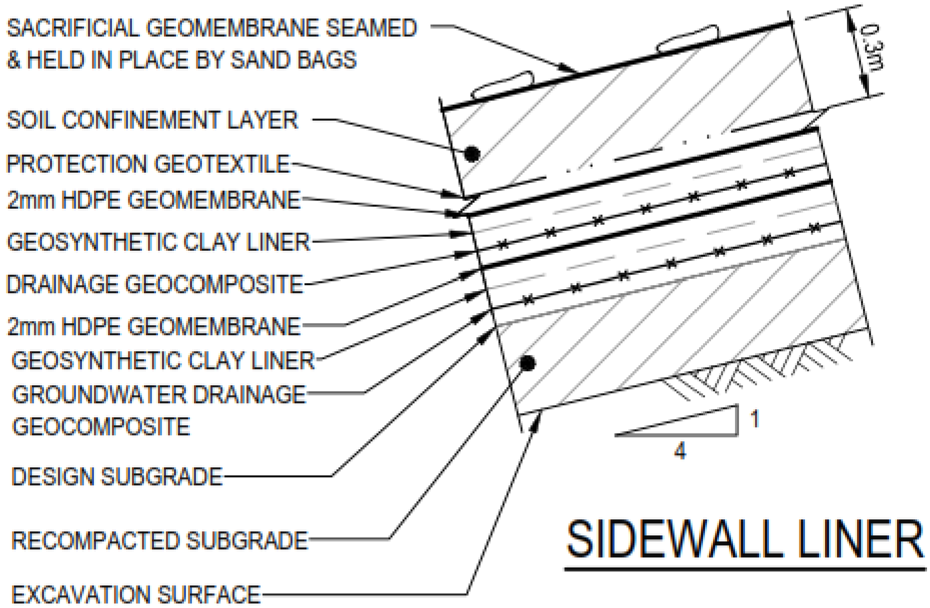

Figure 6 Leachate containment and collection system (sidewall)

4.6.2 Primary leachate collection system

The design intent of the primary leachate collection system is to provide a mechanism for collecting and conveying leachate generated from the waste to the leachate sumps for extraction. The timely extraction of leachate removes the leachate hydraulic head (the driver for possible leakage) from the barrier system, thereby reducing the risk of leakage to as low as reasonably possible (ALARP). The primary leachate collection system consists of:

Separation geotextile (base only)

A non-woven needle punched separation geotextile is included over the full extent of the drainage aggregate (refer below) in order to provide separation between the waste material and drainage layer. The separation geotextile will be manufactured from polypropylene.

Drainage aggregate and associated pipework (base only)

Drainage aggregate is included over the full extent of the base. The drainage aggregate has been specified such that a durable, natural, chemically resistant aggregate will be selected. In addition to the drainage aggregate, perforated leachate collection pipework is included to allow collection of generated leachate and to minimise any hydraulic head over the primary lining system.

Sacrificial geomembrane (sidewall only)

A sacrificial geomembrane is included over the full extent of the soil confinement layer (refer below) in order to provide protection against weathering (i.e. wind, rain, ultraviolet light), minimise leachate generation and provide a medium to transfer surface water directly to the sump for collection. The sacrificial geomembrane will be progressively rolled back so the waste can be directly placed against the soil confinement layer and then the sacrificial membrane placed back over the waste and keyed into the cover system. The sacrificial geomembrane will be manufactured from HDPE in accordance with GM13.

Extraction system

The extraction system consists of:

- Perforated leachate collection pipework to allow collection of leachate percolating into the drainage aggregate layer.
- A 2 m deep collection sump located in the lowest point of each eastern sub-cell, backfilled with drainage aggregate. The sump has base dimensions of 10 m x 10 m.
- Two pipe extraction risers (perforated in the base of the sump, solid against the sidewall). These risers will contain the extraction pumps to remove the leachate and transfer to the leachate rising main. The risers also provide clean-out capability should any clogging occur in the sump.

To allow post-closure access to the risers, the sumps will be located adjacent to the eastern perimeter of the containment cell.

4.6.3 Primary barrier system

The design intent of the primary barrier system is to provide for containment of the waste and any leachate generated for 100 years as well as to minimise seepage into the ground to ALARP. The primary barrier system will extend over the full extent of the containment cell and will be continuous throughout each sub-cell. The primary barrier system will be anchored at the top of the cell batters in a trench sized to consider the interface properties of the different materials. The primary barrier system will be connected to the final cap system when the final cap is installed to provide full containment. The primary barrier system consists of:

- A 2 mm HDPE geomembrane liner (product type based on the results of durability, interface transmissivity (with the chosen geosynthetic clay liner (GCL) and interface shear testing with adjacent geosynthetics.
- A GCL (Product type based on the results of interface transmissivity (with the chosen geomembrane, and interface shear testing with adjacent geosynthetics).

To minimise degradation of the primary barrier system to ALARP, a protection layer has been included which consists of:

- A non-woven needle punched protection geotextile is included over the full extent of the primary barrier system in order to provide protection to the primary barrier system during placement of the soil confining layer as well as long-term overburden pressure during filling and post-closure. The detailed design of the protection geotextile will be based on compression testing. Based on the results of the testing, appropriate reduction factors for creep, installation damage and overall factor of safety will be applied. The protection geotextile will be manufactured from polypropylene
- A 300 mm soil confining layer is included as part of the primary liner system below the sacrificial geomembrane. The confining layer will form a protective barrier, which will improve the service-life of the primary barrier system by providing protection from weathering and damage during operations. This will slow antioxidant depletion, reducing the exposure to the waste material.

4.6.4 Leak detection system

The leak detection system for the containment cell consists of:

- Sand drainage layer: the leak detection system consists of a coarse sand layer over the full extent of the base, to collect any seepage through the primary barrier system. Any seepage into the system will flow to one of the two extraction sumps located in the low point of the eastern perimeter of the cell.
- Drainage geocomposite: the leak detection system on the sidewalls consists of a drainage geocomposite, which will collect any seepage through the primary barrier system on the sidewall. Any collected seepage through the sidewall barrier system will be conveyed through the drainage geocomposite to the sand drainage layer at the base of the containment cell.

Any leakages through the primary barrier system will be conveyed into an extraction system consisting of:

- A 2 m deep collection sump located in the lowest point of each eastern sub-cell, backfilled with drainage aggregate. The sump has base dimensions of 5 m x 10 m.
- Two pipe extraction risers (perforated in the base of the sump, solid against the sidewall). These risers will contain the extraction pumps to remove any leakages and transfer to the leachate rising main. The risers also provide clean-out capability should any clogging occur in the sump.

To allow post-closure access to the risers, the sumps will be located adjacent to the eastern perimeter of the containment cell.

4.6.5 Secondary barrier system

The secondary barrier system will be anchored at the top of the cell batters in a trench sized to consider the interface properties of the different materials. The secondary barrier system consists of:

- A 2 mm HDPE geomembrane liner (product type based on the results of durability, interface transmissivity (with the chosen geosynthetic clay liner (GCL) and interface shear testing with adjacent geosynthetics.

4.6.6 Groundwater diversion system

A groundwater diversion system is included in the design to minimise liner uplift by the vadose zone water to ALARP through local fractured geology and potential ingress of water between the liner and excavation.

The diversion system will consist of a drainage geocomposite over the entire base and sidewalls of the containment cell below the secondary barrier system. The detailed design of the drainage geocomposite will be based on the results of transmissivity, clogging and interface shear testing. Based on the results of the testing, appropriate reduction factors for creep, clogging, installation damage, intrusion and overall factor of safety will be applied.

Any groundwater intercepted by the diversion system will seep into a groundwater extraction system consisting of:

- A 2.2 m deep collection sump located in the lowest point of each eastern sub-cell, backfilled with drainage aggregate. The sump has base dimensions of 6.4 m x 5 m.
- Two pipe extraction risers (perforated in the base of the sump, solid against the sidewall). These risers will contain the extraction pumps to remove any groundwater for disposal. The risers also provide clean-out capability should any clogging occur in the sump.

To allow post-closure access to the risers, the sumps will be located adjacent to the eastern perimeter of the containment cell. Once sufficient waste is placed within the cell, the risk of liner uplift will no longer exist.

4.7 Cap design

The capping layer is comprised of the following (top to bottom):

- 150 mm soil topsoil layer to be revegetated.
- 1500 mm soil subsoil layer
- Separation geotextile
- 300 mm recycled drainage aggregate
- Protection geotextile
- LLDPE geomembrane
- 300 mm seal bearing layer
- GCL
- Separation geotextile (if required)

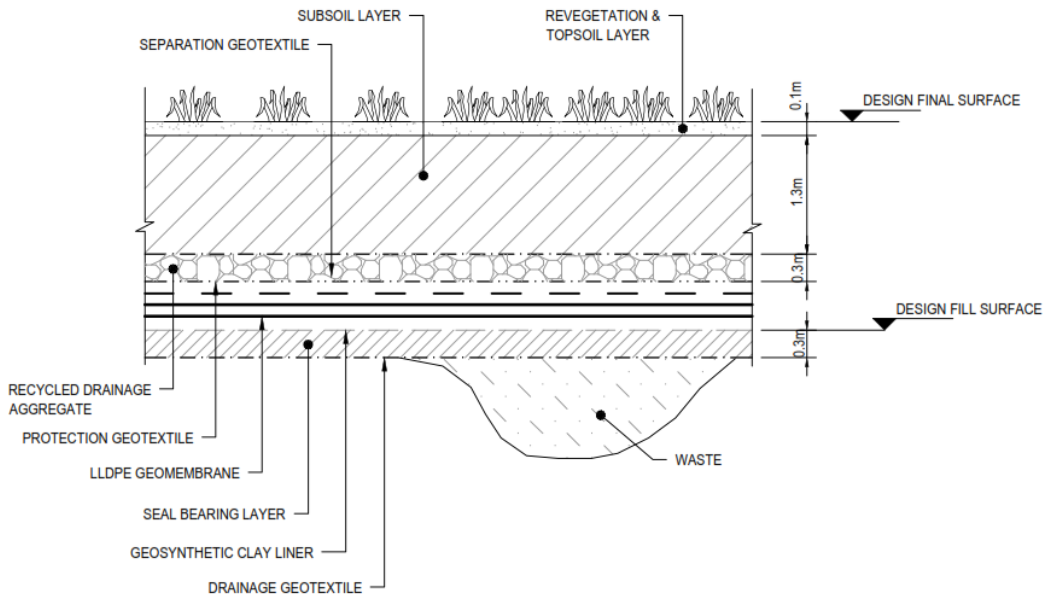

Figure 7 Capping system

The design basis of the final cover and cap system has been developed to include the following (from top to bottom):

- A soil based revegetation cover system of approximately 1.7 m depth, vegetated with native (or other approved alternative) flora species. The flora species will be selected to not compromise the integrity of the final cover system, will minimise the post closure maintenance requirements and will not negatively impact on the neighbouring flora and fauna.
- A sub-surface drainage system to drain excess infiltration to the sites' external surface water management system.
- A primary barrier system comprising of a linear-low density polyethylene (LLDPE) liner underlain by a GCL. The LLDPE will be welded to the sidewall primary geomembrane liner to produce a complete seal around the entire containment cell.
- A seal-bearing layer consisting of excavated material from onsite to cover the fill materials prior to construction of the capping system.
- A separation geotextile (if required) to add stability and separate the placed seal bearing materials from the waste fill below.

The final landform will be sloped at approximately 1 in 20 to the crest of the containment cell and grade down at approximately 1V:4H down to 1V:5H to the natural ground surface to:

- Minimise pooling of surface waters
- Promote surface water run-off
- Allow for easy access for site maintenance including access to all environmental and site controls
- Reduce the visual impact on the surrounding sensitive receptors
- Minimise the post closure maintenance requirements

The cap will be constructed in two phases, an interim and a final phase to allow for progressive capping of the cells. The interim cap will provide a temporary soil barrier until there is sufficient area to construct the final cap.

4.8 Landfill gas system design

The design intent of the landfill gas system design is to collect and extract landfill gas generated within the containment cell. The landfill gas collection system consists of a series of landfill gas collection infrastructure over the full extent of the containment cell. Eight horizontal 600 mm wide gas trenches are provided spanning the extent of the final cap and will be recessed 600 mm into the waste mass. The 600 mm x 600 mm horizontal gas trenches will be backfilled with aggregate and a DN160 slotted HDPE pipe installed.

The horizontal gas trenches meet at the centre-point of the containment cell cap at a central gas vent that consists of a DN160 perforated HDPE pipe spanning from the revegetated surface drilled down to 2 m above the base of the monocell and will be surrounded by recycled aggregate. A series of eight additional vertical gas bores are to be drilled at certain locations on the alignment of the horizontal gas trenches. The vertical gas bores key into the overlying horizontal gas trench and consist of 300 mm diameter bores drilled to within 2 m above the base of the monocell and will be backfilled with drainage aggregate.

4.9 Appurtenances

4.9.1 Anchor trench design

Anchorage will be provided for geosynthetic materials at the crest of sidewalls to:

- Hold materials during construction – a phased approach of installation will begin from bottom to top
- Hold materials during operations for:
  - Balance of tensile strength and expected loads
  - Friction interfaces assumed
- Tie in cap materials

Two anchor trenches will be provided for anchorage of:

- Primary barrier system and leak detection system
- Secondary barrier system and groundwater diversion system

Both anchor trenches will be located at the crest of the sidewalls and consist of a 500 mm x 500 mm excavated trench to be backfilled with compacted fill, sized based upon construction staging and wind loading calculations.

4.9.2 Stormwater and flood management design

Protection from the high rainfall events is required. To achieve this, the following safeguards are included in the design.

- Containment cell perimeter bunds will be provided to divert rainwater to the site sediment basins.
- Two sediment detention basins will be located at low points around the site. The sediment detention basins will be used to prevent sediment load in the Black Waterholes creek and provide water for revegetation irrigation.
- Infrastructure will be provided to remove stormwater from containment cell.
- Internal staging bunds are provided to provide separation of stormwater and leachate within the cells once filling commences to reduce leachate generated within the containment cell.

4.10 Material and durability considerations

4.10.1 Design life requirements

A 100-year design life will be adopted for the primary barrier systems:

The barrier system is a composite system including multiple layers of geosynthetics. The geomembrane liner is the fundamental barrier at the base of the primary barrier system and as such, the likelihood of the complete lining system meeting the 100-year design life would be a conservative[1] reflection of the integrity of the containment cells. The following works have been undertaken to provide HAKK with confidence that the system will meet the required design life:

- Development of a comprehensive geosynthetics test work program to determine the most suitable materials to be used for the liner system (Refer to section 4.10.2)
- Robust design including:
  - A GCL layer placed directly beneath the geomembrane layer to offer an additional barrier.
  - The batter slopes have been optimised to 4(H):1(V) to reduce tension in the material from the soil-confining layer. The majority of the force is perpendicular to the slope rather than parallel.
  - Protection geotextile between the geomembrane and soil-confining layer to minimise damage to underlying barriers.

In addition to careful design and material selection, the following documents have been prepared to document approaches and minimise damage to the barrier systems during construction, operation and closure:

- A *Construction Quality Assurance* (CQA) program to ensure minimal damage to the liner during and after installation and that the construction is as per the Design Specification. Leak location surveys will be undertaken as part of the CQA work so that any damage is identified and immediately rectified. For details, refer to the *Technical Specification* (Appendix H) and *Construction Quality Assurance Plan* (Appendix I).

The above system of safeguards will ensure that the design life requirements will be met.

4.10.2 Liner integrity/durability outcomes and implications for design

A comprehensive geosynthetics selection program has been developed to determine the most suitable materials to be used for the liner system. This involves:

- Careful evaluation and selection of candidate geomembranes and geosynthetics through desktop literature and industry review.
- Accelerated geomembrane aging tests to predict liner service life in contact with existing leachate from the Capped Waste Stockpile. This test was undertaken by ExcelPlas to assist with the selection of the most suitable geomembranes. The Geomembrane Testing Report is contained in Appendix E with service-life estimates suggesting that all candidate geomembranes tested will meet the expected 100 year design life.
- Review of interface friction between the various layers of soil and geosynthetic materials to ensure stability during construction and at the various stages of filling, as well as minimise strain on the liner systems.

[1] As a geomembrane overlays a GCL layer and secondary lining system, failure of the geomembrane may not necessarily mean complete failure of the barrier system

4.10.3 Summary of liner and capping materials

The proposed basal design and nominated materials are summarised in Table 3.

Table 3 Summary of proposed basal design and nominated materials

Systems	Basal layer	Reference to Technical Specification section
Protection Systems	Separation geotextile	Geotextile
Leachate drainage layer	300 mm drainage aggregate	Drainage aggregate
Primary liner system	Protection geotextile	Geotextile
	2 mm HDPE geomembrane	PE geomembrane
	Geosynthetic clay liner	Geosynthetic Clay Liner
Leak detection system	300 mm sand drainage layer	Sand drainage layer
Secondary barrier system	2 mm HDPE geomembrane	PE geomembrane
Groundwater drainage system	Drainage geocomposite	Geonet drainage composite

Table 4 Summary of proposed sidewall design and nominated materials

Systems	Sidewall layer	Materials
Protection system	Sacrificial geomembrane	PE geomembrane
	Soil confinement layer	Soil confining layer
Primary liner system	Protection geotextile	Geotextile
	2 mm HDPE geomembrane	PE geomembrane
	Geosynthetic clay liner	Geosynthetic Clay Liner
Leak detection system	Drainage geocomposite	Geonet drainage composite
Secondary barrier system	2 mm HDPE geomembrane	PE
Groundwater drainage system	Drainage geocomposite	Geonet drainage composite

Table 5 Summary of proposed capping design and nominated materials[2]

Systems	Capping	Materials
Revegetation layer	Revegetation and topsoil	Revegetation layer
	Subsoil	Revegetation layer
Subsurface drainage system	Separation geotextile	Geotextile
	Recycled drainage aggregate	Drainage aggregate
Barrier capping layer	Protection geotextile	Geotextile
	LLDPE geomembrane	PE geomembrane
	Geosynthetic clay liner	Geosynthetic Clay Liner
	Seal bearing layer	Seal bearing layer
	Drainage geotextile	Geotextile

4.11 Stormwater management

A series of culverts were designed to replace the existing culverts within the Unnamed Creek below the new access road. These have been designed with a capacity for the 10 year ARI storm event. However it should be noted that no overtopping of the access road is anticipated for storm events up to and including the 100 year ARI storm event.

[2] Sensor system to be confirmed

4.12 Construction considerations

The containment cell's construction staging has been designed to be hydraulically independent of each other to allow for progressive filling, capping, closure, environmental monitoring and maintenance of each sub cell. The overall footprint has been subdivided into 4 No. subcells.

The containment cell will be constructed with intracell bunds to allow for staged filling (refer to Section 4.13.2 S*taged filling*) and management of stormwater (Section 4.13.2 *Surface water management*).

4.12.1 Excavation and materials balance

Following the stripping of the remaining existing vegetation and topsoil, approximately 100,000 m^3 of excavation will be required to form the subgrade of the containment cell. During excavation, the material will be separated for reuse onsite with no material permitted to leave the site.

Consideration was made to the site-specific geotechnical investigation results. This influenced the material balance for the site.

The excavated material will be reused in:

- Preparation of the subgrade levels including construction of perimeter bunds and intracell bunds, access roads and drains
- The soil confining layer over the primary barrier system
- The seal bearing layer above the waste when it reaches final levels
- The revegetation layers of the final cap.

Indicative material quantities are provided in Table 6.

Table 6 Summary of capacity requirements for different scenarios

Component	Material requirement (m^3)
Excavation	100,000
Formation of cell subgrade - filling	22,300
Soil confining layer	7,000
Seal bearing layer	10,500
Subsoil layer	66,500
Topsoil layer	7,700

To facilitate construction the following temporary works will be required:

- Sufficient area onsite to allow temporary stockpiling of excavated material required for operations or closure
- Sufficient area onsite to allow permanent stockpiling of excavated material not required for operations or closure (no excavated material to go offsite)
- Temporary access roads into the containment cells during construction particularly during lining operations.

4.12.2 Containment cell construction access

The cell access roads, as described in Section 4.13.1, are incorporated into the design of the cells and will be formed in the subgrade of the cell as part of the general earthworks. These access ramps will also be used during construction to access the base of the cells.

- If additional ramps are required during construction, these will be removed prior to the placement of the liner
- No lined areas will be traversed by construction equipment unless sufficient protection is provided. Details are described in the *Technical Specification* (contained in Appendix H).

4.12.3 Construction quality assurance

CQA and quality control (QC) testing of the materials and services employed in the construction of the cells is an important aspect of the construction process. The CQA program is intended to provide a level of confidence that the completed project has been constructed in accordance with the design and specification.

The CQA Plan includes testing requirements for various aspects of the works including:

- Earthworks
- Subgrade preparation
- Material manufacture, supply, installation, testing, repairs and submittals including geosynthetics, drainage aggregate for liner and capping systems
- Waste placement
- Field trials
- Documentation of works

4.13 Operational considerations

The operation of the containment cell will be developed to meet the following minimum requirements:

- Risks reduced to ALARP
- Maximise available airspace (i.e. optimise the compaction density)
- Minimise leachate generation
- Minimise degradation or loss in performance of the containment cell barrier and leachate management systems
- Allow for closure of the containment cells to be undertaken as soon as practicable

4.13.1 Cell access and traffic management

Access to the containment cell will be provided in the form of an all-weather access road leading from the site entrance to the east of the cell. The all-weather access road will be provided to the entire perimeter of the containment cell. The site access roads are designed to shed water away from the containment cell to minimise flood and road damage.

From the site roads, access into the cells will be provided over the lined and protected batter. Four access roads have been incorporated into the containment cell as shown in the Containment Cell General Arrangement Access Roads – 22-18015-C007 (Appendix J).

The access roads are 8 m wide and have a maximum grade of 10% and will be filled over with waste fill and located to allow access throughout all stages of filling. As the waste levels rise, access will be over the landfilled waste.

As part of the detailed design, an access road capping system will be developed to provide protection for the liner and drainage systems below.

All roads will be constructed to service mobile heavy plant and equipment, except where identified for light vehicles only, e.g. access to administration building.

4.13.2 Containment cell operational requirements

Staged filling

The containment cell is subdivided into four sub-cells by intracell bunds. The *Technical Specification* (Appendix H) provides technical requirements for the placement of waste materials.

Table 7 provides the indicative capacity of each stage of filling, assuming intermediate batters at 1(V):4(H).

Table 7 Summary of stage capacities

Stage	Approx. capacity (m^3)
SE Subcell	63,200
SW Subcell	87,300
NE Subcell	72,300
NW Subcell	129,000

During site establishment, site infrastructure such as fencing, access roads and stormwater infrastructure will be constructed. The containment cell area will be cleared and grubbed. Excavation and installation of the groundwater, basal lining, leak detection and leachate collection systems will follow. The containment cells will be filled progressively, with unfilled stages used for stormwater management. The excavated material will be used for rehabilitation (closure and capping) of the cells, with rehabilitation works commencing as soon as each stage has been filled to its capacity.

Refer to Section 4.7 for a description of the capping works.

Surface water management

To minimise stormwater entering into the developed containment cell, perimeter bunds have been provided around the active containment cell stage. The water from these perimeter bunds will be conveyed in vegetated channels to a series of sediment basins for management of sediment-laden waters. A series of perimeter drains surrounding the stockpile area collect sediment-laden run-off from the stockpile area. An upstream diversion drain, north of the stockpile, minimises run-on into the stockpile area and stockpile sediment drains.

Intracell bunds have been included within the containment cell; these will allow staging filling of the cell and allow for the separation of surface water and leachate. A description of the staged filling is included in the section above. Surface water from the unfilled stages will be able to be extracted and transferred to the surface water management system for monitoring and discharge.

Ongoing monitoring of surface water parameters will be undertaken throughout the operations to ensure water being discharged from the site meets the required discharge limits.

Leachate management

Water coming into contact with any waste fill will be classified as leachate and require collection and treatment.

The leachate will drain to one of the two leachate sumps, located at the eastern boundary of the containment cells and each sump will contain two extraction risers. Leachate extraction pumps will be used to extract the leachate which will be pumped to the leachate buffer storage dam for temporary storage. The leachate sump will contain sensors to indicate leachate levels and a control system to automate the pumping of leachate

Leachate generation should be minimised by reducing the area of exposed waste and covering as soon as practicable. The Specification (Appendix H) provides technical requirements for the placement of the mixed wastes and details methods for minimising leachate generation.

It is expected that leachate generation will be negligible once the final cap is installed.

Liner protection

The containment cell leachate containment and collection system requires protection throughout the filling phase. Sources of damage include:

- Machine or other impact
- Chemical interactions
- Settlement of the subgrade
- Settlement of the waste (in particular the steel bars some of which may be several meters long)

The following aspects have been included in the design to provide engineered protection:

- A protection geotextile above the primary barrier system
- A 300 mm soil confining layer over the entire barrier system
- A designed access ramp

The materials will also be specifically selected based on the results of compatibility testing as described in Section 4.10.

4.14 Safety in Design

The primary objective of the Safety in Design (SiD) review process is to ensure that the design has been critically reviewed from a health and safety perspective, so that hazards and associated risks with construction, maintenance, operations, end users and disposal have been eliminated, or where this is not possible, reduced to as low as reasonably practicable. A safety in design report has been prepared and included in Appendix M.

<u>**It should be noted that the safety in design report, along with the SiD risk register, should be passed onto all subsequent parties involved in the project, including but not limited to the client, relevant party completing any later design development, constructor and asset operator.**</u>

Appendices

Appendix A Owners Requirements

Final Owner's Requirements (Version 0)

Design Area	Owner's Requirement
Functional Goal(s)	• Total containment of contaminated materials • Practical constructible design
Safety and security	• Safety in Design - Safety of workers and community both during construction and during ongoing operation • Security measures that contribute to a prolonged lifespan
Environmental	• All environmental requirements (note that any conditions of consent will not likely be available until mid-2016) prescribed by legislation, regulations and authorities (such as the NSW EPA) are satisfied • Minimise reduction of existing biodiversity offset lands
Reliability and durability	• Able to withstand foreseeable internal and external environmental factors (such as internal gas production, significant rain events, earthquakes, burrowing fauna, etc.) • Design life of containment cell to be 100+ years and design life of associated infrastructure to be maximised to minimise life-cycle costs
Maintainability	• Minimum ongoing maintenance • Ease of maintenance with minimal specialist skills required for maintenance activities
Flexibility	• Flexible design to allow for variations in contained material volumes
Quality of materials and construction	• Maximise site-won materials (including recycled materials if acceptable) without compromising reliability or design life • Construction specifications and construction quality assurance necessary to achieve functional goals and design life
Aesthetics	• Minimise visual impact to the extent practical • Aesthetics reasonably acceptable to the local community
Budget	• Minimise cost of design and construction without compromising functional goals and lifespan
Cost estimate	• Detailed cost estimate for construction through to completion and handover (including design verification and construction quality assurance) • Construction cost estimate based on current and

Design Area	Owner's Requirement
	reliable data, estimating methods and actual construction experience • Accuracy of at least +/- 30%, preferably using standardised estimate classification such as AACE Class 3. • Preliminary schedule for construction of the containment cell
Operational and life-cycle cost	• Minimise ongoing operational costs • Minimise total life-cycle cost
Sustainability and future use	• Design and construct to facilitate future resource recovery from containment cell • Design and construct with consideration for potential future uses of the site • Maximise sustainability to the extent that is practical
Innovation	• Utilise innovation where practical and without compromising design life
Warranty requirements	• Performance monitoring of containment cell for a minimum of five (5) years post completion
Documentation requirements	• Effective and efficient document management and control • Documentation submitted in both native and PDF formats • Satisfaction of all vendor data requirements
Stakeholder requirements	• What are the key hot buttons for your community?

Note:

It is noted that this list may change during the development of the design. Consideration will have to be given to the program and associated workings/costings should the list change significantly.

Appendix B Liner System Comparison

Hydro Aluminium Kurri Kurri

Lining System Comparison Report

October 2017

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Appendices

1. Introduction

1.1 General

GHD Pty Ltd (GHD) has been engaged by Hydro Aluminium Kurri Kurri Pty Ltd (herein referred to as 'HAKK') to prepare a preliminary engineering design report and supporting documentation for a proposed Containment Cell (herein referred to as 'the site) for the HAKK Demolition and Remediation Project. GHD's Scope of Services covers the detailed design, constructability review, quality specifications, project cost estimate, schedule and other related requirements. The future Containment Cell will be an engineered facility for the purpose of disposing and managing various waste streams generated by the Capped Waste Stockpile and the demolition and remediation of the Smelter.

1.2 Purpose of this report

The purpose of this report is to provide a basis for an informed discussion around the design basis for the proposed containment cell lining and capping systems, in particular the secondary liner profile.

1.3 Scope and limitations

This report: has been prepared by GHD for Hydro Aluminium Kurri Kurri and *may only be used and relied on by Hydro Aluminium Kurri Kurri for the purpose agreed between GHD and the Hydro Aluminium Kurri Kurri as set out in section 1.2 of this report.*

GHD otherwise disclaims responsibility to any person other than Hydro Aluminium Kurri Kurri arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Hydro Aluminium Kurri Kurri and others who provided information to GHD (including Government authorities)], which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

GHD has prepared the preliminary cost comparison set out in section 4 of this report ("Cost Comparison") using information reasonably available to the GHD employee(s) who prepared this report; and based on assumptions and judgments made by GHD.

The Cost Estimate has been prepared for the purpose of comparison of options only and must not be used for any other purpose.

The Cost Comparison is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Comparison and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the works can or will be undertaken at a cost which is the same or less than the Cost Comparison.

2. Proposed options and assessment criteria

2.1 Proposed options

The following alternate liner cover options were identified for further evaluation:

- Option 1: EIS liner with primary GCL and confining/protection layer on sidewall
- Option 2: EIS liner with primary and secondary GCL and attenuation layer in lieu of compacted clay and confining/protection layer on sidewall
- Option 3: BGM liner and confining/protection layer on sidewall
- Option 4: BGM liner with attenuation layer and confining/protection layer on sidewall
- Option 5: EIS liner with primary GCL and capping GCL and confining/protection layer on sidewall

These options are presented in Table 1 and Table 2 below.

Table 1 Summary of options – final cap (from top to bottom)

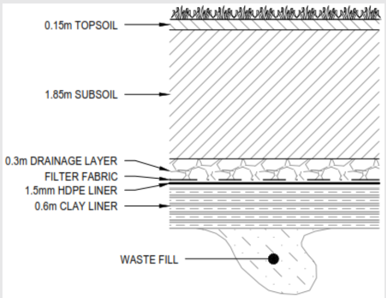
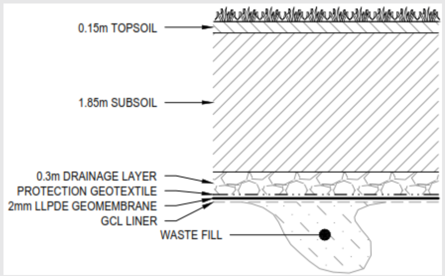
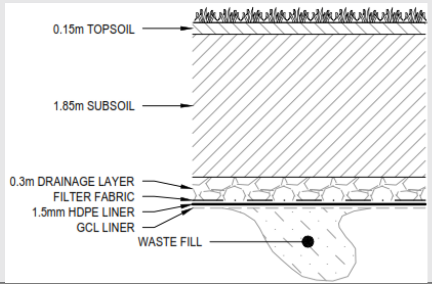
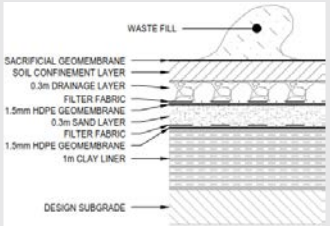
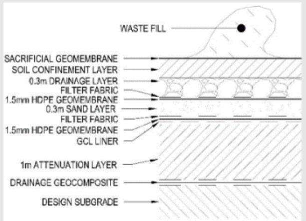
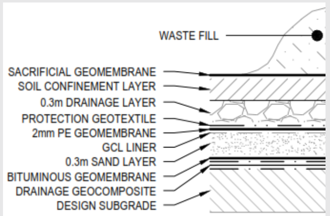
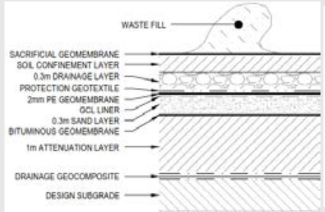
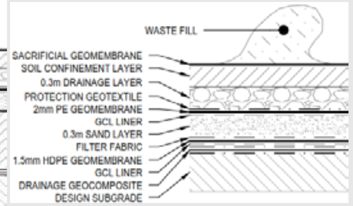
Layer description	Option 1	Option 2	Option 3
Topsoil/revegetation layer	• Revegetation • Topsoil (0.15 m) • Subsoil (1.85 m)	Similar	Similar
Subsurface/infiltration drainage layer	0.3 m drainage layer	Similar	Similar
Sealing layer	• Filter fabric to provide protection to the HDPE • 1.5 mm thick HDPE liner • 0.6 m thick clay liner of permeability 1 x 10-9 m/s	• Protection geotextile • 2 mm LLDPE Geomembrane • Geosynthetic Clay Liner	• Filter fabric to provide protection to the HDPE • 1.5 mm thick HDPE liner • Geosynthetic Clay Liner
			

Table 2 Summary of options - liner

Layer description	Option 1	Option 2	Option 3	Option 4	Option 5
Confinement/protection layer	Sidewalls only • Sacrificial GMB • Soil confinement/ protection layer	Similar	Similar	Similar	Similar
Leachate collection system	0.3 m gravel drainage layer	Similar	Similar	Similar	Similar
Primary barrier system	• Filter fabric to provide protection to the HDPE • 1.5 mm thick HDPE liner	Similar	• Protection geotextile • 2 mm PE geomembrane • Geosynthetic clay liner	• Protection geotextile • 2 mm PE geomembrane • Geosynthetic clay liner	• Protection geotextile • 2 mm PE geomembrane • Geosynthetic clay liner
Leak location system	0.3 m sand leachate detection layer	Similar	Similar	Similar	Similar
Secondary barrier system	• Filter fabric to provide protection to the HDPE • 1.5 mm thick high density polyethylene (HDPE) liner • 1 m thick clay liner of permeability 1 x 10^{-9} m/s	• Filter fabric to provide protection to the HDPE • 1.5 mm thick high density polyethylene (HDPE) liner • GCL • 1 m attenuation layer	• Bituminous geomembrane	• Bituminous geomembrane • 1 m Attenuation layer	• Filter fabric to provide protection to the HDPE • 1.5 mm thick high density polyethylene (HDPE) liner • GCL

Layer description	Option 1	Option 2	Option 3	Option 4	Option 5
Groundwater collection system	No system proposed	Drainage geocomposite	Drainage geocomposite	Drainage geocomposite	Drainage geocomposite
					

3. Failure mechanisms

3.1 Overview

A register of possible failure mechanisms for the containment cell has been developed.

In developing the register, the following aspects were considered:

- The design components
- The phases of site operation
- The possible failure mechanisms
- The driver for the failure
- The preventative measures

3.2 Design components

Components of the containment cell which were considered include:

- The final cap, consisting of
  - Soil cap – revegetation soils and vegetation
  - Barrier cap – seal bearing layer and geomembrane barrier
- The earthworks including:
  - The excavation of the cells
  - Cell perimeter bunds
  - The access ramps
  - The intercell bunds
- The leachate collection and extraction system including sump
- The primary barrier protection system
- The primary barrier system
- The leak detection and extraction system including sump
- The secondary barrier system
- The groundwater diversion and extraction system including sump

3.3 Phased of site operation

For each design component, the following phases were considered:

- Construction
- Operation
- Closure
- Post-closure

3.4 Failure mechanisms, drivers and preventative measures

The likely modes of failure and the prerequisites for that failure mechanism were identified for each design component over the various phases of the site.

A range of preventative measures were then identified. The preventative measures considered include:

- Engineering design and calculations including factors of safety
- Testing against specification and construction quality assurance (CQA) during construction phase
- Inspection and monitoring post construction
- Alternate pathways or backup systems
- Recommendations for construction or operational guidance or procedures

The preventative measures should be considered in the preparation of the detailed design documentation, including the specification, the CQA plan and any other plans being prepared for the containment cells.

3.5 Failure of containment system

3.5.1 During operation

All cell barrier and drainage systems would need to fail for leachate to be released to the environment during operations.

The failure tree for containment failure is included in Figure 1. For containment to be breached, one failure in every category would have to occur.

3.5.2 After closure

For release of waste to the environment to occur following installation of the final cap, both the capping system and the cell liner system would have to fail.

The failure tree for containment failure is included in Figure 2. For containment to be breached, one failure in every category would have to occur.

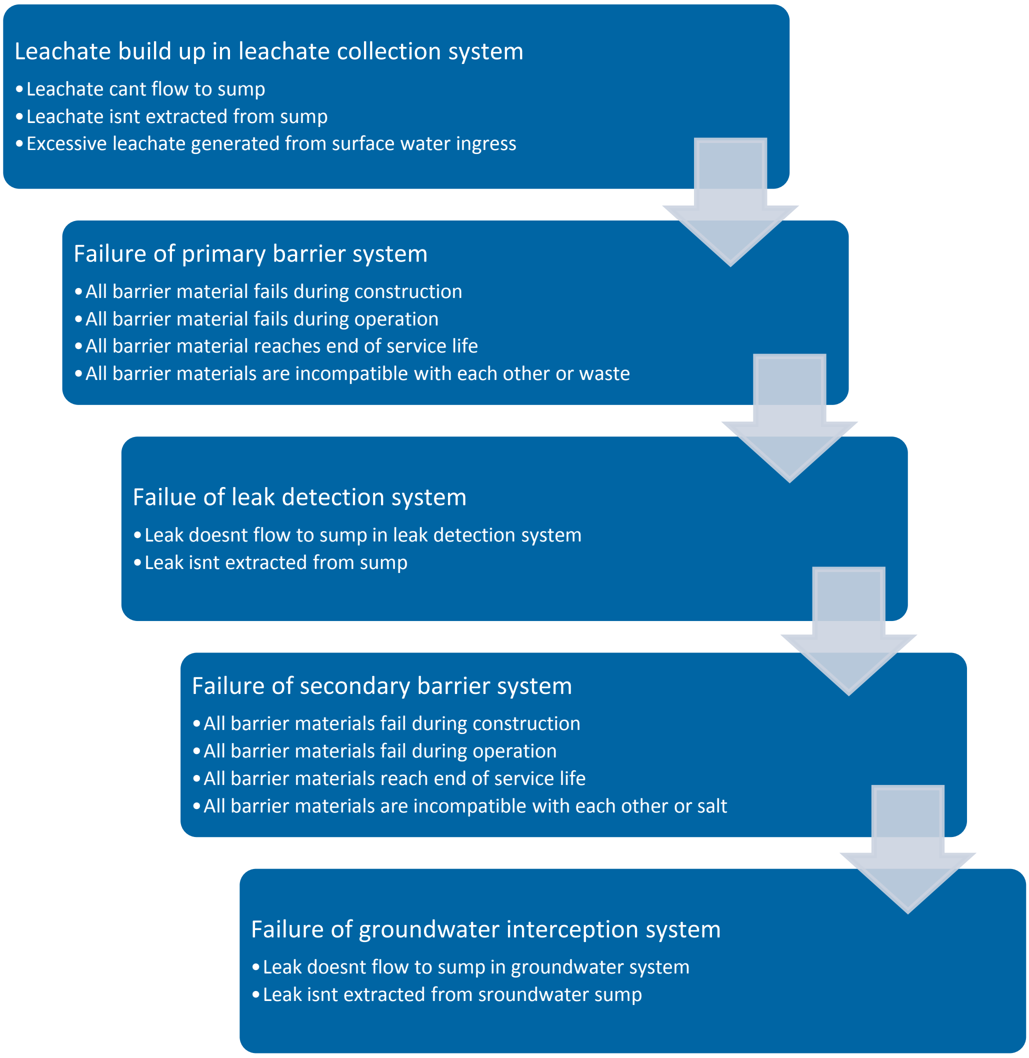


Figure 1 Failure tree for cell operational phase

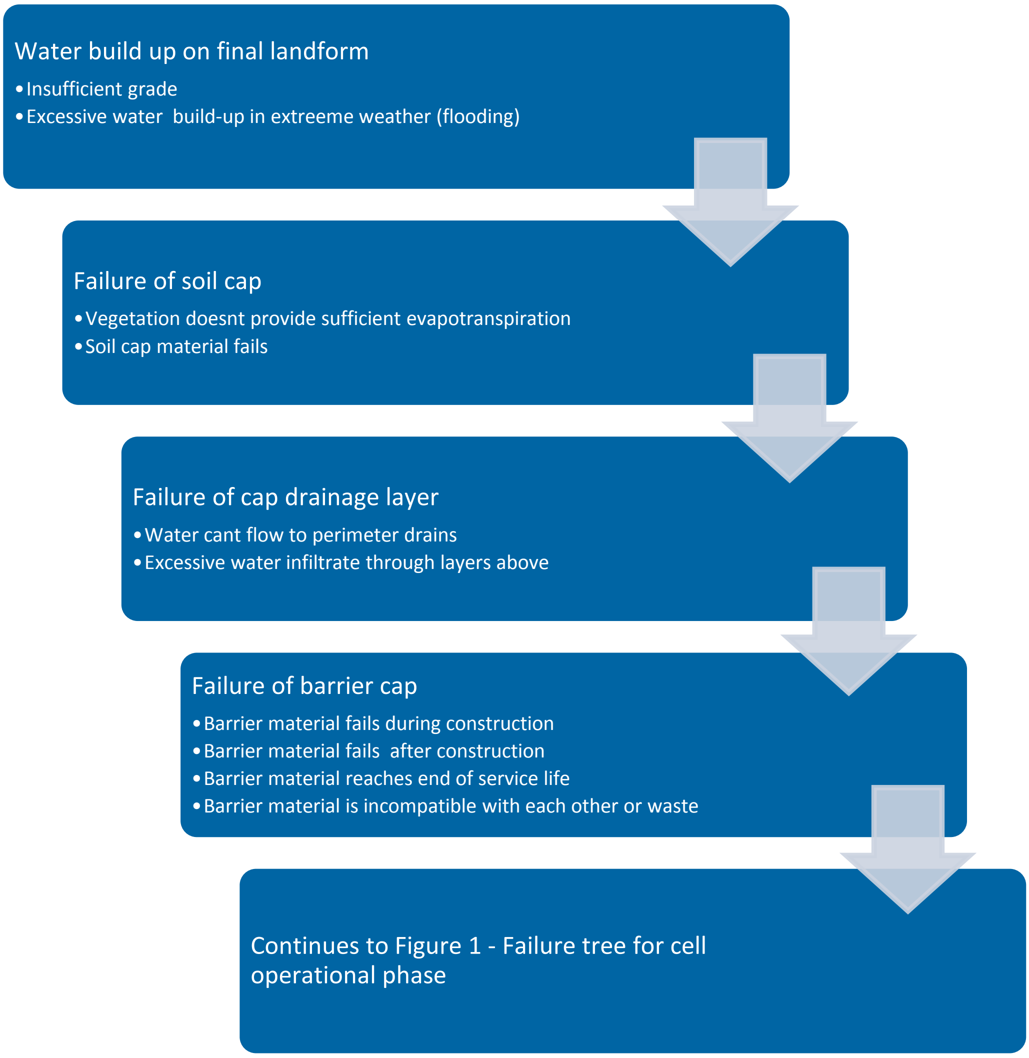


Figure 2 Failure tree following cell capping

4. Cost comparison

4.1 General

Order of magnitude cost estimates were developed for each option for comparative purposes to support the evaluation.

4.2 Assumptions and exclusions

For the purpose of these works, GHD notes the following:

- The cost estimates have been developed for comparative purposes only and only include direct costs for material supply and installation. Indirect costs associated with construction preliminaries, supervision, site establishment, contractor overhead, project management and maintenance have been excluded. Contingent risks (or Owners risks), Owners costs, and escalation in costs from the base date of the estimate have also been excluded
- Supply, installation and costs for the compacted clay layer was based on the material having to be imported to site. This cost is quite sensitive and requires confirmation
- The attenuation layer was assumed to be the same thickness as the compacted clay layer and constructed from onsite material
- Supply and installation costs for all geosynthetics (excluding BGM) were based on data collected by GHD from previous similar projects
- BGM supply and installation costs were provided by Coletanche
- Based on the information provided regarding the waste gas characteristics, a suitably designed treatment and venting system would be required as part of the cover system to manage the gas and prevent liner uplift and damage. Given this would be required for all options, this has not been considered in the cost comparison

4.3 CAPEX summary

A summary of the comparative cost estimate for the secondary liner is provided in Table 3, with a breakdown of the various costs and total provided in Appendix B.

Table 3 Summary of CAPEX cost comparison of secondary liner system

Option	CAPEX (secondary liner only)	CAPEX difference (compared to EIS [1]
1 (EIS)	$6.4 million	NIL
2 (EIS with attenuation)	$3.8 million	- $2.6 million
3 (BGM)	$1.1 million	- $5.7 million
4 (BGM with attenuation)	$1.7 million	- $4.7 million

[1] Includes excavation cost saving as additional excavation is not required to include a compacted clay or attenuation layer

Table 4 Summary of CAPEX cost comparison of the final capping system

Option	CAPEX (secondary liner only)	CAPEX difference (compared to EIS [2]
1 (EIS)	$4.8 million	NIL
2 (EIS with GCL)	$3.2 million	- $1.6 million

[2] Includes excavation cost saving as additional excavation is not required to include a compacted clay or attenuation layer

5. Discussion and recommendations

5.1 Failure mechanism analysis

The preparation of the failure mechanism analysis (refer Appendix A) identifies the key source of leakage is via accumulation of leachate within the cell. The source of which is rainfall on the containment cell during construction and filling and through the cap profile in the long term.

5.2 Primary liner

Based on the analysis of the failure mechanisms, preventative measures were identified that EIS compliant primary liner system should be augmented to a composite lining system. As such GHD recommends that a GCL be included in the primary lining profile.

5.3 Secondary lining

The secondary lining system will be designed to provide an additional barrier with an equal service life to the primary barrier and therefore the design profile of the secondary liner matches the design profile of the primary liner.

5.4 Capping layer

Based on the analysis of the failure mechanisms, the required preventative measures confirmed the suitability of the EIS compliant capping system. GHD noted however that construction of a compacted clay layer would add significant cost and increase the height of the cell. It addition, any infiltration through the cap would be rainwater and therefore attenuation would not be required. As such GHD recommends this layer be substituted for a GCL.

5.5 Recommendations

Having reviewed the various lining system options and considerations developed during the early design phases, the following systems are recommended to be progressed through detailed design (Refer to Figure 3, Figure 4 and Figure 5).

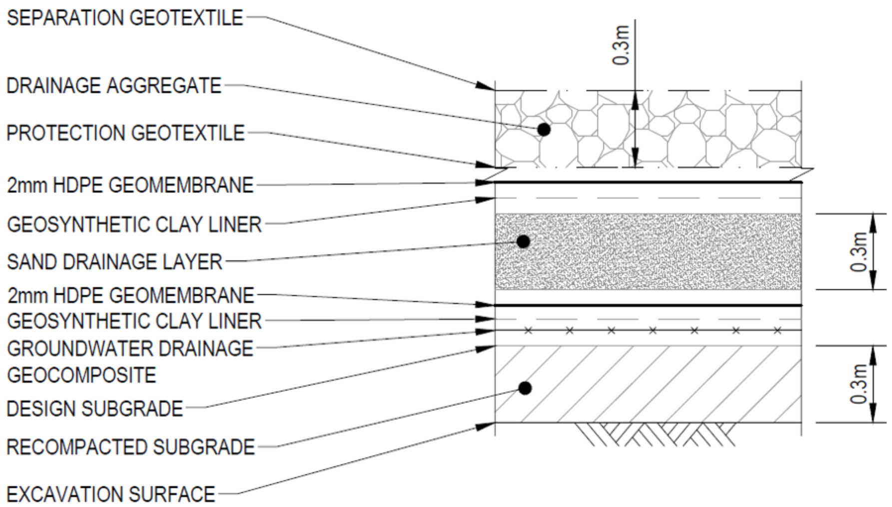


Figure 3 Base lining system

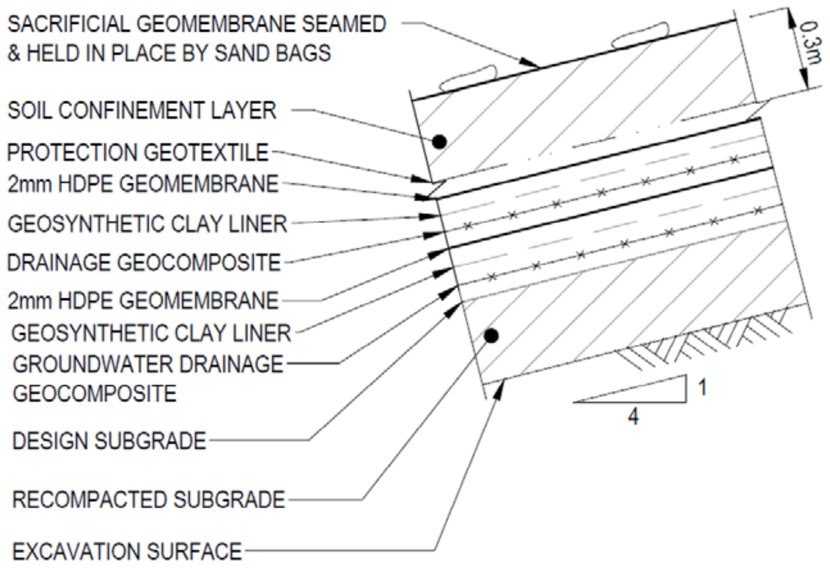


Figure 4 Sidewall lining system

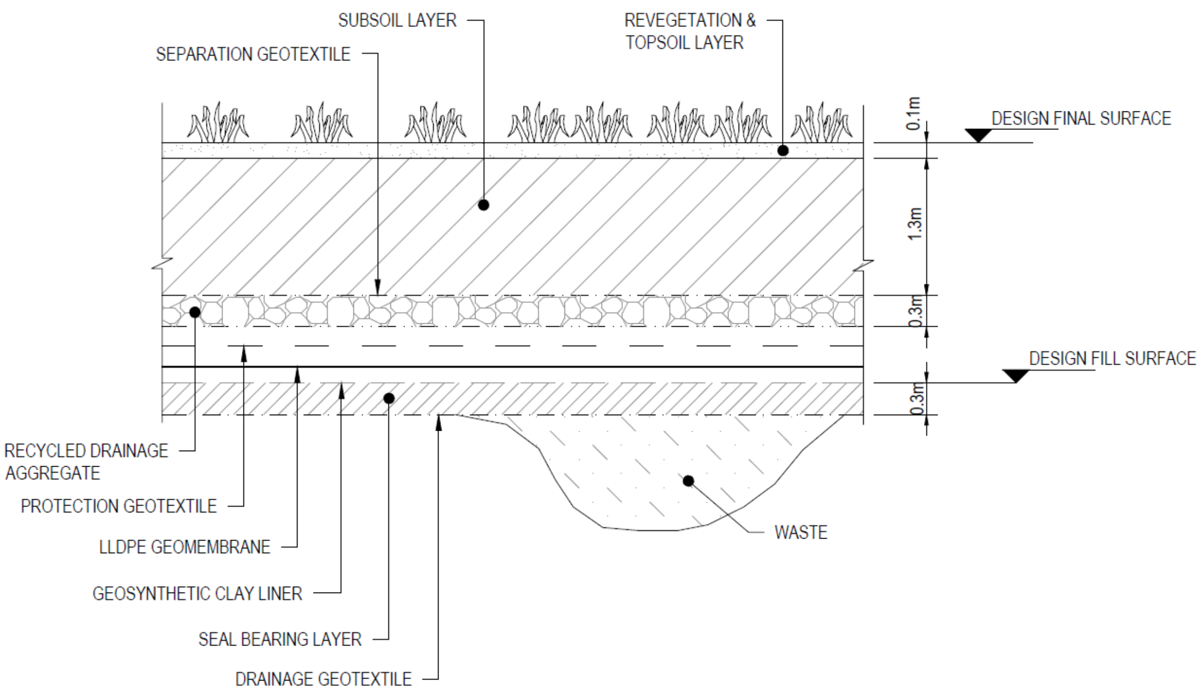


Figure 5 Cap system

Appendices

Appendix A – Failure Mechanisms

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
1.	Soil cap	Closure	Stability - low friction angle at material interface	• Active wedge	• Specify appropriate material (shear strength) • Construction quality assurance of installed materials • Design with shallow grades
2.	Soil cap	Post-closure	Stability - saturation	• Build-up of water in cap materials	• Include subsoil drainage layer • Design final surface with sufficient grades to shed water • Undertake regular inspections immediately following closure and post-closure
3.	Soil cap	Closure	Vegetation - doesn't establish	• Lack of nutrients	• Assess fertility of materials • Specify appropriate material • Undertake regular inspections immediately following closure and post-closure
4.	Soil cap	Post-closure	Vegetation - dies, incompatibility with climate	•	• Select local, native vegetation • Undertake regular inspections post-closure
5.	Soil cap	Closure	Hydraulic head - insufficient grades	• Requires ponding of water over failure location for leakage to take place	• Design final surface with suitable grades • Undertake compaction of waste • No sludge beneath the cap
6.	Soil cap	Post-closure	Hydraulic head - settlement of waste	• Requires ponding of water over failure location for leakage to take place	• Undertake compaction of waste • No sludge beneath the cap • Design final surface with sufficient grades such that water will still shed with some settlement

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
7.	Soil cap	Post-closure	Damage – flora and fauna	• Insufficient protection in place • Requires ponding of water over failure location for leakage to take place	• Include contingency in cap thickness • Include site fence • Undertake regular inspections post-closure • Choose vegetation with appropriate root depth • Include biotic barrier
8.	Soil cap	Post-closure	Damage - human (accidental or otherwise)	• Insufficient protection in place • Requires ponding of water over failure location for leakage to take place	• Include some contingency in cap thickness • Include site fence • Undertake regular inspections post-closure • Include biotic barrier
9.	Soil cap	Post-closure	Damage - erosion	• Flowing water on cap surface	• Specify appropriate material • Make cap thick to have some contingency • Design appropriate drainage • Include quick growing vegetation • Undertake regular inspections post-closure • Undertake erosion analysis • Stabilise where required
10.	Barrier cap	Closure	Damage during construction - mechanical	• Poor construction practice	• Develop WMS • Undertake construction quality assurance including leak location survey for geomembrane layer • Provide sufficient protection materials (above and below barrier materials) • Undertake trial pad for placement of materials above

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
11.	Barrier cap	Post-closure	Damage - mechanical	• Insufficient protection in place • Requires ponding of water over failure location for leakage to take place	• Make cap thick to have some contingency • Provide sufficient protection above and below barrier materials • Undertake testing to confirm protection is sufficient for specific cover material • Provide drainage layer between barrier and soil cap to prevent saturation
12.	Barrier cap	Post-closure	Material failure - settlement of waste	• Requires ponding of water over failure location for leakage to take place	• Undertake testing on • Specify appropriate materials (high strain)
13.	Barrier cap	Post-closure	Material failure - compatibility with waste	• Requires ponding of water over failure location for leakage to take place	• Separate geomembrane and GCL from waste with a soil layer • Undertake compatibility testing of proposed materials
14.	Barrier cap	Closure	Stability - low friction angle at material interface	•	• Specify appropriate material properties (interface requirements, asperity height) • Undertake interface friction testing
15.	Barrier cap	Post-closure	Stability - low friction angle at material interface	•	• Specify appropriate material properties (interface requirements, asperity height) • Provide drainage layer between barrier and soil cap to prevent saturation of the interface • Undertake regular inspections post-closure

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
16.	Barrier cap	Post-closure	Material failure - connection to base liner	• Requires ponding of water over failure location for leakage to take place	• Provide sufficient protection materials (above and below barrier materials) • Undertake construction quality assurance including leak location survey for geomembrane layer
17.	Barrier cap	Post-closure	Material failure - pipe perforations	• Requires ponding of water over failure location for leakage to take place	• Provide sufficient protection materials (above and below barrier materials) • Undertake construction quality assurance including leak location survey for geomembrane layer • Minimise number of perforations
18.	Perimeter bunds	Operation	Stability - retaining waste inside cell, force	•	• Prepare appropriate calculations • Specify appropriate material properties
19.	Perimeter bunds	Operation	Stability - retaining flood waters outside of cell, force	• Build-up of water outside the cell perimeter bund	• Prepare appropriate calculations • Specify appropriate material properties
20.	Perimeter bunds	Operation	Stability - retaining flood waters outside of cell, permeability	• Long term build-up of water outside the cell perimeter bund	• Prepare appropriate calculations • Specify appropriate material properties
21.	Perimeter bunds	Operation	Stability - retaining flood waters outside of cell, water height	•	• Asses PMF
22.	Excavated slopes	Construction	Stability - low friction angle	•	• Undertake geotechnical investigation and assessment • Specify shallow grades
23.	Excavated slopes	Operation	Stability - low friction angle	•	• Undertake geotechnical investigation and assessment • Specify flat slopes

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
24.	Excavated slopes	Construction	Stability - saturation	•	• Undertake geotechnical investigation and assessment • Specify remedial action if groundwater encountered
25.	Excavated slopes	Operation	Stability - saturation	•	• Undertake geotechnical investigation and assessment • Include groundwater diversion system to prevent saturation of sidewalls
26.	Leachate collection system	Operation	Material failure - clogging of separation geotextile	• Precipitate in geotextile material	• Prepare appropriate calculations including reduction factors • Specify appropriate material properties (transmissivity)
27.	Leachate collection system	Operation	Material failure - flow capacity of separation geotextile	•	• Prepare appropriate calculations including reduction factors • Specify appropriate material properties (transmissivity)
28.	Leachate collection system	Operation	Material failure - compatibility of separation geotextile with waste	•	• Undertake material compatibility testing • Specify appropriate material properties (chemical formulation)
29.	Leachate collection system	Operation	Material failure - UV deterioration of separation geotextile	• Requires extended exposure • Requires ponding of water over failure location for leakage to take place	• Include sacrificial protection geotextile • Specify appropriate material properties (UV stability)
30.	Leachate collection system	Construction	Material failure - mechanical damage of separation geotextile	• Requires direct contact of plant with the separation geotextile	• Undertake construction quality assurance • Specify first lift of waste placement • Specify appropriate material properties (strength)

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
31.	Leachate collection system	Operation	Material failure - mechanical damage of separation geotextile	• Requires direct contact of plant with the separation geotextile	• Do not allow direct traversing by vehicles once material is installed
32.	Leachate collection system	Operation	Material failure - clogging of leachate drainage aggregate, sediment	•	• Provide protection for exposed sidewall soil confining layer • Provide separation from soil confining layer below (geotextile) • Prepare appropriate calculations including reduction factors
33.	Leachate collection system	Operation	Material failure - clogging of leachate drainage aggregate, waste	• Requires to precipitate in aggregate	• Prepare appropriate calculations including reduction factors • Provide separation from waste above (geotextile)
34.	Leachate collection system	Operation	Material failure - flow capacity of leachate drainage aggregate material, unclogged	•	• Provide fall to sump • Prepare appropriate calculations including reduction factors • Specify appropriate material properties (hydraulic conductivity)
35.	Leachate collection system	Operation	Material failure - compatibility of leachate drainage aggregate with waste	•	• Specify appropriate material properties (soundness)
36.	Leachate collection system	Construction	Material failure - mechanical damage of leachate drainage aggregate	• Applied load would need to be greater than the capacity of the aggregate	• Specify appropriate material properties (hardness) • Do not allow direct traversing by vehicles once material is installed
37.	Leachate collection system	Operation	Material failure - mechanical damage of leachate drainage aggregate	• Applied load would need to be greater than the capacity of the aggregate	• Specify appropriate material properties (hardness) • Undertake construction quality assurance

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
38.	Leachate collection system	Operation	Material failure - clogging of leachate system drainage geocomposite	• Requires to precipitate in material	• Prepare appropriate calculations including reduction factors • Provide separation from waste above (geotextile)
39.	Leachate collection system	Operation	Material failure - flow capacity of leachate system drainage geocomposite		• Prepare appropriate calculations including reduction factors (intrusion) • Specify appropriate material properties (hydraulic conductivity)
40.	Leachate collection system	Operation	Material failure - compatibility of leachate system drainage geocomposite with waste		• Undertake material compatibility testing • Specify appropriate material properties (chemical formulation)
41.	Leachate collection system	Construction	Material failure - mechanical damage of leachate system drainage geocomposite, tensile failure	• Applied load would need to be greater than the capacity of the geocomposite	• Prepare appropriate calculations including reduction factors • Specify appropriate material properties (tensile strength)
42.	Leachate collection system	Operation	Material failure - mechanical damage of leachate system drainage geocomposite, tensile failure	• Applied load would need to be greater than the capacity of the geocomposite	• Prepare appropriate calculations including reduction factors • Prepare appropriate calculations for anchor trenches • Specify appropriate material properties (tensile strength) • Include operational guidance for vehicle movements into and within cells
43.	Leachate collection system	Construction	Material failure - mechanical damage of leachate system drainage geocomposite, crushing, intrusion of geotextile layers, de-bonding of geotextile layers	• Applied load would need to be greater than the capacity of the geocomposite	• Prepare appropriate calculations including reduction factors • Specify appropriate material properties (tensile strength) • Undertake construction quality assurance

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
44.	Leachate collection system	Operation	Material failure - mechanical damage of leachate system drainage geocomposite, crushing, intrusion of geotextile layers, de-bonding of geotextile layers	• Applied load would need to be greater than the capacity of the geocomposite	• Prepare appropriate calculations including reduction factors • Specify appropriate material properties (tensile strength) • Include operational guidance for vehicle movements into and within cells
45.	Leachate extraction system	Operation	Material failure - clogging of sump pipes	• Requires to precipitate in pipes or perforations	• Provide way to clean out by flushing • Prepare appropriate calculations for perforations including reduction factors
46.	Leachate extraction system	Operation	Material failure - sump pipe incompatibility with waste	•	• Undertake material compatibility testing • Specify appropriate material (chemical formulation)
47.	Leachate extraction system	Operation	Material failure - insufficient flow rates achieved for effective pumping	•	• Prepare perforation sizing and spacing calculations
48.	Leachate extraction system	Operation	Material failure - insufficient flow volume achieved for effective pumping	•	• Prepare sump and pump sizing calculations
49.	Barrier system protection	Construction	Stability - low friction angle at material interface for soil confining layer	•	• Undertake interface friction testing • Provide shallow batter slopes • Undertake construction quality assurance
50.	Barrier system protection	Operation	Stability - low friction angle at material interface for soil confining layer	•	• Undertake regular inspections • Provide shallow batter slopes

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
51.	Barrier system protection	Operation	Stability - saturation of soil confining layer	•	• Specify appropriate material • Provide erosion protection (drainage geocomposite) • Extend drainage geocomposite up sidewalls to height of potential saturation (PMF) • Undertake regular inspections
52.	Barrier system protection	Operation	Damage - human (accidental or otherwise)	•	• Specify appropriate material • Provide protection (drainage geocomposite) • Include operational guidance for vehicle movements into and within cells • Undertake regular inspections
53.	Barrier system protection	Operation	Damage - erosion of soil protection layer	•	• Specify appropriate material • Provide erosion protection (drainage geocomposite) • Undertake regular inspections
54.	Primary leachate barrier system	Construction	Material failure - installation damage to geomembrane incl. welds	•	• Undertake construction quality assurance including leak location survey • Install monitoring system
55.	Primary leachate barrier system	Construction	Material failure - installation damage to GCL		• Undertake construction quality assurance

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
56.	Primary leachate barrier system	Construction	Material failure - installation damage to geomembrane from placement of aggregate/soil material above		• Provide protection (geotextile, soil confining layer) • Specify appropriate material (geomembrane thickness, puncture resistance and material above particle size distribution) • Undertake trial pad to confirm machine and lift thicknesses • Undertake construction quality assurance including leak location survey • Install soil material from bottom of the slope, pushing upwards
57.	Primary leachate barrier system	Operation	Material failure - installation damage to geomembrane from placement of waste	• Requires direct contact with geomembrane • Requires ponding of water over failure location for leakage to take place	• Provide protection (geotextile, soil confining layer) • Specify appropriate material (geomembrane thickness, puncture resistance and material above particle size distribution) • Include operational guidance for vehicle movements into and within cells • Undertake regular inspections
58.	Primary leachate barrier system	Operation	Material failure - compatibility of geomembrane with waste	• Requires direct contact with geomembrane • Requires ponding of water over failure location for leakage to take place	• Undertake material compatibility testing • Specify appropriate material (chemical formulation)
59.	Primary leachate barrier system	Operation	Material failure - compatibility of GCL with waste	• Requires failure of leachate collection or extraction system • Requires failure of the primary barrier geomembrane • Requires ponding of water over failure location for leakage to take place	• Undertake material compatibility testing • Specify appropriate material (chemical formulation)

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
60.	Primary leachate barrier system	Operation	Material failure - wash out of bentonite in GCL	• Flow of water adjacent to GCL material • Requires failure of leachate collection or extraction system • Requires failure of the primary barrier geomembrane • Requires ponding of water over failure location for leakage to take place	• Specify non-woven geotextile layers for carrier and cover
61.	Primary leachate barrier system	Operation	Material failure - desiccation of GCL	• Wetting and drying of GCL when exposed • Requires failure of leachate collection or extraction system • Requires failure of the primary barrier geomembrane • Requires ponding of water over failure location for leakage to take place	• Provide protection and confining layer (min 300mm) as soon as practical
62.	Primary leachate barrier system	Operation	Material failure - internal shear of GCL	• Loading of GCL causing shear • Requires failure of leachate collection or extraction system • Requires failure of the primary barrier geomembrane • Requires ponding of water over failure location for leakage to take place	• Prepare calculations with appropriate factors of safety • Specify appropriate material • Install soil material from bottom of the slope, pushing upwards
63.	Primary leachate barrier system	Operation	Material failure - high hydraulic head from above (leachate collection system)	• Requires failure of leachate collection or extraction system • Requires ponding of water over failure location for leakage to take place	• Maintain leachate extraction system from leachate collection layer

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
64.	Leak detection system	Operation	Material failure - clogging of leachate drainage aggregate in leak detection sump	• Requires failure of leachate collection or extraction system • Requires failure of the primary barrier geomembrane • Requires that the primary barrier system to fail • Requires to precipitate in drainage aggregate	• Prepare appropriate calculations including reduction factors • Specify appropriate material properties (permeability) • Include clean out capability in sump
65.	Leak detection system	Operation	Material failure - compatibility of leachate drainage aggregate in leak detection sump with waste	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail	• Undertake material compatibility testing • Specify appropriate material properties (chemical formulation)
66.	Leak detection system	Construction	Material failure - mechanical damage of leachate drainage aggregate in leak detection sump	• Applied load would need to be greater than the capacity of the aggregate	• Specify appropriate material properties (hardness) • Undertake construction quality assurance
67.	Leak detection system	Operation	Material failure - mechanical damage of leachate drainage aggregate in leak detection sump	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Applied load would need to be greater than the capacity of the aggregate • Requires ponding of water over failure location for leakage to take place	• Specify appropriate material properties (hardness)
68.	Leak detection system	Operation	Material failure - clogging of leak detection system sand layer	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires to precipitate in sand layer • Requires ponding of water over failure location for leakage to take place	• Specify appropriate material properties • Include pipework

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
69.	Leak detection system	Operation	Material failure - flow capacity of leak detection system sand layer	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail	• Prepare calculations with appropriate factors of safety • Specify appropriate material
70.	Leak detection system	Operation	Material failure - compatibility of leak detection system sand layer with waste	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail	• Undertake material compatibility testing • Specify appropriate material
71.	Leak detection system	Operation	Material failure - clogging of leak detection system monitoring system on sidewalls	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires to precipitate in material	• Prepare calculations with appropriate factors of safety • Specify appropriate material • Undertake material compatibility testing
72.	Leak detection system	Operation	Material failure - flow capacity of leak detection system monitoring system on sidewalls	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail	• Prepare calculations with appropriate factors of safety • Specify appropriate material
73.	Leak detection system	Operation	Material failure - compatibility of leak detection system monitoring system on sidewalls with waste	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail	• Undertake material compatibility testing • Specify appropriate material
74.	Leak detection system	Construction	Material failure - mechanical damage of leak detection system monitoring system on sidewalls tensile failure	• Applied load would need to be greater than the capacity of the material	• Undertake construction quality assurance
75.	Leak detection system	Operation	Material failure - mechanical damage of leak detection system monitoring system on sidewalls, tensile failure	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Applied load would need to be greater than the capacity of the material	• Prepare calculations with appropriate factors of safety • Specify appropriate material • Include operational guidance for vehicle movements into and within cells

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
76.	Leak detection system	Construction	Material failure - mechanical damage of leak detection system monitoring system on sidewalls, crushing, intrusion of geotextile layers, de-bonding of geotextile layers	• Applied load would need to be greater than the capacity of the material	• Undertake construction quality assurance
77.	Leak detection system	Operation	Material failure - mechanical damage of leak detection system monitoring system on sidewalls, crushing, intrusion of geotextile layers, de-bonding of geotextile layers	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Applied load would need to be greater than the capacity of the material	• Prepare calculations with appropriate factors of safety • Specify appropriate material • Include operational guidance for vehicle movements into and within cells
78.	Leak extraction system	Operation	Material failure - clogging of sump pipes in leak detection sump	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires to precipitate in material	• Provide way to clean out by flushing • Prepare appropriate calculations for perforations including reduction factors
79.	Leak extraction system	Operation	Material failure - sump pipe incompatibility with waste in leak detection sump	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail	• Undertake material compatibility testing • Specify appropriate material (chemical formulation)
80.	Leak extraction system	Operation	Material failure - insufficient flow rates achieved for effective pumping in leak detection sump	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail	• Perforation sizing and spacing calculations
81.	Leak extraction system	Operation	Material failure - insufficient flow volume achieved for effective pumping in leak detection sump	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail	• Sump / pump sizing calculations
82.	Secondary leachate barrier system	Construction	Material failure - installation damage to geomembrane incl. welds	•	• Undertake construction quality assurance incl. leak location survey
83.	Secondary	Construction	Material failure - installation damage	•	• Undertake construction quality

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
	leachate barrier system		to GCL		assurance
84.	Secondary leachate barrier system	Operation	Material failure - compatibility of geomembrane with waste	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Requires ponding of water over failure location for leakage to take place	• Specify appropriate material (chemical formulation)
85.	Secondary leachate barrier system	Operation	Material failure - compatibility of GCL with waste	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Requires ponding of water over failure location for leakage to take place	• Specify appropriate material (chemical formulation)
86.	Secondary leachate barrier system	Operation	Material failure - wash out of bentonite in GCL	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Requires flow of water adjacent to GCL • Requires ponding of water over failure location for leakage to take place	• Specify non-woven geotextile layers for carrier and cover
87.	Secondary leachate barrier	Operation	Material failure - desiccation of GCL	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail	• Cover as soon as practical

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
	system			• Requires that the leak detection drainage or extraction system fail • Wetting and drying of GCL when exposed • Requires ponding of water over failure location for leakage to take place	
88.	Secondary leachate barrier system	Operation	Material failure - internal shear of GCL	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Loading of GCL causing shear • Requires ponding of water over failure location for leakage to take place	• Prepare calculations with appropriate factors of safety • Specify appropriate material
89.	Secondary leachate barrier system	Operation	Material failure - high hydraulic head from above (leak detection system)	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail	• Automated extraction system from leak detection system
90.	Secondary leachate barrier system	Operation	Material failure - high hydraulic head from below (groundwater diversion system)	• Requires failure of groundwater diversion or extraction system • Requires failure of GCL and geomembrane materials • Requires high water table	• Locate above water table • Extraction system from groundwater system
91.	Groundwater diversion system	Operation	Material failure - clogging of leachate drainage aggregate in groundwater diversion system sump	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Requires secondary barrier system to fail	• Locate above water table • Specify appropriate material properties

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
92.	Groundwater diversion system	Operation	Material failure - compatibility of leachate drainage aggregate in groundwater diversion system sump with waste	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Requires secondary barrier system to fail	• Locate above water table • Undertake material compatibility testing • Specify appropriate material (chemical formulation)
93.	Groundwater diversion system	Construction	Material failure - mechanical damage of leachate drainage aggregate in in groundwater diversion system sump	• Applied load would need to be greater than the capacity of the material	• Locate above water table • Prepare appropriate calculations including reduction factors • Specify appropriate material
94.	Groundwater diversion system	Operation	Material failure - mechanical damage of leachate drainage aggregate in in groundwater diversion system sump	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Requires secondary barrier system to fail • Applied load would need to be greater than the capacity of the material • Requires ponding of water over failure location for leakage to take place	• Locate above water table • Prepare appropriate calculations including reduction factors • Specify appropriate material • Include operational guidance for vehicle movements into and within cells

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
95.	Groundwater diversion system	Operation	Material failure - clogging of groundwater system drainage geocomposite	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Requires secondary barrier system to fail OR • Requires high water table	• Prepare appropriate calculations including reduction factors • Specify appropriate material • Locate above water table
96.	Groundwater diversion system	Operation	Material failure - flow capacity of groundwater diversion system drainage geocomposite	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Requires secondary barrier system to fail OR • Requires high water table	• Prepare appropriate calculations including reduction factors • Specify appropriate material • Locate above water table
97.	Groundwater diversion system	Operation	Material failure - compatibility of groundwater diversion system geocomposite with waste	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Requires secondary barrier system to fail	• Undertake material compatibility testing • Specify appropriate material (chemical formulation)
98.	Groundwater diversion system	Construction	Material failure - mechanical damage of groundwater diversion system drainage geocomposite, tensile failure	• Applied load would need to be greater than the capacity of the material	• Undertake construction quality assurance • Do not allow direct traversing by vehicles once material is installed

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
99.	Groundwater diversion system	Operation	Material failure - mechanical damage of groundwater diversion system drainage geocomposite, tensile failure	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Requires secondary barrier system to fail • Applied load would need to be greater than the capacity of the material	• Prepare appropriate calculations including reduction factors • Specify appropriate material
100.	Groundwater diversion system	Construction	Material failure - mechanical damage of groundwater diversion system drainage geocomposite, crushing, intrusion of geotextile layers, de-bonding of geotextile layers	• Applied load would need to be greater than the capacity of the material	• Prepare appropriate calculations including reduction factors • Specify appropriate material
101.	Groundwater diversion system	Operation	Material failure - mechanical damage of groundwater diversion system drainage geocomposite, crushing, intrusion of geotextile layers, de-bonding of geotextile layers	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Requires secondary barrier system to fail • Applied load would need to be greater than the capacity of the material	• Prepare appropriate calculations including reduction factors • Specify appropriate material • Include operational guidance for vehicle movements into and within cells

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
102.	Groundwater extraction system	Operation	Material failure - clogging of sump pipes in groundwater diversion system sump	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Requires secondary barrier system to fail • Requires precipitation of in sump pipes or perforations OR • Requires high groundwater table • Requires source of clogging	• Prepare appropriate calculations including reduction factors • Specify appropriate material • Locate above water table
103.	Groundwater extraction system	Operation	Material failure - sump pipe incompatibility with waste in groundwater diversion system sump	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Requires secondary barrier system to fail	• Undertake material compatibility testing • Specify appropriate material (chemical formulation)
104.	Groundwater extraction system	Operation	Material failure - insufficient flow rates achieved for effective pumping in groundwater diversion system sump	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Requires secondary barrier system to fail OR • Requires high groundwater table	• Perforation sizing and spacing calculations

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
105.	Groundwater extraction system	Operation	Material failure - insufficient flow volume achieved for effective pumping in groundwater diversion system sump	• Requires failure of leachate collection or extraction system • Requires that the primary barrier system to fail • Requires that the leak detection drainage or extraction system fail • Requires secondary barrier system to fail OR • Requires high groundwater table	• Sump / pump sizing calculations
106.	Liner system	Construction	Stability - interface friction	•	• Prepare calculations
107.	Liner system	Construction	Stability - anchor trench pull-out	• Applied load would need to be greater than the capacity of the anchor trench	• Prepare calculations
108.	Liner system	Operation	Stability - interface friction	•	• Prepare calculations • Include operational guidance for vehicle movements into and within cells
109.	Liner system	Operation	Stability - anchor trench pull-out	• Applied load would need to be greater than the capacity of the anchor trench	• Prepare calculations • Design trench with factors of safety • Include operational guidance for vehicle movements into and within cells
110.	Access ramp	Construction	Stability - excavated surface	•	• Review geotechnical investigation results • Specify shallow grades

Item	Component	Phase	Failure mechanism	Driver for failure	Preventative measure
111.	Access ramp	Operation	Stability - excavated surface	•	• Design surface for expected vehicle loads with factors of safety • Include operational guidance for vehicle movements into and within cells • Specify flat slopes
112.	Access ramp	Operation	Stability - liner materials	•	• Prepare calculations • Include operational guidance for vehicle movements into and within cells • Specify shallow grades
113.	Access ramp	Operation	Stability - ramp materials	• Applied load would need to be greater than the capacity of the materials	• Prepare calculations • Include operational guidance for vehicle movements into and within cells • Specify shallow grades
114.	Access ramp	Operation	Material failure - mechanical damage to liner due to vehicles, puncture	• Applied load would need to be greater than the capacity of the materials	• Design appropriate protection systems for expected vehicle loads with factors of safety • Undertake visual inspections of access roads for areas of damage • Include operational guidance for vehicle movements into and within cells
115.	Intercell bund	Operation	Stability - retaining waste in operational cell, force	• Applied load would need to be greater than the capacity of the bund	• Prepare calculations
116.	Intercell bund	Operation	Stability - retaining flood waters in non-operational cell, force	• Build-up of water adjacent to sump	• Install pumping system to remove water • Prepare calculations
117.	Intercell bund	Operation	Stability - retaining flood waters in non-operational cell, permeability	• Build-up of water adjacent to sump	• Install liner over intercell bund

Appendix B – Cost Comparisons

CAPEX Options Comparison
Cover Sheet

Client:	Hydro	**Job Number:**	2218005	**Revision:**	A
Project:	HAKK	**Prepared by:**	A Roberts	**Date:**	22-Jun-16
Subject:	Cell Optimisation	**Checked by:**	D Barrett	**Date:**	22-Jun-16

Purpose:
This CAPEX Options comparison is undertaken to obtain a preliminary indication of the order of magnitude of the capital costs for various options. It is suitable for providing:
- a preliminary comparison of options
- an indication of whether there is a case for further study of an option
- for rejection of an option

It is not suitable for meaningful economic evaluation or positive acceptance of an option.

Assumptions:
- Unit Rates include materials, labour and equipment
- Costs are based upon those items listed and calculated in the Unit Rate sheet
- Supply costs are based on an exchange rate of US$0.76
- Additional adjustments are based on engineering judgement, experience and site-specific degree of difficulty
- All materials will be supplied by the Contractor unless otherwise noted
- Depth to bedrock assumed to be 4m
- Adequate supplies of water for dust control and eartworks compaction are available daily, free of charge
- No groundwater ingress into the cells occurs as excavation proceeds

Exclusions:
- Indirect costs such as mobilization, camps, supervision (including CQA), site management and administration, light vehicles, survey set out and as-builts, HSE, rain delays, site offices and associated facilities, insurances, fees, site inductions etc.
- Site investigations, lab testing, evironmental reports etc.
- GST
- CPI adjustment
- Project finance
- Internal staging infrastructure such as bund construction etc. (assumed to be included in lining costs)
- Utilities connections
- Insurance
- BoP infrastructure
- Capped waste stockpile excavation and decomissioning
- All operational costs

References:
1. Engineering experience & recent similar projects
2. EIS drawings
3. Design basis
4. Value engineering workshops

Disclaimer:
The CAPEX estimates are estimates only. Actual prices, costs and other variables may be different to those used to prepare the CAPEX estimates. GHD does not represent, warrant or guarantee that the works can or will be undertaken at a cost which is the same or less than the CAPEX estimates. Subject to the above, GHD expressly disclaims responsibility for any error in, or omission from these CAPEX estimates.

Material Stream	Volume (m3)	Quantity (tonnes)	Density (tonnes/m3)
Non-recyclable demolition material including hazourdous materials	25,000	37000	1.48
Contaminated soils	50,000	100000	2.00
Capped Waste Stockpile	190,000	370000	1.95
Total capacity required	265,000	507,000	1.91
20% Bulking	55,000		

CAPEX Options Comparison
Unit Rates and Adjustments

Client:	Hydro	**Job Number:**	2218005	**Revision:**	00
Project:	HAKK	**Prepared by:**	A Roberts	**Date:**	22-Jun-16
Subject:	Cell Optimisation	**Checked by:**	D Barrett	**Date:**	22-Jun-16

Item #	Item Description	Units	Unit Rate	Inflation & Location Adjustments	Additional Adjustments	Adjusted Unit Rate	Notes
Earthworks							
1	Clearing and grubbing	ha	$798.00	0%	0%	$798.00	-
2	Excavation - residual soils	m3	$18.00	0%	0%	$18.00	To stockpile
3	Excavation - rock	m3	$45.00	0%	0%	$45.00	To stockpile
4	Sump excavation	m3	$213.00	0%	0%	$213.00	-
5	Subgrade preparation	m2	$2.38	0%	0%	$2.38	Compaction & conditioning
6	Perimeter bunds around cell (onsite)	m3	$15.77	0%	0%	$15.77	-
Groundwater drainage system							
7	Drainage aggregate	m3	$78.00	0%	0%	$78.00	20-40mm Agregate
8	Sump pipework	m	$268.00	0%	0%	$268.00	DN200
9	Clean out riser pipe DN200	m	$37.06	0%	0%	$37.06	DN200
10	Drainage geocomposite	m2	$12.21	0%	0%	$12.21	GMG512
11	Excavate anchor trenches	m3	$106.00	0%	0%	$106.00	-
Secondary liner and leak detection							
12	Drainage aggregate - sump	m3	$78.00	0%	0%	$78.00	20-40mm Agregate
13	Sump pipework	m	$268.00	0%	0%	$268.00	HDPE DN450
14	Clean out riser pipe DN200	m	$37.06	0%	0%	$37.06	HDPE DN200
15	Drainage sand (imported)	m3	$20.00	0%	0%	$20.00	Sand
16	Protection geotextile	m2	$12.50	0%	0%	$12.50	Nominally 500 g/m2
17	Geomembrane	m2	$12.38	0%	0%	$12.38	2mm HDPE geomembrane
18	Geosynthetic clay liner	m2	$16.00	0%	0%	$16.00	Equivalent to Bentoliner BLST
19	Bituminous Geomembrane	m2	$10.50	0%	0%	$10.50	Coletanche ES3
20	Attenuation Layer	m3	$9.38	0%	0%	$9.38	-
21	Compacted Clay Layer	m3	$17.50	0%	300%	$70.00	Assumes clay is to be imported
22	Excavate anchor trenches	m3	$106.00	0%	0%	$106.00	-
Primary liner and leak detection - base							
23	Protection geotextile	m2	$14.44	0%	0%	$14.44	Nominally 1000 g/m2
24	Geomembrane	m2	$12.38	0%	0%	$12.38	2mm HDPE geomembrane
25	Geosynthetic clay liner	m2	$16.00	0%	0%	$16.00	Equivalent to Bentoliner BLST
26	Drainage geocomposite	m2	$15.00	0%	0%	$15.00	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
Primary liner and leak detection - sidewall							
27	Confining layer (onsite)	m3	$9.38	0%	0%	$9.38	-
28	Protection geotextile	m2	$14.44	0%	0%	$14.44	Nominally 1000 g/m2
29	Geomembrane	m2	$12.38	0%	0%	$12.38	2mm HDPE geomembrane
30	Geosynthetic clay liner	m2	$16.00	0%	0%	$16.00	Equivalent to Bentoliner BLST
31	Drainage geocomposite	m2	$15.00	0%	0%	$15.00	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
32	Excavate anchor trenches	m3	$106.00	0%	0%	$106.00	-
Leachate collection system							
33	Sacrificial geomembrane	m2	$7.00	0%	0%	$7.00	1mm PE geomembrane
34	Seperation geotextile	m2	$12.50	0%	0%	$12.50	Nominally 1000 g/m2
35	Drainage aggregate - base (imported)	m3	$78.00	0%	0%	$78.00	20-40mm Agregate
36	Drainage geocomposite - sidewalls	m2	$15.00	0%	0%	$15.00	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
37	Drainage aggregate sump (imported)	m3	$78.00	0%	0%	$78.00	20-40mm Agregate
38	Sumpwork pipe DN450	m	$828.00	0%	0%	$828.00	DN450
39	Clean out riser pipe DN200	m	$37.06	0%	0%	$37.06	DN200
40	Excavate anchor trenches	m3	$106.00	0%	0%	$106.00	-
Landfill cap							
41	Seal bearing layer (onsite)	m3	$9.38	0%	0%	$9.38	-
42	Compacted Clay Layer	m3	$17.50	0%	300%	$70.00	Assumes clay is to be imported
43	Geosynthetic clay liner	m2	$10.00	0%	0%	$10.00	Equivalent to Bentoliner BLST
44	Geomembrane	m2	$11.00	0%	0%	$11.00	2mm LLDPE
45	Drainage aggregate	m3	$15.00	0%	0%	$15.00	Assumes material is available onsite
46	Subsoil material (onsite)	m3	$9.38	0%	0%	$9.38	-
47	Topsoil (imported)	m3	$45.00	0%	0%	$45.00	-
48	Revegetation	m2	$2.34	0%	0%	$2.34	-

CAPEX Options Comparison
Design Option 1

Client:	Hydro	**Job Number:**	4127557	**Revision:**	A
Project:	HAKK	**Prepared by:**	A Roberts	**Date:**	22-Jun-16
Subject:	EIS Profile	**Checked by:**	D Barrett	**Date:**	22-Jun-16

Item #	Item Description	Units	Adjusted Unit Rate	No. of Units	Cost	Notes
Earthworks						
1	Clearing and grubbing	ha	$798.00	7	$5,383	-
2	Excavation - residual soils	m3	$18.00	164,060	$2,953,074	To stockpile
3	Excavation - rock	m3	$45.00	32,520	$1,463,400	To stockpile
4	Sump excavation	m3	$213.00	600	$127,800	-
5	Subgrade preparation	m2	$2.38	61,797	$147,076	Compaction & conditioning
6	Perimeter bunds around cell (onsite)	m3	$15.77	4,540	$71,601	-
				Subtotal	$4,768,334	
Groundwater drainage system						
7	Drainage aggregate	m3	$78.00	150	$11,700	20-40mm Agregate
8	Sump pipework	m	$268.00	132	$35,376	DN200
9	Clean out riser pipe DN200	m	$37.06	132	$4,892	DN200
10	Drainage geocomposite	m2	$12.21	61,797	$754,537	GMG512
11	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$828,786	
Secondary liner and leak detection						
12	Drainage aggregate - sump	m3	$78.00	150	$11,700	20-40mm Agregate
13	Sump pipework	m	$268.00	264	$70,752	HDPE DN450
14	Clean out riser pipe DN200	m	$37.06	264	$9,784	HDPE DN200
15	Drainage sand (imported)	m3	$20.00	18,539	$370,780	Sand
16	Protection geotextile	m2	$12.50	61,797	$772,458	Nominally 500 g/m2
17	Geomembrane	m2	$12.38	61,797	$765,043	2mm HDPE geomembrane
18	Geosynthetic clay liner	m2	$16.00	0	$0	Equivalent to Bentoliner BLST
19	Bituminous Geomembrane	m2	$10.50	0	$0	Coletanche ES3
20	Attenuation Layer	m3	$9.38	0	$0	-
21	Compacted Clay Layer	m3	$70.00	61,797	$4,325,767	Assumes clay is to be imported
22	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$6,336,865	
Primary liner and leak detection - base						
23	Protection geotextile	m2	$14.44	24,169	$349,003	Nominally 1000 g/m2
24	Geomembrane	m2	$12.38	24,169	$299,215	2mm HDPE geomembrane
25	Geosynthetic clay liner	m2	$16.00	0	$0	Equivalent to Bentoliner BLST
26	Drainage geocomposite	m2	$15.00	24,169	$362,538	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
				Subtotal	$1,010,756	
Primary liner and leak detection - sidewall						
27	Confining layer (onsite)	m3	$9.38	11,288	$105,884	-
28	Protection geotextile	m2	$14.44	37,627	$543,341	Nominally 1000 g/m2
29	Geomembrane	m2	$12.38	37,627	$465,828	2mm HDPE geomembrane
30	Geosynthetic clay liner	m2	$16.00	37,627	$602,039	Equivalent to Bentoliner BLST
31	Drainage geocomposite	m2	$15.00	37,627	$564,412	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
32	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$2,303,785	
Leachate collection system						
33	Sacraficial geomembrane	m2	$7.00	37,627	$263,392	1mm PE geomembrane
34	Seperation geotextile	m2	$12.50	24,169	$302,115	Nominally 1000 g/m2
35	Drainage aggregate - base (imported)	m3	$78.00	7,251	$565,559	20-40mm Agregate
36	Drainage geocomposite - sidewalls	m2	$15.00	37,627	$564,412	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
37	Drainage aggregate sump (imported)	m3	$78.00	150	$11,700	20-40mm Agregate
38	Sumpwork pipe DN450	m	$828.00	66	$54,648	DN450
39	Clean out riser pipe DN200	m	$37.06	66	$2,446	DN200
40	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$1,786,554	
Landfill cap						
41	Seal bearing layer (onsite)	m3	$9.38	14,745	$138,306	-
42	Compacted Clay Layer	m3	$70.00	29,490	$2,064,273	Assumes clay is to be imported
43	Geosynthetic clay liner	m2	$10.00	0	$0	Equivalent to Bentoliner BLST
44	Geomembrane	m2	$11.00	49,149	$540,643	2mm LLDPE
45	Drainage aggregate	m3	$15.00	14,745	$221,172	Assumes material is available onsite
46	Subsoil material (onsite)	m3	$9.38	131,656	$1,234,933	-
47	Topsoil (imported)	m3	$45.00	10,119	$455,340	-
48	Revegetation	m2	$2.34	67,458	$157,851	-
				Subtotal	$4,812,518	
				Total	$19,447,189	

CAPEX Options Comparison
Design Option 2

Client:	Hydro	**Job Number:**	4127557	**Revision:**	A
Project:	HAKK	**Prepared by:**	A Roberts	**Date:**	22-Jun-16
Subject:	EIS with Attenuation	**Checked by:**	D Barrett	**Date:**	22-Jun-16

Item #	Item Description	Units	Adjusted Unit Rate	No. of Units	Cost	Notes
Earthworks						
1	Clearing and grubbing	ha	$798.00	7	$5,383	-
2	Excavation - residual soils	m3	$18.00	164,060	$2,953,074	To stockpile
3	Excavation - rock	m3	$45.00	32,520	$1,463,400	To stockpile
4	Sump excavation	m3	$213.00	600	$127,800	-
5	Subgrade preparation	m2	$2.38	61,797	$147,076	Compaction & conditioning
6	Perimeter bunds around cell (onsite)	m3	$15.77	4,540	$71,601	-
				Subtotal	$4,768,334	
Groundwater drainage system						
7	Drainage aggregate	m3	$78.00	150	$11,700	20-40mm Agregate
8	Sump pipework	m	$268.00	132	$35,376	DN200
9	Clean out riser pipe DN200	m	$37.06	132	$4,892	DN200
10	Drainage geocomposite	m2	$12.21	61,797	$754,537	GMG512
11	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$828,786	
Secondary liner and leak detection						
12	Drainage aggregate - sump	m3	$78.00	150	$11,700	20-40mm Agregate
13	Sump pipework	m	$268.00	264	$70,752	HDPE DN450
14	Clean out riser pipe DN200	m	$37.06	132	$4,892	HDPE DN200
15	Drainage sand (imported)	m3	$30.00	18,539	$556,170	Sand
16	Protection geotextile	m2	$12.50	61,797	$772,458	Nominally 500 g/m2
17	Geomembrane	m2	$12.38	61,797	$765,043	2mm HDPE geomembrane
18	Geosynthetic clay liner	m2	$16.00	61,797	$988,747	Equivalent to Bentoliner BLST
19	Bituminous Geomembrane	m2	$10.50	0	$0	Coletanche ES3
20	Attenuation Layer	m3	$9.38	61,797	$579,653	-
21	Compacted Clay Layer	m3	$70.00	0	$0	Assumes clay is to be imported
22	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$3,759,996	
Primary liner and leak detection - base						
23	Protection geotextile	m2	$14.44	24,169	$349,003	Nominally 1000 g/m2
24	Geomembrane	m2	$12.38	24,169	$299,215	2mm HDPE geomembrane
25	Geosynthetic clay liner	m2	$16.00	24,169	$386,707	Equivalent to Bentoliner BLST
26	Drainage geocomposite	m2	$15.00	24,169	$362,538	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
				Subtotal	$1,397,464	
Primary liner and leak detection - sidewall						
27	Confining layer (onsite)	m3	$9.38	11,288	$105,884	-
28	Protection geotextile	m2	$14.44	37,627	$543,341	Nominally 1000 g/m2
29	Geomembrane	m2	$12.38	37,627	$465,828	2mm HDPE geomembrane
30	Geosynthetic clay liner	m2	$16.00	37,627	$602,039	Equivalent to Bentoliner BLST
31	Drainage geocomposite	m2	$15.00	37,627	$564,412	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
32	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$2,303,785	
Leachate collection system						
33	Sacrificial geomembrane	m2	$7.00	37,627	$263,392	1mm PE geomembrane
34	Seperation geotextile	m2	$12.50	24,169	$302,115	Nominally 1000 g/m2
35	Drainage aggregate - base (imported)	m3	$78.00	7,251	$565,559	20-40mm Agregate
36	Drainage geocomposite - sidewalls	m2	$15.00	37,627	$564,412	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
37	Drainage aggregate sump (imported)	m3	$78.00	150	$11,700	20-40mm Agregate
38	Sumpwork pipe DN450	m	$828.00	66	$54,648	DN450
39	Clean out riser pipe DN200	m	$37.06	66	$2,446	DN200
40	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$1,786,554	
Landfill cap						
41	Seal bearing layer (onsite)	m3	$9.38	14,745	$138,306	-
42	Compacted Clay Layer	m3	$70.00	0	$0	Assumes clay is to be imported
43	Geosynthetic clay liner	m2	$10.00	49,149	$491,494	Equivalent to Bentoliner BLST
44	Geomembrane	m2	$11.00	49,149	$540,643	2mm LLDPE
45	Drainage aggregate	m3	$15.00	14,745	$221,172	Assumes material is available onsite
46	Subsoil material (onsite)	m3	$9.38	131,656	$1,234,933	-
47	Topsoil (imported)	m3	$45.00	10,119	$455,340	-
48	Revegetation	m2	$2.34	67,458	$157,851	-
				Subtotal	$3,239,739	
				Total	$16,470,638	

CAPEX Options Comparison
Design Option 3

Client:	Hydro	**Job Number:**	4127557	**Revision:**	A
Project:	HAKK	**Prepared by:**	A Roberts	**Date:**	22-Jun-16
Subject:	BGM only	**Checked by:**	D Barrett	**Date:**	22-Jun-16

Item #	Item Description	Units	Adjusted Unit Rate	No. of Units	Cost	Notes
Earthworks						
1	Clearing and grubbing	ha	$798.00	7	$5,383	-
2	Excavation - residual soils	m3	$18.00	140,089	$2,521,594	To stockpile
3	Excavation - rock	m3	$45.00	32,520	$1,463,400	To stockpile
4	Sump excavation	m3	$213.00	600	$127,800	-
5	Subgrade preparation	m2	$2.38	61,797	$147,076	Compaction & conditioning
6	Perimeter bunds around cell (onsite)	m3	$15.77	4,540	$71,601	-
				Subtotal	$4,336,854	
Groundwater drainage system						
7	Drainage aggregate	m3	$78.00	150	$11,700	20-40mm Agregate
8	Sump pipework	m	$268.00	132	$35,376	DN200
9	Clean out riser pipe DN200	m	$37.06	132	$4,892	DN200
10	Drainage geocomposite	m2	$12.21	61,797	$754,537	GMG512
11	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$828,786	
Secondary liner and leak detection						
12	Drainage aggregate - sump	m3	$78.00	150	$11,700	20-40mm Agregate
13	Sump pipework	m	$268.00	264	$70,752	HDPE DN450
14	Clean out riser pipe DN200	m	$37.06	132	$4,892	HDPE DN200
15	Drainage sand (imported)	m3	$20.00	18,539	$370,780	Sand
16	Protection geotextile	m2	$12.50	0	$0	Nominally 500 g/m2
17	Geomembrane	m2	$12.38	0	$0	2mm HDPE geomembrane
18	Geosynthetic clay liner	m2	$16.00	0	$0	Equivalent to Bentoliner BLST
19	Bituminous Geomembrane	m2	$10.50	61,797	$648,865	Coletanche ES3
20	Attenuation Layer	m3	$9.38	0	$0	-
21	Compacted Clay Layer	m3	$70.00	0	$0	Assumes clay is to be imported
22	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$1,117,570	
Primary liner and leak detection - base						
23	Protection geotextile	m2	$14.44	24,169	$349,003	Nominally 1000 g/m2
24	Geomembrane	m2	$12.38	24,169	$299,215	2mm HDPE geomembrane
25	Geosynthetic clay liner	m2	$16.00	24,169	$386,707	Equivalent to Bentoliner BLST
26	Drainage geocomposite	m2	$15.00	24,169	$362,538	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
				Subtotal	$1,397,464	
Primary liner and leak detection - sidewall						
27	Confining layer (onsite)	m3	$9.38	11,288	$105,884	-
28	Protection geotextile	m2	$14.44	37,627	$543,341	Nominally 1000 g/m2
29	Geomembrane	m2	$12.38	37,627	$465,828	2mm HDPE geomembrane
30	Geosynthetic clay liner	m2	$16.00	37,627	$602,039	Equivalent to Bentoliner BLST
31	Drainage geocomposite	m2	$15.00	37,627	$564,412	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
32	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$2,303,785	
Leachate collection system						
33	Sacrificial geomembrane	m2	$7.00	37,627	$263,392	1mm PE geomembrane
34	Seperation geotextile	m2	$12.50	24,169	$302,115	Nominally 1000 g/m2
35	Drainage aggregate - base (imported)	m3	$78.00	7,251	$565,559	20-40mm Agregate
36	Drainage geocomposite - sidewalls	m2	$15.00	37,627	$564,412	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
37	Drainage aggregate sump (imported)	m3	$78.00	150	$11,700	20-40mm Agregate
38	Sumpwork pipe DN450	m	$828.00	66	$54,648	DN450
39	Clean out riser pipe DN200	m	$37.06	66	$2,446	DN200
40	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$1,786,554	
Landfill cap						
41	Seal bearing layer (onsite)	m3	$9.38	14,745	$138,306	-
42	Compacted Clay Layer	m3	$70.00	0	$0	Assumes clay is to be imported
43	Geosynthetic clay liner	m2	$10.00	49,149	$491,494	Equivalent to Bentoliner BLST
44	Geomembrane	m2	$11.00	49,149	$540,643	2mm LLDPE
45	Drainage aggregate	m3	$15.00	14,745	$221,172	Assumes material is available onsite
46	Subsoil material (onsite)	m3	$9.38	131,656	$1,234,933	-
47	Topsoil (imported)	m3	$45.00	10,119	$455,340	-
48	Revegetation	m2	$2.34	67,458	$157,851	-
				Subtotal	$3,239,739	
				Total	$13,396,732	

CAPEX Options Comparison
Design Option 4

Client:	Hydro	**Job Number:**	4127557	**Revision:**	A
Project:	HAKK	**Prepared by:**	A Roberts	**Date:**	22-Jun-16
Subject:	BGM with attenuation	**Checked by:**	D Barrett	**Date:**	22-Jun-16

Item #	Item Description	Units	Adjusted Unit Rate	No. of Units	Cost	Notes
Earthworks						
1	Clearing and grubbing	ha	$798.00	7	$5,383	-
2	Excavation - residual soils	m3	$18.00	164,060	$2,953,074	To stockpile
3	Excavation - rock	m3	$45.00	32,520	$1,463,400	To stockpile
4	Sump excavation	m3	$213.00	600	$127,800	-
5	Subgrade preparation	m2	$2.38	61,797	$147,076	Compaction & conditioning
6	Perimeter bunds around cell (onsite)	m3	$15.77	4,540	$71,601	-
				Subtotal	$4,768,334	
Groundwater drainage system						
7	Drainage aggregate	m3	$78.00	150	$11,700	20-40mm Agregate
8	Sump pipework	m	$268.00	132	$35,376	DN200
9	Clean out riser pipe DN200	m	$37.06	132	$4,892	DN200
10	Drainage geocomposite	m2	$12.21	61,797	$754,537	GMG512
11	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$828,786	
Secondary liner and leak detection						
12	Drainage aggregate - sump	m3	$78.00	150	$11,700	20-40mm Agregate
13	Sump pipework	m	$268.00	264	$70,752	HDPE DN450
14	Clean out riser pipe DN200	m	$37.06	132	$4,892	HDPE DN200
15	Drainage sand (imported)	m3	$20.00	18,539	$370,780	Sand
16	Protection geotextile	m2	$12.50	0	$0	Nominally 500 g/m2
17	Geomembrane	m2	$12.38	0	$0	2mm HDPE geomembrane
18	Geosynthetic clay liner	m2	$16.00	0	$0	Equivalent to Bentoliner BLST
19	Bituminous Geomembrane	m2	$10.50	61,797	$648,865	Coletanche ES3
20	Attenuation Layer	m3	$9.38	61,797	$579,653	-
21	Compacted Clay Layer	m3	$70.00	0	$0	Assumes clay is to be imported
22	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$1,697,223	
Primary liner and leak detection - base						
23	Protection geotextile	m2	$14.44	24,169	$349,003	Nominally 1000 g/m2
24	Geomembrane	m2	$12.38	24,169	$299,215	2mm HDPE geomembrane
25	Geosynthetic clay liner	m2	$16.00	24,169	$386,707	Equivalent to Bentoliner BLST
26	Drainage geocomposite	m2	$15.00	24,169	$362,538	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
				Subtotal	$1,397,464	
Primary liner and leak detection - sidewall						
27	Confining layer (onsite)	m3	$9.38	11,288	$105,884	-
28	Protection geotextile	m2	$14.44	37,627	$543,341	Nominally 1000 g/m2
29	Geomembrane	m2	$12.38	37,627	$465,828	2mm HDPE geomembrane
30	Geosynthetic clay liner	m2	$16.00	37,627	$602,039	Equivalent to Bentoliner BLST
31	Drainage geocomposite	m2	$15.00	37,627	$564,412	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
32	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$2,303,785	
Leachate collection system						
33	Sacraficial geomembrane	m2	$7.00	37,627	$263,392	1mm PE geomembrane
34	Seperation geotextile	m2	$12.50	24,169	$302,115	Nominally 1000 g/m2
35	Drainage aggregate - base (imported)	m3	$78.00	7,251	$565,559	20-40mm Agregate
36	Drainage geocomposite - sidewalls	m2	$15.00	37,627	$564,412	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
37	Drainage aggregate sump (imported)	m3	$78.00	150	$11,700	20-40mm Agregate
38	Sumpwork pipe DN450	m	$828.00	66	$54,648	DN450
39	Clean out riser pipe DN200	m	$37.06	66	$2,446	DN200
40	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$1,786,554	
Landfill cap						
41	Seal bearing layer (onsite)	m3	$9.38	14,745	$138,306	-
42	Compacted Clay Layer	m3	$70.00	0	$0	Assumes clay is to be imported
43	Geosynthetic clay liner	m2	$10.00	49,149	$491,494	Equivalent to Bentoliner BLST
44	Geomembrane	m2	$11.00	49,149	$540,643	2mm LLDPE
45	Drainage aggregate	m3	$15.00	14,745	$221,172	Assumes material is available onsite
46	Subsoil material (onsite)	m3	$9.38	131,656	$1,234,933	-
47	Topsoil (imported)	m3	$45.00	10,119	$455,340	-
48	Revegetation	m2	$2.34	67,458	$157,851	-
				Subtotal	$3,239,739	
				Total	$14,407,865	

CAPEX Options Comparison
Design Option 5

Client:	Hydro	**Job Number:**	4127557	**Revision:**	A
Project:	HAKK	**Prepared by:**	A Roberts	**Date:**	22-Jun-16
Subject:	EIS Profile with GCL in cap	**Checked by:**	D Barrett	**Date:**	22-Jun-16

Item #	Item Description	Units	Adjusted Unit Rate	No. of Units	Cost	Notes
Earthworks						
1	Clearing and grubbing	ha	$798.00	7	$5,383	-
2	Excavation - residual soils	m3	$18.00	164,060	$2,953,074	To stockpile
3	Excavation - rock	m3	$45.00	32,520	$1,463,400	To stockpile
4	Sump excavation	m3	$213.00	600	$127,800	-
5	Subgrade preparation	m2	$2.38	61,797	$147,076	Compaction & conditioning
6	Perimeter bunds around cell (onsite)	m3	$15.77	4,540	$71,601	-
				Subtotal	$4,768,334	
Groundwater drainage system						
7	Drainage aggregate	m3	$78.00	150	$11,700	20-40mm Agregate
8	Sump pipework	m	$268.00	132	$35,376	DN200
9	Clean out riser pipe DN200	m	$37.06	132	$4,892	DN200
10	Drainage geocomposite	m2	$12.21	61,797	$754,537	GMG512
11	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$828,786	
Secondary liner and leak detection						
12	Drainage aggregate - sump	m3	$78.00	150	$11,700	20-40mm Agregate
13	Sump pipework	m	$268.00	264	$70,752	HDPE DN450
14	Clean out riser pipe DN200	m	$37.06	132	$4,892	HDPE DN200
15	Drainage sand (imported)	m3	$20.00	18,539	$370,780	Sand
16	Protection geotextile	m2	$12.50	61,797	$772,458	Nominally 500 g/m2
17	Geomembrane	m2	$12.38	61,797	$765,043	2mm HDPE geomembrane
18	Geosynthetic clay liner	m2	$16.00	61,797	$988,747	Equivalent to Bentoliner BLST
19	Bituminous Geomembrane	m2	$10.50	0	$0	Coletanche ES3
20	Attenuation Layer	m3	$9.38	0	$0	-
21	Compacted Clay Layer	m3	$70.00	61,797	$4,325,767	Assumes clay is to be imported
22	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$7,320,720	
Primary liner and leak detection - base						
23	Protection geotextile	m2	$14.44	24,169	$349,003	Nominally 1000 g/m2
24	Geomembrane	m2	$12.38	24,169	$299,215	2mm HDPE geomembrane
25	Geosynthetic clay liner	m2	$16.00	24,169	$386,707	Equivalent to Bentoliner BLST
26	Drainage geocomposite	m2	$15.00	24,169	$362,538	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
				Subtotal	$1,397,464	
Primary liner and leak detection - sidewall						
27	Confining layer (onsite)	m3	$9.38	11,288	$105,884	-
28	Protection geotextile	m2	$14.44	37,627	$543,341	Nominally 1000 g/m2
29	Geomembrane	m2	$12.38	37,627	$465,828	2mm HDPE geomembrane
30	Geosynthetic clay liner	m2	$16.00	37,627	$602,039	Equivalent to Bentoliner BLST
31	Drainage geocomposite	m2	$15.00	37,627	$564,412	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
32	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$2,303,785	
Leachate collection system						
33	Sacraficial geomembrane	m2	$7.00	37,627	$263,392	1mm PE geomembrane
34	Seperation geotextile	m2	$12.50	24,169	$302,115	Nominally 1000 g/m2
35	Drainage aggregate - base (imported)	m3	$78.00	7,251	$565,559	20-40mm Agregate
36	Drainage geocomposite - sidewalls	m2	$15.00	37,627	$564,412	8.0mm geocomposite drain (with 120gsm geotextile on both sides)
37	Drainage aggregate sump (imported)	m3	$78.00	150	$11,700	20-40mm Agregate
38	Sumpwork pipe DN450	m	$828.00	66	$54,648	DN450
39	Clean out riser pipe DN200	m	$37.06	66	$2,446	DN200
40	Excavate anchor trenches	m3	$106.00	210	$22,281	-
				Subtotal	$1,786,554	
Landfill cap						
41	Seal bearing layer (onsite)	m3	$9.38	14,745	$138,306	-
42	Compacted Clay Layer	m3	$70.00	0	$0	Assumes clay is to be imported
43	Geosynthetic clay liner	m2	$10.00	49,149	$491,494	Equivalent to Bentoliner BLST
44	Geomembrane	m2	$11.00	49,149	$540,643	2mm LLDPE
45	Drainage aggregate	m3	$15.00	14,745	$221,172	Assumes material is available onsite
46	Subsoil material (onsite)	m3	$9.38	131,656	$1,234,933	-
47	Topsoil (imported)	m3	$45.00	10,119	$455,340	-
48	Revegetation	m2	$2.34	67,458	$157,851	-
				Subtotal	$3,239,739	
				Total	$20,031,362	

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Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	A Roberts	D Barrett		D Barrett		30.06.17
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Appendix C Leachate Assessment

Hydro Aluminium Kurri Kurri Pty Ltd

Leachate Management

Options Assessment Report

September 2017

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1. Introduction

1.1 General

GHD Pty Ltd (GHD) has been engaged by Hydro Aluminium Kurri Kurri Pty Ltd (herein referred to as 'Hydro') to prepare a detailed engineering design report and supporting documentation for a proposed containment cell for the Hydro Demolition and Remediation Project (the Project). The future containment cell will be an engineered facility for the purpose of immobilising and managing various waste streams generated by the Capped Waste Stockpile and the demolition and remediation of the Smelter.

1.2 Purpose of this report

The purpose of this report is to document the study of leachate management options for the proposed containment cell at the Hydro Aluminium Kurri Kurri Pty Ltd Demolition and Remediation Project.

1.3 Limitations

This report has been prepared by GHD for Hydro Aluminium Kurri Kurri Pty Ltd and may only be used and relied on by Hydro Aluminium Kurri Kurri Pty Ltd for the purpose agreed between GHD and Hydro Aluminium Kurri Kurri Pty Ltd.

GHD otherwise disclaims responsibility to any person other than Hydro Aluminium Kurri Kurri Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer section 1.4). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Hydro Aluminium Kurri Kurri Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

GHD has prepared the cost estimates in this report using information reasonably available to GHD and based on assumptions and judgments outlined by GHD in Section 1.4 of this report. The Cost Estimate is a preliminary estimate only. Actual prices, costs and other variables may be different to those used to prepare the Cost Estimate and may change. Unless as otherwise specified in this report, no detailed quotation has been obtained for actions identified in this report. GHD does not represent, warrant or guarantee that the project can or will be undertaken at a cost which is the same or less than the Cost Estimate.

Where estimates of potential costs are provided with an indicated level of confidence, notwithstanding the conservatism of the level of confidence selected as the planning level, there remains a chance that the cost will be greater than the planning estimate, and any funding would not be adequate. The confidence level considered to be most appropriate for planning purposes will vary depending on the conservatism of the user and the nature of the project. The user should therefore select appropriate confidence levels to suit their particular risk profile.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

1.4 Assumptions

Section 2 of this document provides basis of design information and key assumptions used in developing the options for the project.

1.5 Available documentation

Information made available to GHD in the production of this report included:

- Ramboll Environ (2015), Environmental Impact Statement – Former Hydro Aluminium Kurri Kurri Smelter Demolition and Remediation
- D&M (1992 Part 2 of 3), Waste Storage Environmental Impact Statement
- Douglas & Partners (1990), Investigation Report – Toxicity Testing
- Hydro Aluminium Kurri Kurri Pty Ltd, CWS - Leachate and gas monitoring.xlsx
- Hydro Aluminium Kurri Kurri Pty Ltd, Leachate Analysis_KMcN.xlsx
- Ramboll Environ (2015), Characteristics of the Capped Waste Stockpile
- NSW Environment Protection Authority, Environmental Protection Licence - NSW Licence number 1548
- Hunter Water Corporation (1999), Major Trade Waste Permit
- Hunter Water Corporation (2013), Trade Wastewater Agreement

- Ramboll Environ (2016), Draft Capped Waste Stockpile Assessment
- Pulver Cooper & Blackley (2016), Stormwater Management Report - Flood Modelling Review

2. Leachate management design basis

2.1 Scope of leachate management

The Environmental Impact Statement - Former Hydro Aluminium Kurri Kurri Smelter Demolition and Remediation (Ramboll Environ, 2015) describes a requirement for a significant quantity of contaminated groundwater to be treated.

At the leachate design basis workshop (23/5/16) Fiona Robinson (Ramboll Environ) advised that it has been demonstrated and presented to the regulator that the leachate affected groundwater plume extending out from the Capped Waste Stockpile (CWS) is not currently causing environmental harm.

The removal of waste and remediation of the CWS will subsequently result in an improvement in groundwater quality over time. Therefore, it is no longer considered necessary to extract and treat the contaminated groundwater plume extending out from the CWS.

During excavation of waste from the CWS, a layer of contaminated natural ground under the waste material will also be removed. During this activity it is expected that there will be some contaminated groundwater ingress into the excavation.

The leachate system is therefore required to manage the following water sources:

- Leachate from the CWS:
  - stormwater that falls on the CWS and becomes contaminated during excavation
  - residual leachate in the waste material and contaminated groundwater that enters the CWS excavation during the extraction of waste material and the underlying contaminated natural ground
- Leachate from the containment cell:
  - stormwater that falls within waste containing sub-cells in the containment cell and becomes contaminated during the placement of waste
  - residual leachate generated from the containment cell following capping of the sub-cells

The leachate management system to which this design basis applies does not allow for:

- treatment of the existing contaminated groundwater plume extending out from the CWS, site stormwater other than that falling in the CWS or containment cell generating leachate, or existing water stored in on site dams
- treatment of any leachate associated with off site stockpiles e.g. the three smaller landfill sites contributing waste material to the containment cell

2.2 Leachate quality

The collected groundwater quality data in the vicinity of the CWS is significantly more extensive than leachate quality data.

An active interception trench was constructed downstream of the CWS in 2014 to intercept and pump out affected groundwater. Groundwater wells in the vicinity of the CWS interception trench provide an indication of relative levels of contamination from the leachate, although the contaminant concentrations may be more dilute than those in the CWS.

Additional sampling was conducted from new wells in the CWS in November and December 2015 to provide more representative leachate water quality data.

2.2.1 Capped waste stockpile material composition

The Characteristics of the Capped Waste Stockpile (2015) report noted the following regarding the composition of the CWS.

> *The following materials are understood to be contained within the Capped Waste Stockpile:*
>
> *Spent pot lining*
>
> *Carbon Plant shot blast refuse, including grit and dust*
>
> *Carbon Plant dust collector product*
>
> *Collar mix (coke, pitch) spillage*
>
> *Carbon Plant floor sweepings*
>
> *Packing coke oversize*
>
> *Contaminated bath*
>
> *Rotary breaker oversize*
>
> *Pot lining mix (hot ramming paste)*
>
> *Rodding mix (coke, graphite, pitch and anthracene oil)*
>
> *Stud joining mix*
>
> *Pitch spills/pencil pitch*
>
> *Aluminium swarf*
>
> *Scrap aluminium billets*
>
> *Anode cover material*
>
> *Butt from spent anodes*
>
> *Ahead of schedule anodes*
>
> *Dross*
>
> *Pot bottom aluminium*
>
> *Consumable gaskets, insulation material (synthetic mineral fibre, asbestos)*
>
> *General rubbish, including plastic, wood and steel.*

With the exception of spent pot lining, the majority of these materials are associated with the Carbon Plant, which produced carbon anodes from liquid pitch and petroleum coke. The main chemicals of concern for these materials are Polycyclic Aromatic Hydrocarbons (PAHs). PAHs associated with pitch, coke and anodes have a low solubility in water and are unlikely to generate leachable concentrations.

In addition to the material in the existing CWS, other materials e.g. contaminated soils, smelter wastes, asbestos and glass and demolition wastes, will be stored in the proposed containment cell, which may impact on the quality of the leachate generated. However, leachate quality will be dominated by the CWS material.

2.2.2 Historical leachate pond water quality

Table 1 summarises a range of water quality data from the previous leachate pond (also refered to as cathode pile dam – see “Collected Leachate” in Figure 1 below, extracted from Figure 4.3 in Waste Storage EIS (D&M, 1992 Part 2 of 3)). Part of this summary table was sourced from the Waste Storage EIS (D&M, 1992 Part 2 of 3). This information was supplemented with additional analytes from the original sourced data used in the Waste Storage EIS and additional sample (Investigation Report - Toxicity Testing - Douglas & Partners 1990) not included in the EIS.

Table 1 Historical leachate pond water quality

	Coffey & Partners (1987)	Patterson & Britton (1990)	D J Douglas (1990)	Houseman (Nov 1990)	Douglas & Partners (1990)
pH (pH units)	10.6	10.5		10.9	10.8
Total Alkalinity as $CaCO_3$ (mg/L)	22,300			17,100	48,400
Electrical Conductivity (uS/cm)		51,600		40,600	
Sodium (mg/L)	4,800	16,400-17,100	15,300	15,800	11 [(1)]
Potassium (mg/L)	75	140-168	102	102	88
Calcium (mg/L)	30	<2	<0.8		3
Magnesium (mg/L)	2	0.2	2		2
Iron (mg/L)	20	73-79			36
Aluminium (mg/L)	<1				
Silicon (as Si) (mg/L)	25				
Chloride (mg/L)	700		810	460	
Fluoride (mg/L)	1,100	3,300	3,420	4,200	2,500
Sulphide (mg/L)		present			126
Sulphate (mg/L)	4,000		6,740	3,990	
Cyanide (mg/L)	70	130-200	133	148	158
Carbonate as CO3 (mg/L)				10,540	
Arsenic (mg/L)		0.7			1
Bismuth (mg/L)		0.15			<0.1
Cadmium (mg/L)		<0.01			<0.05
Cobalt (mg/L)		0.27			0.2
Chromium (mg/L)		<0.05			0.1
Copper (mg/L)		0.6			1.05
Manganese (mg/L)		<0.1			<0.05
Molybdenum (mg/L)		1.5			1.25
Nickel (mg/L)		2.1			1.35
Lead (mg/L)		<0.1			0.3
Antimony (mg/L)		<0.2			<0.1
Tin (mg/L)		<0.1			<0.1
Uranium (mg/L)		3			<0.1
Vanadium (mg/L)		7.4			4.8
Tungsten (mg/L)		0.4			<0.2
Zinc (mg/L)		<0.1			0.35

[1] This value is likely to be in g/L rather than in mg/L as reported in Investigation Report - Toxicity Testing - Douglas & Partners, 1990.

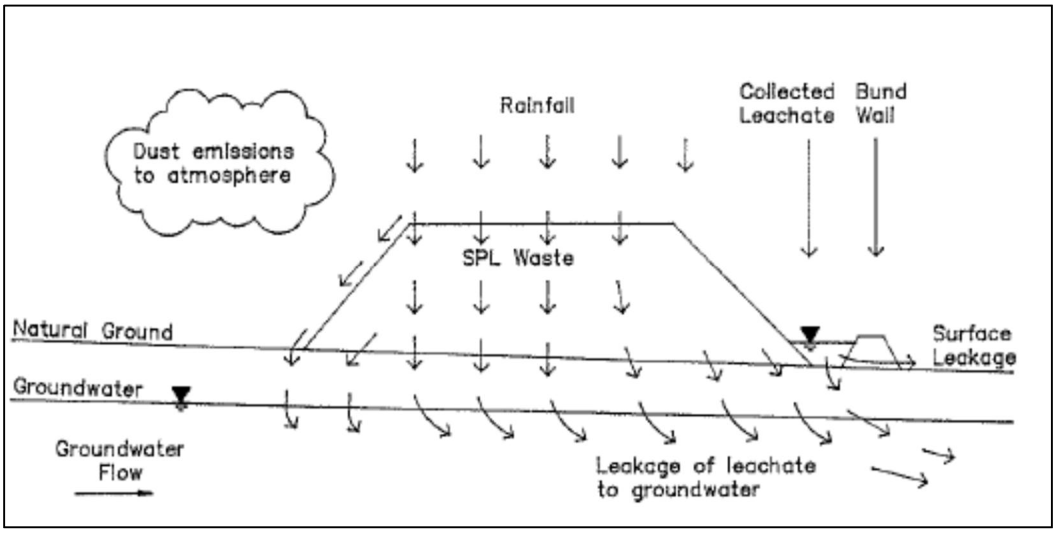

Figure 1 Leachate pond schematic (prior to capping)

2.2.3 Active interception trench

As the purpose of the active interception trench is to capture shallow groundwater that has been contaminated by the capped stockpile, samples from this trench will define the composition of the leachate-impacted groundwater rather than the leachate itself. While these samples will show indicatively what contaminants are entering the groundwater and their relative concentrations, these samples may represent contaminant concentrations at lower levels than they will be present in leachate not diluted by groundwater.

Similarly, groundwater wells in the vicinity of the CWS provide an indication of relative levels of contamination from the leachate but the contaminant concentrations are likely to be more diluted than those in the undiluted leachate.

Table 2 summarises data from samples of leachate-impacted groundwater taken from the active interception trench pump outlet from 7/05/2014 to 18/09/2015 (CWS - Leachate and gas monitoring.xlsx).

Table 2 Leachate active interception trench water quality (pump outlet)

Parameter	Soluble Fluoride mg/L	pH
Min	289	9.1
Max	794	9.9
Average	628	9.6
Median	641	9.6

Note: Statistics based on 182 samples

Table 3 summarises data from samples of leachate-impacted groundwater taken near the vegetation impact areas from 27/02/2013 to 4/09/2015 (Leachate Analysis_KMcN.xlsx).

Table 3 Leachate interception trench water quality (bores)

Parameter	Leachate 1 - Start of vegetation impact area, immediately below interception trench		Leachate 2 - Intersection of road and bottom of vegetation impact area 1	
	pH	Soluble Fluoride mg/L	pH	Soluble Fluoride mg/L
Count	9	9	10	10
Min	8.3	15.4	7.8	15.1
Max	9.6	372.0	9.3	162.0
Average	9.1	255.2	8.5	74.4
Median	9.0	303.0	8.5	60.1

Table 4 presents a more comprehensive analyte suite for two samples from the active interception trench taken in June 2015 (Characteristics of the Capped Waste Stockpile – 2015).

Table 4 Interception trench water quality

Chemical	LT01 (3/6/2015) mg/L	LT02 (4/6/15) mg/L
pH (pH units)	9.7	9.7
Electrical Conductivity (uS/cm)	15,000	16,000
Aluminium	46	42
Iron	33	31
Fluoride	480	490
Total Cyanide	79	85
Mercury	<0.00005	<0.00005
Calcium	7	<5
Potassium	18	13
Sodium	5,600	5,600
Magnesium	3.6	2.4
Hydroxide Alkalinity as CaCO3	<5	<5
Bicarbonate Alkalinity as CaCO3	3,300	3,500
Carbonate Alkalinity as CaCO3	4,600	4,700
Total Alkalinity as CaCO3	7,900	8,200
Sulphate	1,900	2,000
Chloride	160	150
TRH C6-C10	<0.01	<0.01
TRH C10-40	<0.1	<0.1
BTEX	<0.002	<0.002
Benzo(a)pyrene	<0.001	<0.001
Total PAHs	<0.002	<0.002
PCBs	<0.002	<0.002

2.2.4 Additional leachate sampling

Prior to the recent core drilling and well installation, the only analyses of leachate available appears to be from the old leachate collection pond around 1990. The results from sampling in this pond may also have been influenced by varying volumes of stormwater runoff and evaporation in the pond.

To supplement historical water quality data from the leachate pond and leachate affected groundwater from the intercept trench, GHD recommended additional sampling be conducted from new wells in the Capped Waste Stockpile to provide more representative leachate water quality data.

Ramboll Environ arranged for wells to be drilled in a number of locations in the CWS. These wells fulfilled the dual purpose of obtaining core samples for EIS purposes, as well as enabling leachate sampling to be undertaken for this assessment. Two rounds of sampling were conducted due to limited sample volume availability and on both occasions, samples were extracted by Ramboll Environ and GHD prepared the samples for laboratory analysis.

At the time of sampling, only two of the six new wells generated sufficient leachate to sample for full laboratory analysis:

- MW202 which was sampled from the level of the waste
- MW206 which was sampled from below the waste in the natural ground level

Sufficient water was present in two other wells to provide limited water quality information:

- MW203 which was sampled from below the waste in the natural ground level
- MW204 which was sampled from below the waste in the natural ground level

Although the recent samples from the CWS may have been influenced by groundwater intrusion (potentially diluted), the results are expected to be more representative of anticipated leachate quality than historical groundwater figures.

When the material in the existing capped waste stockpile is exposed to atmosphere during its transfer to the new containment cell, the change from anaerobic to aerobic conditions (redox potential) may result in changes to liquid and solids chemistry and may impact the leachate characteristics. No existing information on the change in solids/leachate chemistry due to oxygen exposure has been identified.

The leachate testing conducted to date is likely to have identified the key contaminants likely to appear in the leachate. However, there is a risk that the leachate generated may have higher concentrations than the current sampling data indicates, as discussed above.

The relevant well locations are shown in Figure 2 (an extract from Figure 2 in the Draft Capped Waste Stockpile Assessment (Ramboll Environ, 2016)).

Figure 2 Capped waste stockpile sampling wells (per Ramboll Environ)

On 11 November 2015, sufficient sample was extracted from MW206 to satisfy the required analyses but only a portion of the analyses were able to be conducted on the limited sample from MW202. A second round of sampling on 9 December 2015 yielded sufficient additional sample from MW202 to complete the required analyses. Some additional analytes were tested for both MW202 and MW206 during the second round of sampling by another laboratory.

In parallel with analysis of GHD's samples from 11 November, Ramboll Environ had some analyses conducted on several samples which are also included in this section.

A summary of the leachate testing results is provided in Table 5. The consolidated full analysis results spreadsheet and supporting laboratory reports for GHD's samples are included in Appendix A. The laboratory reports supporting Ramboll Environ's results in Table 5 are included in the Draft Capped Waste Stockpile Assessment (Ramboll Environ, 2016).

It is possible that leachate may contain asbestos fibres from material stored in the CWS. Risks associated with handling and disposal of the asbestos contaminated leachate and associated solids residues will need to be managed.

Table 5 Capped waste stockpile leachate water quality

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Sample date		11/11/15	11/11/15	9/12/15	9/12/15	11/11/15	11/11/15	11/11/15	11/11/15	9/12/15
Laboratory/Source		ALS	Environ	ALS	Eurofins	Environ	Environ	ALS	Environ	Eurofins
Parameter	Unit									
pH - field	pH Unit		9.08	9.14		9.16	10.28		10.68	10.97
Electrical Conductivity - field	µS/cm		26,800	38,344		17,500	36,800		42,600	49,204
Total Dissolved Solids (Calc.)	mg/L				32,000			44,800		
Suspended Solids (SS)	mg/L				240			375		
Hydroxide Alkalinity as $CaCO_3$	mg/L		<1		< 10			<1	<1	
Carbonate Alkalinity as $CaCO_3$	mg/L		26,700		6,700			26,200	24,700	
Bicarbonate Alkalinity as $CaCO_3$	mg/L		727		20,000			1,210	242	
Total Alkalinity as $CaCO_3$	mg/L		27,400		27,000			27,400	25,000	
Silicon as SiO_2	mg/L				< 200			47.5		
Chloride	mg/L		568		870			564	522	
Calcium (Dissolved)	mg/L				5			2		
Magnesium (Dissolved)	mg/L				41			<1		
Sodium (Dissolved)	mg/L		8,300		12,000			20,100	16,700	
Aluminium (Dissolved)	mg/L		0.2	0.26			0.79	7.76	2.41	

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Aluminium (Total)	mg/L			9.02				7.01		
Arsenic (Dissolved) Arsenic (Total)	mg/L			0.251 0.249				0.509 0.428		
Barium (Dissolved) Barium (Total)	mg/L			0.239 0.293				0.034 0.043		
Chromium (Dissolved) Chromium (Total)	mg/L			0.144 0.15				0.06 0.057		
Cobalt (Dissolved) Cobalt (Total)	mg/L			0.34 0.375				0.238 0.263		
Copper (Dissolved) Copper (Total)	mg/L			0.023 0.032				<0.010 <0.010		
Manganese (Dissolved) Manganese (Total)	mg/L			0.54 0.581				0.02 0.021		
Molybdenum (Dissolved) Molybdenum (Total)	mg/L			1.26 1.41				1.14 1.46		
Nickel (Dissolved) Nickel (Total)	mg/L			0.288 0.314				0.115 0.146		
Strontium (Dissolved) Strontium (Total)	mg/L			0.199 0.227				0.038 0.042		
Vanadium (Dissolved) Vanadium (Total)	mg/L			1.76 1.92				0.25 0.39		
Zinc (Dissolved) Zinc (Total)	mg/L			0.075 0.129				<0.050 <0.052		
Boron (Dissolved) Boron (Total)	mg/L			<0.10 <0.10				3.51 3.87		
Iron (Dissolved) Iron (Total)	mg/L			14.6 19.4				30.3 44.3		

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Bromine (Dissolved) Bromine (Total)	mg/L			6.8 6.08				4.7 4.19		
Iodine (Dissolved) Iodine (Total)	mg/L			9.1 7.49				2.9 2.56		
Lead (Total)	mg/L			0.016				<0.010		
Lithium (Total)	mg/L			0.015				<0.010		
Arsenious Acid, As (III)	µg/L	<0.5						<0.5		
Arsenic Acid, As (V)	µg/L	72						310		
Mercury (Dissolved) Mercury (Total)	mg/L		<0.0001	<0.0001 0.0122				<0.0001 <0.0001	<0.0001	
Cyanide (Total) Cyanide (WAD) Cyanide (Free)	mg/L		7.81 <0.040		21 0.047	 <0.040	227 <0.040	205 <0.400	223 <0.040	
Fluoride	mg/L		1,880		250	0.2	1,380	1,700	1,640	
Ammonia as N	mg/L				48			529		
Total Nitrogen as N	mg/L				75			594		
Total Phosphorus as P	mg/L				5.2			8.6		
Reactive Phosphorus as P	mg/L				< 0.05			3.91		
Sulfate as SO_4	mg/L		1,250		2,040			7,660	9,000	
Total Organic Carbon	mg/L	2,570			310			1,890		
Oil & Grease	mg/L	13						6		
Chemical Oxygen Demand	mg/L				2,900			1,700		
Benzene (MAH) Benzene (BTEXN)	µg/L	42 44			29			<5 <5		

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Toluene (MAH) Toluene (BTEXN)	µg/L	11 10			<20 -			5 <5		
2-Propanone (Acetone)	µg/L	<50			<20			340		
Chloroform	µg/L	19			<20			8		
Sum of PAHs	µg/L	<2	2.4					79	122	
Carbazole	µg/L	<2						4		
TPH C10 - C36 Fraction	µg/L	510	120					510	840	
TRH >C10 - C40 Fraction	µg/L	540	600					550	870	
Sum of BTEX	µg/L	54	29					<5	10	
Naphthalene (PAH) Naphthalene (BTEXN)	µg/L	<2 5	1.4 <5		<4			9 48	30.2 48	
Formaldehyde	µg/L	168						423		
Acetaldehyde	µg/L	10.1						19		
m-Cresol	µg/L	<0.1						21.6		
o-Cresol	µg/L	<0.1						10.4		
p-Cresol	µg/L	<0.1						26		
Phenol (Phenolics 1) Phenol (Phenolics 2)	µg/L	<2 <0.1			<3			12 123		

Although a range of other parameters will require attention to satisfy required treated water quality (depending on the option selected), key contaminants of concern in the analyses to date are cyanide and fluoride, due to their toxic nature and relatively elevated concentrations.

2.3 Leachate quantity

Although some volumetric information is available regarding flows pumped from leachate interception trenches, these flows comprise both leachate generated from the stockpile and natural groundwater intrusion, so they do not reflect the actual leachate generation volumes.

The leachate flows adopted as the design basis including leachate from excavation of the CWS and the new containment cell are presented in Appendix B. As design progresses on the proposed containment cell, these leachate quantities may vary from the current estimates. The most up to date estimates of leachate quantity would be used in detailed design or specification developed for the particular leachate management system adopted.

Based on preliminary design of the new containment cell, GHD has estimated leachate generation for both the historical mean and high rainfall years for various stages of development of the new cell and excavation of the CWS. The following assumptions have been adopted:

- Following final capping of the new containment cell, it has been assumed that the leachate volume generated from the containment cells will reduce to about 15% of the preceding year, reducing to approximately 1% of the final capped year flow after about 3 years, and continuing to taper further from there until the flow is at 0.01% of the final capped flow. This minimum flow is assumed to continue into the foreseeable future.
- During excavation of the CWS, leachate will be generated through rainfall on the exposed waste material and some groundwater ingress into the excavation will occur. The groundwater ingress volume is expected to be small relative to the direct rainfall leachate through the stockpile material and ingress is expected to be associated with stormwater events. It is considered that the estimated leachate flows will account for groundwater ingress during excavation of the CWS.
- Once the waste material and contaminated natural soil has been removed from the CWS and the excavation has been filled, no further extraction of leachate from the active leachate interception trench or from other extraction points related to the CWS will occur for the purposes of leachate treatment.

2.4 Regulatory requirements

The Environmental Protection Licence (EPL) for the site (NSW Licence number 1548) has a number of conditions relevant to the management of leachate on the site.

The only licensed discharge point is to the irrigation area per Section 2-P1 of the EPL. The licence notes that the licensee must comply with Section 120 of the Protection of the Environment Operations Act 1997 (Section 3-L1 of the EPL). The irrigation of effluent in this area must comply with the conditions outlined in Section 4-O4 of the EPL. To meet the conditions in Section 4-O4 the leachate must be treated to a quality acceptable for discharge (see Section 2.5.1).

A surface water monitoring program must be undertaken per Section 5-M2. A groundwater interception trench from the Capped Waste Stockpile must be in operation per Section 8-U1. A groundwater monitoring program must be implemented for groundwater adjacent to the Capped Waste Stockpile per Section 9-E1. The particulars of these conditions are included below for reference.

P1 Location of monitoring/discharge points and areas

P1.1 The following points referred to in the table are identified in this licence for the purposes of the monitoring and/or the setting of limits for discharges of pollutants to water from the point.

P1.2 The following utilisation areas referred to in the table below are identified in this licence for the purposes of the monitoring and/or the setting of limits for any application of solids or liquids to the utilisation area.

Table 6 Water and land

EPA Identification no.	Type of Monitoring Point	Type of Discharge Point	Location Description
11		Discharge to utilisation area	Irrigation area

L1 Pollution of waters

L1.1 Except as may be expressly provided in any other condition of this licence, the licensee must comply with Section 120 of the Protection of the Environment Operations Act 1997.

O4 Effluent application to land

O4.1 Effluent application must not occur in a manner that causes surface runoff.

O4.2 Spray from effluent application must not drift beyond the boundary of the premises.

O4.3 Livestock access to any effluent application area must be denied during effluent application and until the applied effluent area has dried.

O4.4 The quantity of effluent/solids applied to the utilisation area must not exceed the capacity of the area to effectively utilise the effluent/solids.

For the purpose of this condition, 'effectively utilise' include the use of the effluent/solids for pasture or crop production, as well as the ability of the soil to absorb the nutrient, salt, hydraulic load and organic material.

M2 Environmental monitoring

M2.1 The environmental monitoring program must include the following:

M2.2 Surface water monitoring.

The licensee must undertake a surface water monitoring program for potential pollutants, including fluoride, pH and conductivity and provide a report with each Annual Return. The report should include but need not be limited to the following:

a) Plan showing sampling locations;

b) Trend analysis of monitored parameters;

c) Conclusion and any recommendations from the assessment of surface water monitoring.

U1 Groundwater interception - Capped Waste Stockpile

U1.1 The licensee is to construct and operate a groundwater interception trench in accordance with the document titled "Leachate Interception Trench, Capped Waste Stockpile", provided to the EPA on 15 April 2014.

The licensee is to complete the construction of the leachate interception trench by no later than FRIDAY 31 October 2014.

E1 Groundwater monitoring adjacent to the Capped Waste Stockpile

E1.1 The licensee is to implement a groundwater monitoring program in accordance with the "Groundwater Water Monitoring Program, Capped Waste Stockpile", provided to the EPA on 15 April 2014.

E1.2 At the completion of 12 months of monitoring, a report must be provided to the EPA that includes:

a) Aquifer characterisation, including aquifer behaviour;

b) Trend analysis of monitored parameters in key wells; and

c) Conclusion and recommendations from the assessment of leachate impact on groundwater.

This report is to be provided to the EPA no later than 31 March 2015.

2.5 Treated water quality requirements

2.5.1 Dust suppression and irrigation

The leachate management strategy may involve the reuse of treated leachate, potentially reducing the extent and cost of treatment or disposal. Potential reuse applications for treated leachate include dust suppression during decommissioning and rehabilitation activities, and irrigation under the existing EPL.

To estimate the capacity of vegetation and soils in an irrigation area to sustain the applied contaminant load, background monitoring and irrigation modelling (for example Medli modelling) is typically used.

Hydro and Ramboll Environ have noted that the vegetation in the irrigation area does not show any visible adverse impact and has not previously been adversely impacted and this demonstrates the ability of the irrigation area to handle the historical loads of nutrients and salts. In addition, Hydro and Ramboll Environ note that there have been various analysis and assessments of the irrigation water and the surrounding environment undertaken e.g. water quality of North Dams 1 and 2 and downstream surface water quality, that can be used to demonstrate that irrigation can continue at the current hydraulic and contaminant loadings.

On this basis, an assessment has been made of the impact on the current irrigation practice if treated and/or untreated leachate is added to site runoff in the North Dams.

The assessment is based on the following:

- Irrigation volumes from 2006 and 2008 (d tab 4.3 Rain 2008.xls) have been combined with North Dams electrical conductivity (EC) and fluoride (F) concentrations from 2012, 2013, 2014 (Leachate Analysis_KMcN.xlsx) to determine irrigated mass loads of TDS (calculated from EC) and F.
- The average of the annual rainfall from 2006 (below average) and 2008 (above average) was close to the average over a 20 year period from 1989 to 2008, so the average of the irrigated flows from 2006 and 2008 was assumed to approximate average irrigation volumes. Therefore, the average mass load from the above calculations was considered to be the “sustainable” irrigation mass load for TDS and F. The sustainable loads assumed are 96 t TDS/yr and 4.2 t F/yr.
- Average North Dams TDS and F concentrations were assumed to increase by 10% (from the averaged 2012 to 2015 concentrations) to reflect additional stormwater runoff contamination expected during the demolition activities.

- Leachate flows from the highest average flow 12 month period (using 50% AEP rainfall year data) over the various stages of the landfill exercise were used to determine the additional contaminant loads that leachate would contribute to the North Dams, the blended water quality and the subsequent contaminant loads to the irrigation area.

Several scenarios are considered below:

- A – Leachate is treated to meet the expected local runoff water quality so does not impact the concentrations in the North Dams
- B – 50% of the leachate is treated to the expected runoff water quality and the remaining leachate reports to the North Dams untreated
- C – All leachate reports to the North Dams untreated

All 3 scenarios result in reductions to the average irrigation flows able to be applied to the existing irrigation area due to increase in the expected runoff concentrations during decommissioning, and this source representing a significant majority of the hydraulic flow to the North Dams.

The irrigation volume reductions due to the limiting contaminant overloading relative to the assumed sustainable irrigated mass load (TDS or F) are shown in Table 7.

Table 7 Indicative irrigation volume reductions due to expected North Dams water quality and leachate contribution

North Dam Leachate Scenario	Indicative Irrigation Volume Reduction
A – Leachate is treated to meet the expected runoff water quality so does not impact the concentrations in the North Dams	~ 10%
B – 50% of the leachate is treated to the expected runoff water quality and the remaining leachate is contributed to the North Dams untreated	~40-60%
C – All leachate is contributed to the North Dams untreated	~60-80%

To reduce the impact on irrigation loads and avoid further limiting the ability to manage water levels in the North Dams, the following may be worth further consideration:

- Can additional irrigation area be made available to increase irrigated flows/loads?
- How much dust suppression water can be utilised to offset the reduced irrigation potential?
- Is the assessment of "sustainable loading" appropriate?

It may be appropriate to consider a short-term sustainable annual loading based on the higher of the two irrigation volume years provided (i.e. 2008). Corresponding water quality for 2008 could be used with irrigated flows from 2008 to calculate the load of TDS and F applied to the irrigation area in 2008. This would represent a real example of a potentially higher short-term load successfully applied to the irrigation area without any identified adverse consequences (as far as GHD understands). If a short-term (12-24 mths) application of up to the same annual loads was applied during the waste transfer exercise with considerably lower irrigated load in the future following decommissioning, the environmental impact may be considered acceptable by the EPA. However, without site-specific irrigation modelling, the capacity of vegetation and soils in the irrigation area to sustain the proposed contaminant load is not known. The effect of an increased short-term sustainable loading would be a reduced impact on the flows that could be irrigated, or conversely a reduction in the amount of additional area required to irrigate average flows. The combined capacity of the North Dams is approximately 33 ML (Pulver Cooper & Blackley (2016), Stormwater Management Report - Flood Modelling Review). At full capacity, this represents a retention time of about 5 to 6 weeks based on an average 50% AEP month rainfall and 2 to 3 weeks based on a wet 90% AEP month rainfall.

It is not expected that these retention times will materially affect the annual contaminant loads applied to the irrigation area. However, if the North Dams are not well mixed, there is a risk that pockets of higher concentration leachate could be drawn into the irrigation pump suction and may have an acute adverse impact on the irrigation area. In developing leachate management options involving blending leachate in the North Dams, consideration will need to be given to encouraging mixing of the leachate with the balance of the North Dams inflows and avoiding short-circuiting of leachate to the irrigation pump suction.

The rudimentary assessment in Table 7 considers an average 50% AEP rainfall year and does not include any water balance modelling. Depending on the site water balance and the actual rainfall received, the assumed irrigated volumes (average of 2006 and 2008) may not be sufficient to manage the water levels in the North Dams. The irrigated contaminant loads should be monitored and a contingency should be developed in case the sustainable annual loads are irrigated in less than 12 months and additional water must be removed from the North Dams.

Site runoff estimation

The 50% AEP and 90% AEP rainfall year stormwater flow volumes into the North Dams were estimated and used in the calculation of blended North Dams water quality. The basis for determination of the annual runoff flows is outlined below.

Rainfall data is available from Kurri Kurri Golf Club (KKGC) - 3.4 km away from the site, or from Branxton (Dalwood Vineyard) - 17.7 km away from the site. The data for the site was sourced from Branxton (Dalwood Vineyard), understanding that it is a more complete representation. Rainfall information can be extracted from 1900 to 2015 from the Branxton (Dalwood Vineyard) station, whereas KKGC provides information beginning only in 2007. Both sets were compared for consistency for the years 2007 – 2016 and were considered to provide comparable information.

Historical monthly rainfall data spanning from 1900 till 2015 was used to estimate the stormwater flow volumes.

The catchment area outlined in pink in Figure 3 was delineated based upon the assumption that the total catchment of the pond is represented by the gravity catchment of the pond as well as the impervious area of the site. The assumed impervious area of the site is shown in yellow below. It has been assumed based on discussion with Hydro and Ramboll Environ that for the purpose of the irrigation assessment exercise all runoff from the given catchment reports via gravity or pumping to the North Dams. The North Dams are the ultimate receiving dams and are shown in green. Other ponds within the catchment have not been differentiated as these have been considered as impervious areas whose runoff reports to the North Dams and as such, these other ponds are included in the light brown shaded area.

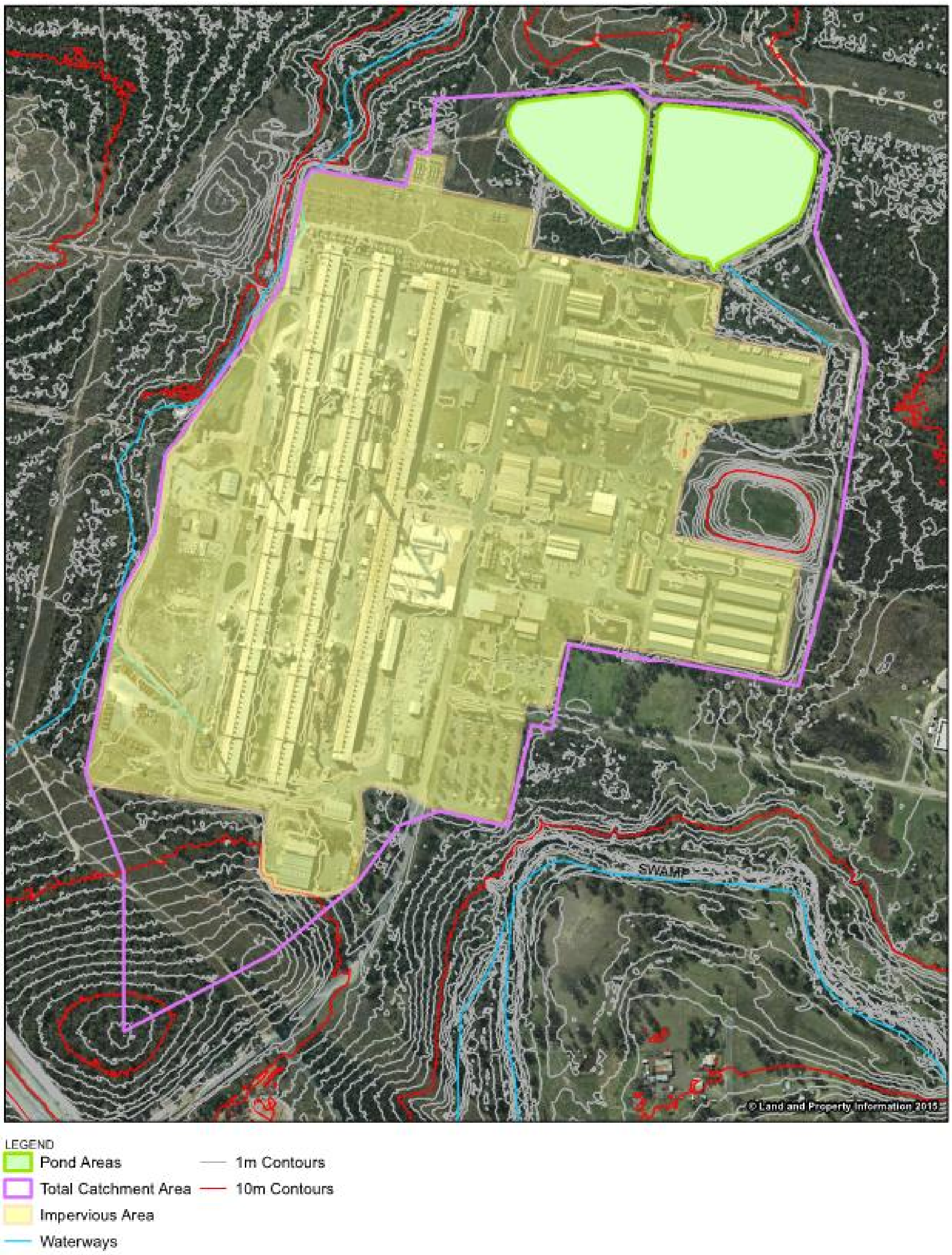

Figure 3 Site runoff catchment basis

The assumed runoff coefficient for pervious substances was estimated on the catchment properties Wollombi Brook catchment at Paynes Crossing (taken from Calibrations of the AWBM for use on ungauged catchments – pp42 of 48 - Calibrations of the AWBM). A potential runoff coefficient for the pervious areas may be equal to 0.11. A runoff coefficient of 0.11 was assumed.

For impervious areas, a coefficient of 0.60 was conservatively assumed. This estimated was based upon available literature and GHD has conservatively adopted low runoff coefficient values. A runoff coefficient for asphalt may be equal to 0.85, however due to demolition and civil works, it is likely that the current impervious surface will become more pervious. As the required use of stormwater is to provide dilution for treated leachates, the conservative design corresponds to reduced stormwater flows (and reduced runoff coefficients). Accordingly, a runoff coefficient of 0.60 was assumed.

Based upon the historical rainfall data, monthly and yearly runoff volumes were determined using the catchment areas and runoff coefficient. It should be noted that development of runoff volumes have high levels of uncertainty without observed site data. Literature has been used to develop estimates as best as practical at this stage and estimates were conservative where applicable.

2.5.2 Trade waste

The Hydro smelter has been discharging process water to trade waste for treatment at the Kurri Kurri Wastewater Treatment Facility for some time. The discharge is licenced under an existing Trade Wastewater Agreement (2013) with Hunter Water Corporation.

The Minor Trade Wastewater General Conditions included with the 2013 agreement include the following requirements.

Table 8 General requirements for all trade wastewater discharged to sewer

Parameter	Requirement
Temperature	Not more than 38 degrees Celsius
Colour	Not noticeable when diluted 100 times in clear water
pH	7 to 10
Fibrous material	None which could block our sewer
Solids matter	Not longer than 20 millimetres, must not settle faster than 3 metres in an hour

A change in the nature/source of the trade waste would require consultation with Hunter Water Corporation and conditions of the agreement would be reviewed and likely revised to reflect the altered process and water quality.

The previous version of this agreement (Major Trade Waste Permit, 1999) included the conditions presented in Table 9. It is anticipated that at least these parameters would be included in any revised version of the current agreement to reflect the discharge of treated leachate to sewer.

Table 9 Previous major trade waste permit conditions

Parameter	Requirement
Non-Filterable Residue (Suspended Solids)	Not to exceed 500 mg/L
Fluoride	Not to exceed 5 mg/L
pH	Not to be less than 6.5 or greater than 10
Total Oil and Grease (TOG)	Not to exceed 70 mg/L
Instantaneous rate of discharge	Not to exceed 5 L/s
Maximum daily discharge	150 Kilolitres
Discharge times	Discharge permitted 24 hrs per day, 7 days per week

In developing a new suite of contaminant concentration conditions for the trade wastewater agreement, Hunter Water Corporation would likely take into consideration the Australian Sewage Quality Management Guidelines (Water Services Association of Australia, June 2012).

These guidelines assist utilities to better manage loads and concentrations of inputs to their sewerage system to manage risks to the sewerage collection system and to the sewage treatment system. General guidelines on contaminant concentrations for sewerage collection systems can be applied to all sewage systems without the need to determine limits for local treatment systems.

Guideline concentrations provided to protect sewage treatment systems should not be considered to represent a definite line of division between safe and unsafe acceptance of trade waste due to the highly variable nature of sewage systems in Australia. However, these provide indicative concentration limits to assist in assessing whether the leachate could be economically treated to the likely levels required by Hunter Water Corporation.

Relevant guideline concentrations tables have been extracted from the Australian Sewage Quality Management Guidelines for consideration during the options study and are included in Appendix C. These include:

- Table C3: Guideline concentrations for discharge to sewerage systems
- Table C4: BEARPIT threshold values (Best Economic and Reasonable Pre treatment Technology)
- Table C5: Typical threshold concentrations (mg/L) for common substances in sewage that are known to inhibit activated sludge, nitrification and anaerobic digestion processes.
- Table C7: Typical concentrations for common substances in 'domestic' sewage (Source: City West Water's data).

2.5.3 Contractor disposal

In November 2015, a generic enquiry was made to Steve Fenton from Worth Recycling in Kurri Kurri regarding acceptance criteria for liquid waste. The acceptance criteria noted that if the stream is outside the concentration limits specified above, Worth Recycling would examine and assess on a case by case basis to see if they have a suitable treatment option.

During the current options study, additional waste contractors were consulted to assess feasibility and cost for leachate collection and disposal.

Cleanaway confirmed they expect to be able to handle the leachate at their Olympic Park Facility in Sydney and provided budget pricing and expected price variability.

JR Richards & Sons advised that, based on initial leachate analysis results and the samples provided, they were unable to provide offsite primary stage treatment options. This was largely due to the high TDS results recorded.

During the course of the options study, Toxfree took over ownership of the Worth Recycling facility in Kurri Kurri. Toxfree advised that they would be able to receive and treat the leachate, and provided budget pricing for both their existing Windsor facility and the planned new facility in Kurri Kurri.

Additional information regarding Cleanaway and Toxfree pricing and comments is included in the sensitivity analysis in Appendix E.

2.6 Leachate management option considerations

2.6.1 Existing site constraints and opportunities

To reduce the capacity and cost of a leachate treatment system, buffer storage capacity can be utilised to attenuate peak flows. Storage capacity could also assist in landfill leachate management (i.e. receipt of pumped leachate from one leachate location to the other to enable single treatment location).

A number of existing systems have been identified that may be able to be incorporated into the leachate management system to reduce costs. Infrastructure identified as potentially reusable for this purpose is described below. As leachate management options are developed the ability to utilised this infrastructure will be further assessed.

Based on the site visit and discussion between Kostas Athanasiadis (GHD) and Matt King (Hydro) on Friday 30th October 2015, GHD understands that a 1 ML tank may be available for use as part of the leachate collection and treatment system. Hydro advised at the leachate design basis workshop (23/5/16) that this tank is not likely to be available for use in the leachate management system, as it needs to be retained for fire-fighting requirements in the event of a fire in the switchyard. Currently, the switchyard is expected to remain connected to the grid for the duration of the project, and hence the fire risk will remain.

The 32A compressor house could be a potential location for a centralised water treatment plant. Power can be supplied to this area from the new power supply as TL6 transformer used to supply the cooling towers for the compressors to the east of this building. This building may be retained for adaptive re-use or its demolition could be delayed until the end of Stage 2 demolition. After treatment the low fluoride clean water could be discharged to the nearby south surge pond where it would be pumped to the east surge pond and north dams.

Raw leachate could be trucked or pumped from the leachate collection ponds at the capped waste stockpile and the new containment cell and stored in Cooling Tower CT2, CT3 and CT4 cold wells. CT2 cold well will hold approximately 54,000 litres, CT3 and CT4 cold wells will hold up to approximately 136,000 litres each (very approximate). It is estimated that approximately 300,000 litres storage in total may be available in the cold wells. Lay flats and pumps could be used to pump the leachate from the cold wells to the WTP.

DC2 and DC3 emergency water head tanks will hold 502,655 litres of raw leachate each or a total of 1,005,310 litres. However, the underground cooling tower pumps in 34B pump house would be needed to pump from the cold well of CT3 and CT4 up to these head tanks. These pumps are no longer serviceable as this area was flooded. It would take some effort to get these pumps going again. 34B pump house is supplied from TL6 transformer, which will have power into the future.

There is an existing sewage pump station (37A sewerage pump house) and pipeline owned and maintained by Hydro that in additional transferring sewage from the site also transfers trade waste into the sewerage system under the existing Trade Wastewater Agreement. The condition of this pipeline is not known at this stage but the pipeline is assumed to be in satisfactory operational condition and may be able to be utilised for the leachate management system. The sewerage system will contract as buildings are demolished but part of it will be retained during Stage 1 demolition. However, it is likely to be shut down during Stage 2 demolition and would be unavailable for trade waste transfer from that time.

Contingent on the final design of proposed containment cell, limited space exists to facilitate storage and treatment of leachate to the east of the planned containment cell. An area of approximately up to 60 m x 40 m appears to be available between the new cell and the nominated stockpile area. This may restrict leachate management options incorporating storage and evaporation ponds.

A fixed power supply from a generator will be located adjacent to the new containment cell which is likely to have some spare capacity. Depending on the leachate management system power demand, some or all of the power requirements may be able to be met from the spare generator capacity if the leachate treatment system is located in that area.

2.6.2 Previous leachate management assessments

Ramboll Environ prepared a Stage 2 Water Treatment Options Report (December 2012) to assess options for treatment of leachate and leachate-affected shallow groundwater. It considered four options including:

- Disposal of intercepted/collected water by a waste contractor
- Collection and storage of water followed by pump to site ponds for evaporative disposal
- Collection and storage of water followed by treatment via a process developed by the University of Newcastle (following research conducted on the site over several years) coupled with disposal of treated effluent by evaporation
- Collection and storage of water followed by chemical treatment designed by ENVIRON coupled with disposal of treated effluent by evaporation

The study concluded that for disposal of small volumes of water (<1 ML), removal by a waste contractor is the simplest and cheapest method. Once volumes of water are in excess of 1 ML (for example disposal of the estimated 50 ML of leachate-affected water), treatment by evaporation alone provides a cost effective solution with costs highly dependent on the construction requirements and sludge disposal.

It was noted that if sludge requires treatment prior to disposal, pre-treatment of the effluent using the ENVIRON designed process provides a more cost effective solution and that small scale evaporation trials would be required to assess the quality of resulting sludge and if treatment by stabilisation or similar is required prior to disposal.

Similar options will be reassessed under the current option study based on new information regarding leachate quality, quantity, constraints and opportunities.

3. Option identification

Given the relatively variable quantities of leachate to be managed over the project life, the following options are suggested as being more practical and cost-effective alternatives to onsite permanent treatment:

- Outsource the leachate treatment to a third party
- Pre-treatment and discharge to sewer under a trade waste agreement
- Pre-treatment to produce a water quality suitable for current irrigation practices
- Reduce leachate volume
  - Evaporation ponds
  - Enhanced evaporation techniques

The options developed for comparison are summarised in Table 10.

All of the options proposed involve the construction of a containment cell and the utilisation of waste contractors to a degree. Contractor/vendor inputs at this stage are limited to conceptual scoping and approximate costing for elements of the total contract scope.

All options consider management of leachate from the site for 5 years of operation (leachate quantities based on 50% AEP rainfall year), after which the leachate generation rate is forecast to decrease significantly.

Balancing storage volumes for options involving on-site treatment (Option 1 to 3) allow for treatment on site for the first 20 months of operation. Following this initial 20 month period, all subsequent leachate generated in the cell would be removed from a sump in the closed cell by contractor for treatment and disposal off site. The cessation of on-site treatment also aligns approximately with the closure of the cell, enabling the cost effective disposal of the contaminated pond liners/soil in the closure.

All options involve balancing storage of leachate for treatment or contractor removal. Balancing storage volumes allowed for are based on peak leachate flows for 90% AEP rainfall years and assume conservatively that up to 1.3ML of leachate storage will be available in the containment cell to assist in managing peak wet weather periods.

Table 10 Leachate disposal options summary

	WATER MANAGEMENT
Option 1 – Treat on site and use for irrigation/dust suppression	
	Truck leachate from cell and CWS to cooling tower cold wells / head tanks
	Pre-treatment + membranes - irrigate permeate via North Dams
	Waste contractor disposal of sludge and brine
	Contractor waste disposal of all leachate after 20 months treating
Option 2 – Treat on site for discharge to trade waste	
	Truck leachate from cell and CWS to cooling tower cold wells / head tanks
	Pre-treatment + membranes - trade waste discharge via sewage pump station, then truck to trade waste once sewage system decommissioned
	Waste contractor disposal of sludge and brine
	Contractor waste disposal of all leachate after 20 months treating
Option 3 – Store and evaporate (mechanically assisted)	
	Floating evaporator units in lined evaporation pond - weather station controlled
	Waste contractor removal of residual brine after majority of water evaporated
	Contractor waste disposal of all leachate after 20 months treating
Option 4 – Waste contractor removal and treatment/disposal off site	
	Leachate stored in containment cell and buffer storage pond
	Leachate is collected by waste contractor from buffer storage pond
	Waste contractor treats and disposes of leachate off site

3.1 Option 1 - Treat on site and use for irrigation and dust suppression

Option 1 involves the capture and treatment of leachate from the CWS and containment cell (Figure 4). The existing cooling tower cold wells would be used to provide buffer storage and the adjacent water head tanks would be used as required to provide additional storage to manage peak leachate generation. Treated leachate would be discharged to the north dams via the south surge pond for irrigation and dust suppression.

Leachate would be trucked from both the CWS and the cell to the cold wells under this option. Pumping was considered for both of these transfers and was a similar overall cost to trucking. Obstructions such as pipework and pumping systems in and around the CWS and cell, where considerable excavation and trucking activities would be occurring in parallel, was another consideration in adopting truck transfers for leachate transfer.

The sludge and brine generated from the treatment process will also need to be appropriately managed. The on-site treatment of the sludge and brine from the leachate treatment process was considered and the costs were in the same order as contractor removal of these wastes. On-site treatment of the sludge and brine would also be a complex and higher risk operation than contractor removal and as such, contractor removal of the sludge and brine was adopted as part of this option.

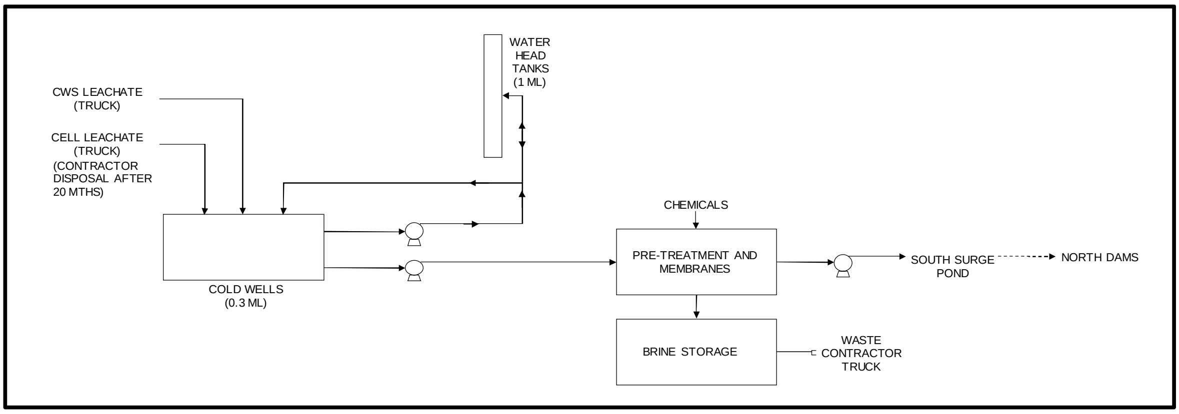

Figure 4 Option 1 - Treat on site for irrigation and dust suppression

3.2 Option 2 - Treat on site for discharge to trade waste

Option 2 involves the capture and treatment of leachate from the CWS and containment cell using a similar process to Option 1 (Figure 5). The existing cooling tower cold wells would be used to provide buffer storage and the adjacent water head tanks would be used as required to provide additional storage to manage peak leachate generation. However, under Option 2, the treated leachate would be discharged to sewer under a Trade Wastewater Agreement.

As for Option 1, leachate would be trucked from both the CWS and the cell to the cold wells for treatment, and the sludge and brine generated from the treatment process would be removed by contractor.

Treated leachate would drain to an existing sewage pump station and pipeline owned and maintained by Hydro, which transfers trade waste into the sewerage system under the existing Trade Wastewater Agreement. The condition of this pipeline is not known at this stage but the pipeline is assumed to be in satisfactory operational condition and may be utilised for the leachate management system. The extent of the sewerage system will contract as buildings are demolished but part of the system will be retained during Stage 1 demolition. However, it is likely to be shut down during Stage 2 demolition and would be unavailable for trade waste transfer from that time. Option 2 assumes that the trade waste has to be trucked to Kurri Kurri Wastewater Treatment Plant from months 16 to 20 after the sewage pump station is decommissioned.

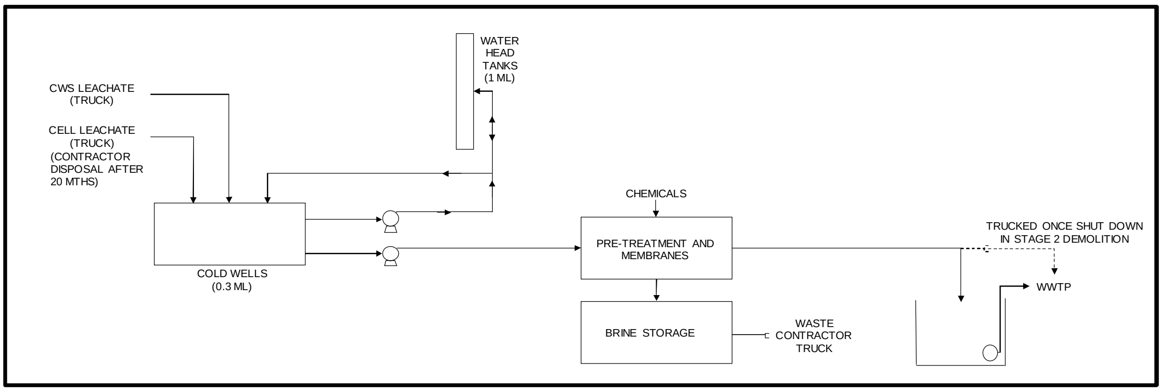

Figure 5 Option 2 - Treat on site for discharge to trade waste

3.3 Option 3 - Store and evaporate (mechanically assisted)

Option 3 involves the capture and containment of leachates which are then transferred into a new lined evaporation pond near the cell for volume reduction (Figure 3). CWS leachate would be trucked to the evaporation pond while leachate from the cell would be pumped.

To enhance natural evaporation rates, floating evaporators would be utilised. These would incorporate weather monitoring and control systems to minimise spray drift or leachate.

Ultimately the residual sludge and brine in the evaporation pond would be removed by contractor for treatment and disposal off site. The contaminated pond lining would be disposed of in the cell before cell closure. Leachate generated after this would be removed from the closed cell by contractor.

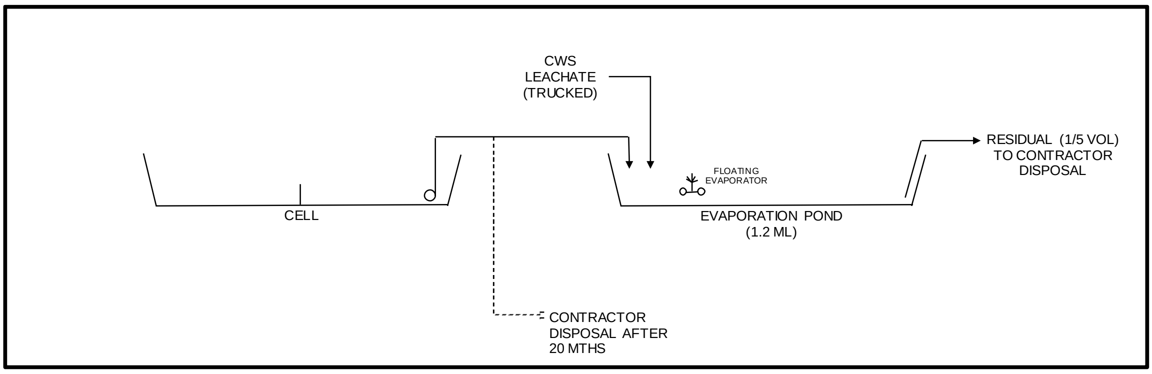

Figure 6 Option 3 - Store and evaporate (mechanically assisted)

3.4 Option 4 - Waste contractor removal and treatment/disposal off site

Option 4 involves the capture and containment of the leachate on site (Figure 7). A new leachate storage pond of approximately 1ML would be constructed to buffer peak leachate generation rates. CWS leachate would be trucked to the evaporation pond while leachate from the cell would be pumped.

The contaminated pond lining would be disposed of in the cell before cell closure. Leachate generated after this would be removed from the closed cell by contractor.

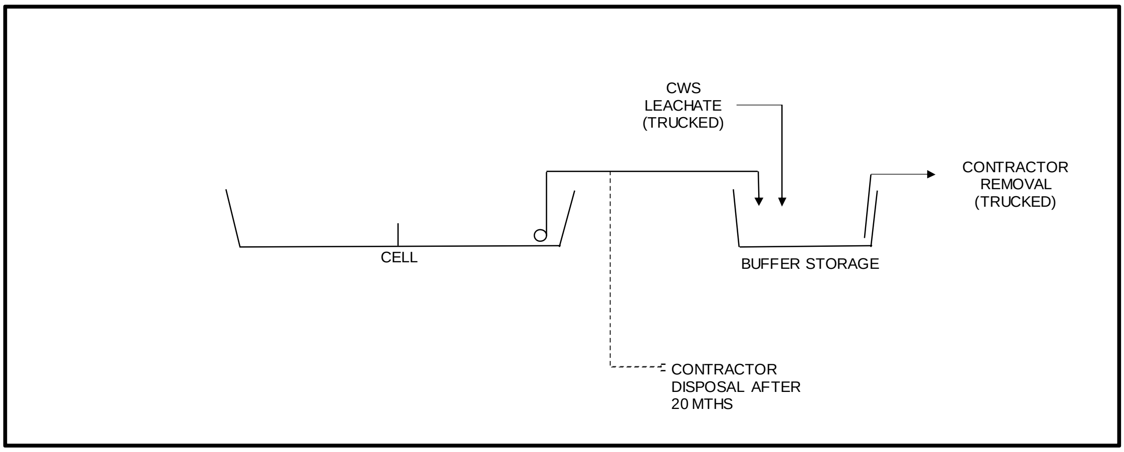

Figure 7 Option 4 - Waste contractor removal and treatment/disposal off site

3.5 Potential option locations

Potential locations and high level layouts for the options have been identified and are shown in Figure 8 and Figure 9.

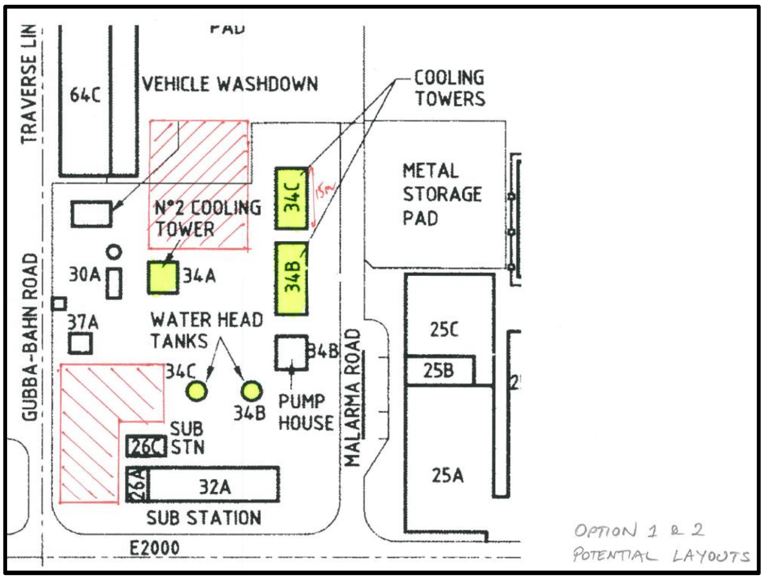

Figure 8 Potential Option 1 and 2 layouts (red, hashed areas show where infrastructure could be sited for both options)

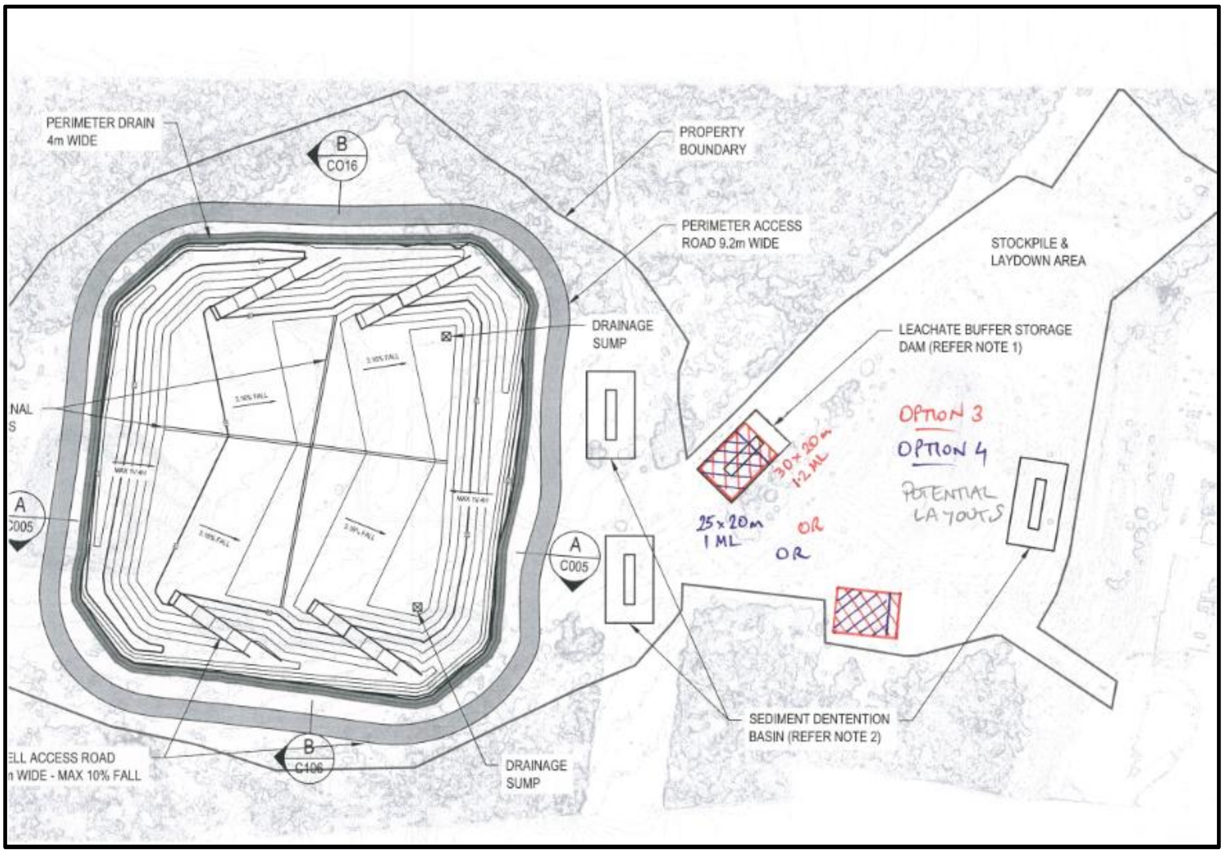

Figure 9 Potential Option 3 and 4 layouts (red, hashed areas show 2 location options for the Option 3 evaporation pond; blue, hashed areas show 2 location options for the Option 4 buffer storage pond)

4. Option scoring and assessment

4.1 Assessment process

A number of assessment criteria were developed and are summarised below:

- Ability to meet water quality (Irrigation, trade waste, contractor removal)
- Cost sensitivity to total leachate volume
- Environmental Impact and risk (energy and waste streams)
- Social (e.g. noise, odour)
- Total Cost - CAPEX/OPEX
- Hydro Staff Resourcing Requirement
- Health and Safety Risk

Options were scored by GHD prior to the Options Assessment Workshop. During the workshop, the scoring criteria were confirmed and relative weightings agreed. The basis for the scores was discussed and modified where required to reflect the consensus of the workshop team, which contained both GHD and Hydro representatives.

Following the workshop, a sensitivity analysis was conducted on the scoring process to assess a number of possible scenarios. These sensitivity cases considered variations in the criteria weightings, scoring and alternative contractor costs. The scoring and sensitivity analyses were subsequently reviewed by GHD based on the workshop discussions and resubmitted to Hydro for review and approval.

The cost estimates for scoring the options were developed with sufficient accuracy to screen options at a conceptual and budgetary level. The cost estimates are included in Appendix D They provide a relative measure between different approaches for the containing and disposal of leachates and should not be used for any other purpose. The accuracy of the cost estimates is not expected to be better than ± 50% for the options discussed in this report.

The options evaluation criteria and scoring matrix is included in Table 11.

Table 11 Options evaluation criteria and scoring matrix

Evaluation Criteria	Weighting	(Good)		Score		(Bad)
		5	**4**	**3**	**2**	**1**
Ability to meet water quality (Irrigation, trade waste, contractor removal)	25%	Almost certain but specific contractor test work required to confirm costs/duration	Very likely but specific contractor test work required to confirm feasibility and costs/duration	Likely but specific contractor test work required to confirm feasibility and costs/duration	Likely but specific contractor test work required to confirm feasibility and costs/duration, multiple risk elements to feasibility and duration/cost	Effectiveness unknown - specific contractor test work required to confirm feasibility and costs/duration
Cost sensitivity to total leachate volume	10%	Low sensitivity to 50% increase in volume - results in cost increase ≤$1.0M	Minimal sensitivity to 50% increase in volume - results in cost increase $1.0 to $1.2M	Moderate sensitivity to 50% increase in volume - results in cost increase $1 .2to $1.4M	Considerable sensitivity to 50% increase in volume - results in cost increase $1.4 to $1.6M	Significant sensitivity to 50% increase in volume - results in cost increase >$1.6
Environmental impact and risk (energy and waste streams)	15%	Negligible environmental impact (energy/waste) or risk of environmental harm (leaching and spills)	Minimal environmental impact (energy/waste) or risk of environmental harm (leaching and spills)	Moderate environmental impact (energy/waste) or risk of environmental harm (leaching and spills)	Considerable environmental impact (energy/waste) or risk of environmental harm (leaching and spills)	Significant environmental impact (energy/waste) or risk of environmental harm (leaching and spills)
Social (e.g. noise, odour)	5%	Negligible social impact	Minimal social impacts	Moderate social impacts	Considerable social impacts	Significant social impacts
Total cost - CAPEX/OPEX	15%	≤$3M	$3 to $3.5M	$3.5 to $4M	$4 to $4.5M	>$4.5M
Hydro staff resourcing requirement	5%	Negligible input from operations staff	Limited attendance by operations staff required (up to 3hr per week)	Moderate attendance by operations staff required (up to 2 hr per day)	Frequent attendance by operations staff required (2 - 5 hr per day)	Additional operational staff required full time.
Health and safety risk	25%	Negligible health and safety risks to contractor or Hydro operating staff - risks readily managed	Minimal health and safety risks to contractor or Hydro operating staff - risks readily managed	Moderate health and safety risks to contractor or Hydro operating staff - risk management requiring frequent attention	Considerable health and safety risks to contractor or Hydro operating staff - significant risk management attention required	High risk operations are required and significant risk mitigation measures will be required

4.2 Assessment outcomes

Following the workshop, a sensitivity analysis was conducted on the scoring process to assess a number of possible scenarios. These sensitivity cases considered variations in the criteria weightings, scoring and alternative contractor costs. The scoring and sensitivity analyses were subsequently reviewed by GHD based on the workshop discussions and resubmitted to Hydro for review and approval.

All sensitivity scenarios considered in the initial assessment found that Option 4 (Waste contractor removal and treatment/disposal off site) was the highest scoring option.

To increase confidence in the outcomes of the initial options assessment, two additional waste contractors were approached to provide leachate removal and treatment rates. Leachate samples from the CWS were provided to three waste contractors to assist the contractors in developing their budget pricing. Pricing and expected price variation was received from two of the contractors and was used to assess a number of additional alternative scenarios in the sensitivity analysis.

The option assessment scores and order of magnitude estimated costs are summarised in Table 12 (highest score = most favourable option).

The options scoring matrix, scoring criteria weightings and sensitivity analysis are included in Appendix F. The option assessment matrix includes comments on the options supporting the scoring. These comments also highlight key risks that have been identified through development and consideration of the options. The bases for the sensitivity scenarios are described in the sensitivity analysis.

Table 12 Option Assessment Scores

Option	Description	Score	Cost
Option 1	Treat on site and use for irrigation / dust suppression	2.85	$4.8M
Option 2	Treat on site for discharge to trade waste	2.30	$4.8M
Option 3	Store and evaporate (mechanically assisted)	2.65	$3.4M
Option 4	Waste contractor removal and treatment/disposal	3.70	$2.9M

Based on the assessment, the utilisation of waste contractors to remove and treat the leachate ranked the highest (option 4). There is a considerable gap to the next best score with the onsite treatment for irrigation / dust suppression ranking second.

Options 4 and 1 scored highest and these options' costs are estimated at approximately $2.9 M and $4.8 M respectively, based on the inclusions and allowances presented in Appendix B. The costs for the options compared ranged from $2.9M (Option 4) to $4.8 M (Options 1 and 2).

Despite the similarities between Option 1 and 2, there is a significant variation in the assessed score. This is due to the increased health and safety risk and environmental risks associated with trucking the treated leachate to the waste water facilities once phase 2 of demolition is complete on site and the sewage pump station is unavailable.

Following assessment of the additional sensitivity scenarios using the refined contractor rates, Option 4 remained the preferred option in 7 of the 8 scenarios considered. The scenario in which Option 4 was not the highest score was scenario H where Option 4 scored 2.85 compared with Option 1, which scored 3.0. In this instance, scenario H considered leachate transport and disposal rates from Toxfree for the Windsor facility including a liquid waste levy.

In scenario H, the score for the first evaluation criteria, "Ability to meet water quality (irrigation, tradewaste, contractor removal)", was reduced from 5 to 4 to reflect the contractor's comment that there was some risk that discharge from the Toxfree treatment process not able to be discharged directly to sewer due to the high residual salinity. The treated water may need to be bled at a controlled rate to sewer or alternatively it may be able to be supplied to an existing industrial recycled water customer who has verbally confirmed to Toxfree that they could accept the quantity and quality of proposed discharge.

4.3 Risks and uncertainties

A variety of risks was identified during the options assessment process. Key risks are discussed below. Additional OHS&E risks are discussed in Section 4.5.

4.3.1 Variation in leachate quantity and quality

The limited leachate testing conducted to date at the CWS is likely to have identified the key contaminants expected to appear in the leachate. However, there is a risk that the leachate generated may have higher concentrations than the current sampling data indicates, as discussed above.

It is possible that leachate may contain asbestos fibres from material stored in the CWS. Risks associated with handling and disposal of the asbestos-contaminated leachate and associated solids residues would need to be appropriately managed.

The leachate flows adopted as the design basis, including leachate from excavation of the CWS and the new containment cell, are discussed in section 2.3. These leachate rates are based on a range of assumptions and are highly dependent on rainfall, which can be variable. One of the option evaluation criteria considered the cost impact of the total leachate volume being 50% higher than allowed for in the design basis. While the cost sensitivity due to this increase in leachate volume has been considered in scoring the options, changes in the total leachate volume will directly affect the overall cost of leachate management. Prior to preparation of the tender specification for leachate management, the estimate leachate rates should be reassessed based on the latest containment cell design and CWS decommissioning plans.

All options involve balancing storage of leachate for treatment or contractor removal. Balancing storage volumes allowed for are based on peak leachate flows for 90% AEP rainfall years and assume conservatively that up to 1.3ML of leachate storage will be available in the containment cell to assist in managing peak wet weather periods. However, careful monitoring and forecasting of stored leachate volumes will be required for any of the options.

4.3.2 Waste contractor capability and pricing

There remains a risk that the waste contractors who have advised that they expect to be able to handle the waste and have provided pricing for this service may not be able to manage the waste for the prices provided, or at all. It is recommended that consideration be given to establishing service contracts with multiple waste contractors during the tender phase to secure primary and alternative contract rates and reduce the risk of rate inflation. Having multiple contractors available may also manage the risk that leachate cannot be removed from site quickly enough following significant rainfall events.

Cleanaway confirmed that they expect to be able to handle the leachate at their Olympic Park Facility in Sydney and provided budget pricing and expected price variability.

Toxfree also advised the likelihood of ability to handle the leachate and budget pricing for both their existing Windsor facility and a planned new facility in Kurri Kurri (expected to be completed in approximately 12 months). The rate for transport and disposal at the planned Kurri Kurri facility is about 8% lower than to manage the waste at the Windsor facility. The Windsor disposal cost has been used in the sensitivity analysis to be conservative and based on there being a lower risk that the Windsor facility will not be a feasible option.

It is intended that treated liquid waste from both the Windsor and the Kurri Kurri facilities would be discharged to the respective council sewerage systems. The anticipated high salinity of the treated leachate may not be acceptable to the councils without modelling to estimate the impact on sewage quality. Constraints on timing and flows discharged to sewer may increase Toxfree's leachate management prices. If neither council will accept the treated leachate, Toxfree have had verbal confirmation from one of their existing industrial recycled water customers that they could accept the proposed quantity and quality of treated leachate.

Both of the Toxfree facilities would need amendments to their existing treatment processes to treat the Hydro leachate. There would be amendments required to adjust the already approved development application and environmental licence for the proposed Kurri Kurri facility. Toxfree consider the risk of not being above to obtain the required approvals for system modifications to accommodate Hydro leachate to be very low. Similarly, Toxfree consider the risk of not being above to obtain the required approvals for system modifications to accommodate Hydro leachate at the existing Windsor facility to be very low.

Additional information regarding Cleanaway and Toxfree pricing and comments is included in the sensitivity analysis in Appendix E.

It should be noted that all four leachate management options considered involve some level of liquid waste removal by waste contractor and as such, the waste contractor risks presented in this section apply to some degree for each of the leachate management options considered.

4.3.3 Irrigation with treated leachate (Option 1)

If Option 1 is developed further, the following risks should be considered.

To estimate the capacity of vegetation and soils in an irrigation area to sustain the applied contaminant load, background monitoring and irrigation modelling (for example Medli modelling) is typically used.

Hydro and Ramboll Environ have noted that the vegetation in the irrigation area does not show any visible adverse impact and has not previously been adversely impacted and this demonstrates the ability of the irrigation area to handle the historical loads of nutrients and salts. In addition, Hydro and Ramboll Environ note that there have been various analysis and assessments of the irrigation water and the surrounding environment undertaken e.g. water quality of North Dams 1 and 2 and downstream surface water quality, that can be used to demonstrate that irrigation can continue at the current hydraulic and contaminant loadings.

On this basis, assumptions have been made to enable an assessment of the impact on the current irrigation practice if treated and/or untreated leachate is added to site runoff in the North Dams. The assessment basis is described in section 2.5. However, without site-specific irrigation modelling, the capacity of vegetation and soils in the irrigation area to sustain the proposed contaminant load has not been independently confirmed.

It is not expected that these retention times will materially affect the annual contaminant loads applied to the irrigation area. However, assuming the North Dams are not well mixed, there is a risk that pockets of higher concentration leachate could be drawn into the irrigation pump suction and may have an acute adverse impact on the irrigation area. If leachate management options involving blending of treated leachate in the North Dams is developed further, consideration will need to be given to encouraging mixing of the leachate with the balance of the North Dams inflows and avoiding short-circuiting of leachate to the irrigation pump suction.

The rudimentary irrigation assessment conducted considers an average 50% AEP rainfall year and does not include any water balance modelling. Depending on the site water balance and the actual rainfall received, the assumed irrigated volumes (average of 2006 and 2008) may not be sufficient to manage the water levels in the North Dams. The irrigated contaminant loads would need to be monitored and a contingency should be developed in case the sustainable annual loads are irrigated in less than 12 months and additional water must be removed from the North Dams.

It is recommended that Hydro discuss any proposed irrigation option involving treated leachate with the EPA to keep them informed of the plan. The EPA may require a more detailed Medli model assessment, including site-specific sampling to confirm the anticipated environmental impact of the temporary irrigation exercise and to support discussions with the EPA.

4.3.4 Trade waste discharge (Option 2)

If Option 2 is developed further, the following risks should be considered.

As noted in section 2.5.2, a change in the nature/source of the trade waste discharged to sewer would require consultation with Hunter Water Corporation. Conditions of the existing Trade Wastewater Agreement would need to be reviewed and likely revised to reflect the altered process and water quality. A range of contaminants in the treated leachate may still be of concern to Hunter Water, which may require more extensive pre-treatment (and hence cost) than allowed for in development of this option.

4.3.5 On site treatment or evaporation process risks (Options 1, 2 and 3)

If Options 1, 2 or 3 are developed further, the following risks should be considered.

The treatment process proposed should be suitable to achieve the required targets, although testing should be undertaken to confirm this assumption. There is some risk of cost increase if more complex treatment or pre-treatment required.

For option 3, mechanically enhanced evaporation rates may vary from design assumptions which may affect duration and cost. With progressive concentration of contaminants in the evaporation pond, scaling may become problematic, leading to earlier commencement of contractor removal (higher cost). Increasing ammonia concentrations in particular may accelerate equipment corrosion.

There is potential for ammonia emissions to occur during water treatment operations. It is considered unlikely that the EPA will require a temporary emissions licence or transitional environmental program to permit the release of ammonia from the temporary treatment processes on site but it is recommended that Hydro discuss this with EPA in the context of the project, as specific EPA requirements for this exercise are difficult to predict with certainty.

4.4 Additional design considerations

A number of opportunities and requirements were identified during the options assessment discussions between Hydro, Ramboll Environ and GHD. These should be further considered as the project progresses:

- Vehicle wheel washing will be required at various locations on site to prevent the mobilisation of asbestos and other contaminants. Contaminated wash water will need to be managed and may be addressed as part of the leachate management process.
- Peak leachate volume management will be critical and as such, further additional buffer storage capacity may be appropriate. The EPA will need to be presented with a robust plan for peak volume containment.

- During excavation of the CWS, leachate from the CWS should be removed from site directly by the waste contractor where possible rather than transferred to the buffer storage pond for subsequent removal off site.
- A portable spill containment bund may be appropriate to manage spill risk at the CWS and buffer storage pond, but its suitability for this application would need to be demonstrated to the EPA.
- All liquid and solids waste on site may contain asbestos and will need to be transported and managed on that basis.
- Pumping and associated power supply at the containment cell may be temporary in nature to avoid significant power infrastructure to service the containment cell area.
- All infrastructure design should consider the short-term nature of the installation and be designed accordingly.

4.5 Safety in Design - Preliminary OHS&E risks identified

A high level Safety in Design assessment was undertaken for the options considered for this project. A summary of the OHS&E risks identified is presented below. A more detailed report is attached as Appendix F.

A number of OHS&E risks were identified through development of the options and were listed in the option scoring notes associated with the scoring matrix. A summary of these high level risks is provided below:

- Contractor treatment processes or treatment on site of the leachate may adjust the equilibrium of dissolved ammonium ions and ammonia gas in the water or sludge causing release of ammonia gas. Potential environmental, safety and odour issues associated with release of ammonia gas would need to be managed by the contractor.
- Ammonia emissions may occur during leachate treatment operations either on site or at contractors' facilities: It is considered unlikely that EPA will require a temporary emissions licence or transitional environmental program to permit the release of ammonia from the temporary treatment processes on site but it is recommended that Hydro discuss this with EPA in the context of the project as specific EPA requirements for this exercise are difficult to predict with certainty.
- The leachate and associated solids residues may be alkaline and toxic and may also contain asbestos fibres. Risks associated with handling and disposal of the asbestos contaminated leachate and associated solids residues will need to be managed.
- If contractors use assisted evaporation technologies, environmental impact must be managed through restricting spray drift to fall inside the dam footprint under all climatic conditions. Other risk mitigation may also be required regarding management of OH&S and odour risks including limiting operations to when the wind direction is away from sensitive receptors. Storage of leachate that has been concentrated by evaporation in a lined evaporation pond also increases the consequences of liner failure and brine contamination of soil/groundwater.
- Harm to irrigation area soils and vegetation through inadequate treatment of leachate and delivery of off-spec water to the North Dams remains a risk that requires ongoing management.
- Regulated waste material spills on site, during transport and during unloading at destinations.

- Inadequate stabilisation of solids material resulting in leaching of toxic contaminants from the waste.
- Potentially significant trucking requirements and associated driving hazards.

No formal risk identification and assessment process has been undertaken at this stage (i.e. a HAZID workshop) to identify all potential hazards. The solutions tendered (and therefore the selected approach) may include other processes not covered in the assessment of options so a formal risk assessment of the preferred tender will need to be conducted to ensure risks are mitigated adequately.

It is recommended that Contractors be required to submit a preliminary risk assessment with their tender based on their proposed process/methodology, including identification of how the Contractor would mitigate and manage those risks. Once the preferred tenderer is awarded the contract, they should be required to attend formal HAZID and HAZOP workshops.

5. Conclusions and recommendations

The following conclusions have been drawn from the options assessment:

- The precise quantity and quality of leachate generated during the decommissioning is difficult to accurately forecast. The volumes and quantities calculated for this study were suitable for relative differentiation between options and identification of a preferred option, but are only indicative for the purposes of estimating the cost of disposal for a particular option.
- Options 4 (Waste contractor removal and treatment/disposal off site) scored the highest in the comparative assessment and has an estimated order of magnitude project cost of $2.9 M.
- The range of costs across all options assessed varied between $2.9 M and $4.8 M.
- There is significant variability in the disposal rates obtained for waste contractor collection and disposal of the leachate off site. Having agreed contract rates established with multiple contractors will assist in both managing the risks of contractor rate inflation and having multiple options for leachate removal in the event of significant rainfall

The following recommendations are made for the next phase of this project:

- Hydro discuss the proposed approaches with the EPA to confirm any other licencing obligations required to cover the exercise.
- Hydro proceed with preliminary design of infrastructure required to facilitate contractor removal of leachate under Option 4. This may include:
  - a buffer storage pond and temporary truck filling area with appropriate spill management provisions
  - a temporary truck filling area with appropriate spill management provisions
  - leachate extraction/transfer pipework and pumping (temporary or permanent) from the containment cell sumps
- The preliminary design should be used as a basis for establishing a project cost and budget for tracking purposes.
- Assessment of the additional design considerations discussed in section 4.4 be undertaken.
- Prior to preparation of the tender specification for leachate management, the estimate leachate rates should be reconsidered based on the latest containment cell design and CWS decommissioning plans to minimise associated risk allowances tenderers may include in their pricing.
- Further consideration be given to the risks discussed in sections 4.3 and 4.5 in developing any subsequent design or development of tender documentation.
- Hydro to include in any tender documentation the relevant risks that have been identified to date to enable contractors to allow for appropriate risk mitigation.
- Contractors be required to submit a preliminary risk assessment with their Tender based on their proposed on site and off site processes, including identification of how the Contractor would mitigate and manage those risks. Once the preferred tenderer is awarded the contract, they should be required to attend formal HAZID and HAZOP workshops as appropriate.

- Consideration should be given to establishing service contracts with multiple waste contractors during the tender phase to secure primary and alternative contract rates and reduce the risk of rate inflation. Having multiple contractors available may also manage the risk that leachate cannot be removed from site quickly enough following significant rainfall events.
- Contractors tender submissions to include:
  – Collection and disposal prices based on a range of different leachate strengths and annual volumes (i.e. lower volumetric rates for higher annual volumes).
  – Guaranteed response times and transport capacity for rapid leachate removal during periods of peak leachate volume generation.
- Regular liaison occur between the containment cell contractor and Hydro regarding the containment cell leachate stored and available volumes.
- Carefully monitor and forecast stored leachate volumes during the operation to ensure sufficient available capacity remains to accommodate peak flow events.
- A comprehensive risk register for the project is developed and maintained.

Appendices

Appendix A Leachate Sample Water Quality

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		**MW202 (Waste Level)**				**MW203 (Natural Ground)**	**MW204 (Natural Ground)**	**MW206 (Natural Ground)**		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
Parameter	**Units**									
pH - field measured	pH Unit		9.08	9.14		9.16	10.28		10.68	10.97
Temp - field measured	^{o}C		21.2	28.2		21.9	22.3		23.4	24.3
Electrical Conductivity - field measured	µS/cm		26800	38344		17500	36800		42600	49204
Dissolved Oxygen - field measured	mg/L		0.08	-		0.15	0.24		0.06	-
REDOX - field measured	mV		-276	-189		-244	-147		-363	-367
pH Value - Laboratory	pH Unit				8.8					
Electrical Conductivity @ 25°C	µS/cm				35000			48400		
Total Dissolved Solids (Calc.)	mg/L				32000			44800		
Suspended Solids (SS)	mg/L				240			375		
Total Solids	mg/L				34000			58000		
Volatile Suspended Solids @ 550°C	mg/L				35			50		
Fixed Suspended Solids @ 550 C (Fraction of Susp	%							87		
Volatile Suspended Solids @ 550 C (Fraction of Su	%							13		
Colour (Apparent)	PCU							5000		
pH Colour	pH Unit							11.1		
Colour (True)	PCU				13000			4500		
pH Colour	pH Unit							11.1		
Gross alpha	Bq/L	<0.42						<0.74		
Gross beta activity - 40K	Bq/L	<0.83						<1.47		
Hydroxide Alkalinity as CaCO3	mg/L		<1		< 10			<1	<1	
Carbonate Alkalinity as CaCO3	mg/L		26700		6700			26200	24700	
Bicarbonate Alkalinity as CaCO3	mg/L		727		20000			1210	242	
Total Alkalinity as CaCO3	mg/L		27400		27000			27400	25000	
Silicon as SiO2	mg/L				< 200			47.5		
Chloride	mg/L		568		870			564	522	
Calcium (Dissolved)	mg/L				5			2		
Magnesium (Dissolved)	mg/L				41			<1		
Sodium (Dissolved)	mg/L		8300		12000			20100	16700	
Potassium (Dissolved)	mg/L		13		46			93	68	
Sodium Adsorption Ratio					360			3910		
Dissolved Metals										
Aluminium	mg/L		0.2	0.26			0.79	7.76	2.41	
Antimony	mg/L			<0.010				<0.010		
Arsenic	mg/L			0.251				0.509		
Beryllium	mg/L			<0.010				<0.010		
Barium	mg/L			0.239				0.034		
Cadmium	mg/L			<0.0010				<0.0010		
Chromium	mg/L			0.144				0.06		
Cobalt	mg/L			0.34				0.238		
Copper	mg/L			0.023				<0.010		
Lead	mg/L			<0.010				<0.010		
Lithium	mg/L			<0.010				<0.010		
Manganese	mg/L			0.54				0.02		
Molybdenum	mg/L			1.26				1.14		
Nickel	mg/L			0.288				0.115		
Selenium	mg/L			<0.10				<0.10		
Silver	mg/L			<0.010				<0.010		
Strontium	mg/L			0.199				0.038		
Thallium	mg/L			<0.010				<0.010		
Tin	mg/L			<0.010				0.012		
Titanium	mg/L							<0.10		
Vanadium	mg/L			1.76				0.25		
Zinc	mg/L			0.075				<0.050		
Boron	mg/L			<0.10				3.51		
Iron	mg/L			14.6				30.3		
Bromine	mg/L			6.8				4.7		
Iodine	mg/L			9.1				2.9		
Total Metals										
Aluminium	mg/L			9.02				7.01		
Antimony	mg/L			<0.010				<0.010		
Arsenic	mg/L			0.249				0.428		
Beryllium	mg/L			<0.010				<0.010		
Barium	mg/L			0.293				0.043		
Cadmium	mg/L			<0.0010				<0.0010		
Chromium	mg/L			0.15				0.057		
Cobalt	mg/L			0.375				0.263		
Copper	mg/L			0.032				<0.010		
Lead	mg/L			0.016				<0.010		
Lithium	mg/L			0.015				<0.010		
Manganese	mg/L			0.581				0.021		
Molybdenum	mg/L			1.41				1.46		
Nickel	mg/L			0.314				0.146		
Selenium	mg/L			<0.10				<0.10		
Silver	mg/L			<0.010				<0.010		
Strontium	mg/L			0.227				0.042		
Thallium	mg/L			<0.010				<0.010		
Tin	mg/L			<0.010				0.023		
Titanium	mg/L							<0.10		
Vanadium	mg/L			1.92				0.39		
Zinc	mg/L			0.129				<0.052		
Boron	mg/L			<0.10				3.87		
Iron	mg/L			19.4				44.3		
Bromine	mg/L			6.08				4.19		
Iodine	mg/L			7.49				2.56		
Arsenious Acid, As (III)	µg/L	<0.5						<0.5		
Arsenic Acid, As (V)	µg/L	72						310		
Organoarenic Compounds (indicative only - by dif	mg/L							0.118		

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
Mercury (Dissolved)	mg/L		<0.0001	<0.0001				<0.0001	<0.0001	
Mercury (Total)	mg/L			0.0122				<0.0001		
Hexavalent Chromium (Dissolved)	mg/L	<0.50						<0.50		
Chlorine - Free	mg/L				< 0.1			<1.0		
Chlorine - Total Residual	mg/L				< 0.1			<1.0		
Total Cyanide	mg/L		7.81		21		227	205	223	
Weak Acid Dissociable Cyanide	mg/L				0.047			<0.400		
Free Cyanide	mg/L		<0.040			<0.040	<0.040		<0.040	
Fluoride	mg/L		1880		250	0.2	1380	1700	1640	
Ammonia as N	mg/L				48			529		
Nitrite as N	mg/L				< 0.2			<0.01		
Nitrate as N	mg/L				< 0.2			0.55		
Nitrite + Nitrate as N	mg/L							0.55		
Organic Nitrogen (as N)	mg/L				27					
Total Kjeldahl Nitrogen as N	mg/L				75			593		
Total Nitrogen as N	mg/L				75			594		
Total Phosphorus as P	mg/L				5.2			8.6		
Reactive Phosphorus as P	mg/L				< 0.05			3.91		
Sulfide as S2-	mg/L	<1.0			< 0.15 (as S)			1.5		
Sulfite as SO3 2-	mg/L	<2			< 15 (as S)			<2		
Thiosulfate as S2O3 2-	mg/L	<20			< 30 (as S)			<20		
Total Sulphur	mg/L				680					
Sulfate as SO4 - Turbidimetric	mg/L		1250		2040			7660	9000	
Total Anions	meq/L							723		
Total Cations	meq/L							877		
Ionic Balance	%							9.56		
Total Organic Carbon	mg/L	2570			310			1890		
Formaldehyde	mg/L				< 0.2			<0.5		
Oil & Grease	mg/L	13						6		
Chemical Oxygen Demand	mg/L				2900			1700		
Nonionic Surfactants as CTAS	mg/L			<10				<5		
Anionic Surfactants as MBAS	mg/L			<0.2				0.1		
Acetates										
Butyl acetate	mg/L				< 0.5					< 0.5
Ethyl acetate	mg/L				< 1					< 1
Propyl acetate	mg/L				< 1					< 1
Vinyl acetate	mg/L				< 2.5					< 2.5
Alkanes										
n-Decane	mg/L				< 0.05					< 0.05
n-Heptane	mg/L				< 0.05					< 0.05
n-Hexane	mg/L				< 0.05					< 0.05
n-Nonane	mg/L				< 0.05					< 0.05
n-Octane	mg/L				< 0.05					< 0.05
n-Pentane	mg/L				< 0.05					< 0.05
Polychlorinated Biphenyls (PCB)										
Aroclor 1016	µg/L	<1						<1		
Aroclor 1221	µg/L	<1						<1		
Aroclor 1232	µg/L	<1						<1		
Aroclor 1242	µg/L	<1						<1		
Aroclor 1248	µg/L	<1						<1		
Aroclor 1254	µg/L	<1						<1		
Aroclor 1260	µg/L	<1						<1		
Aroclor 1262	µg/L	<1						<1		
Total Polychlorinated biphenyls	µg/L	<1	<1					<1	<1	
PCB Surrogate										
Decachlorobiphenyl	%	61						70		
Monocyclic Aromatic Hydrocarbons										
Benzene	µg/L	42			29			<5		
Toluene	µg/L	11			< 20			5		
Ethylbenzene	µg/L	<5			< 20			<5		
meta- & para-Xylene	µg/L	<10			< 40			<10		
Styrene	µg/L	<5			< 20			<5		
ortho-Xylene	µg/L	<5			< 20			<5		
Isopropylbenzene	µg/L	<5			< 20			<5		
n-Propylbenzene	µg/L	<5						<5		
1.3.5-Trimethylbenzene	µg/L	<5			< 20			<5		
sec-Butylbenzene	µg/L	<5						<5		
1.2.4-Trimethylbenzene	µg/L	<5			< 20			<5		
tert-Butylbenzene	µg/L	<5						<5		
p-Isopropyltoluene	µg/L	<5						<5		
n-Butylbenzene	µg/L	<5						<5		
Xylenes - Total	µg/L				< 60					
Oxygenated Compounds										
2-Propanone (Acetone)	µg/L	<50			< 20			340		
Vinyl Acetate	µg/L	<50						<50		
2-Butanone (MEK)	µg/L	<50			< 20			<50		
4-Methyl-2-pentanone (MIBK)	µg/L	<50			< 20			<50		
2-Hexanone (MBK)	µg/L	<50						<50		
Sulfonated Compounds										
Carbon disulfide	µg/L	<5			< 20			<5		
Fumigants										
2.2-Dichloropropane	µg/L	<5						<5		
1.2-Dichloropropane	µg/L	<5			< 20			<5		
cis-1.3-Dichloropropylene	µg/L	<5			< 20			<5		
trans-1.3-Dichloropropylene	µg/L	<5			< 20			<5		
1.2-Dibromoethane (EDB)	µg/L	<5			< 20			<5		
Halogenated Aliphatic Compounds										
Dichlorodifluoromethane	µg/L	<50			< 20			<50		

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		**MW202 (Waste Level)**				**MW203 (Natural Ground)**	**MW204 (Natural Ground)**	**MW206 (Natural Ground)**		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
Chloromethane	µg/L	<50			< 20			<50		
Vinyl chloride	µg/L	<50			< 20			<50		
Bromomethane	µg/L	<50			< 20			<50		
Chloroethane	µg/L	<50			< 20			<50		
Trichlorofluoromethane	µg/L	<50			< 20			<50		
1.1-Dichloroethene	µg/L	<5			< 20			<5		
Iodomethane	µg/L	<5			< 20			<5		
Methylene chloride	µg/L	<5			< 20			<5		
trans-1.2-Dichloroethene	µg/L	<5			< 20			<5		
1.1-Dichloroethane	µg/L	<5			< 20			<5		
cis-1.2-Dichloroethene	µg/L	<5			< 20			<5		
1.1.1-Trichloroethane	µg/L	<5			< 20			<5		
1.1-Dichloropropylene	µg/L	<5						<5		
Carbon Tetrachloride	µg/L	<5			< 20			<5		
1.2-Dichloroethane	µg/L	<5			< 20			<5		
Trichloroethene	µg/L	<5			< 20			<5		
Dibromomethane	µg/L	<5			< 20			<5		
1.1.2-Trichloroethane	µg/L	<5			< 20			<5		
1.3-Dichloropropane	µg/L	<5			< 20			<5		
Tetrachloroethene	µg/L	<5			< 20			<5		
1.1.1.2-Tetrachloroethane	µg/L	<5			< 20			<5		
trans-1.4-Dichloro-2-butene	µg/L	<5						<5		
cis-1.4-Dichloro-2-butene	µg/L	<5						<5		
1.1.2.2-Tetrachloroethane	µg/L	<5			< 20			<5		
1.2.3-Trichloropropane	µg/L	<5			< 20			<5		
Pentachloroethane	µg/L	<5						<5		
1.2-Dibromo-3-chloropropane	µg/L	<5						<5		
Hexachlorobutadiene	µg/L	<5						<5		
Allyl chloride (3-Chloropropene)	µg/L				< 20					
Bis(2-chloroisopropyl)ether	µg/L				< 10					
Halogenated Aromatic Compounds										
Chlorobenzene	µg/L	<5			< 20			<5		
Bromobenzene	µg/L	<5			< 20			<5		
2-Chlorotoluene	µg/L	<5						<5		
4-Chlorotoluene	µg/L	<5			< 20			<5		
1.3-Dichlorobenzene	µg/L	<5			< 20			<5		
1.4-Dichlorobenzene	µg/L	<5			< 20			<5		
1.2-Dichlorobenzene	µg/L	<5			< 20			<5		
1.2.4-Trichlorobenzene	µg/L	<5			< 10			<5		
1.2.3-Trichlorobenzene	µg/L	<5			< 10			<5		
1.2.3.4-Tetrachlorobenzene	µg/L				< 10					
1.2.3.5-Tetrachlorobenzene	µg/L				< 10					
1.2.4.5-Tetrachlorobenzene	µg/L				< 10					
1.3.5-Trichlorobenzene	µg/L				< 10					
Benzyl chloride	µg/L				< 10					
Trihalomethanes										
Chloroform	µg/L	19			< 20			8		
Bromodichloromethane	µg/L	<5			< 20			<5		
Dibromochloromethane	µg/L	<5			< 20			<5		
Bromoform	µg/L	<5			< 20			<5		
Bromochloromethane	µg/L				< 20					
VOC Surrogates										
1.2-Dichloroethane-D4	%	108						104		
Toluene-D8	%	123						121		
4-Bromofluorobenzene	%	111			97			107		
Fluorobenzene	%				93					
Polynuclear Aromatic Hydrocarbons										
Naphthalene	µg/L	<2	1.4		< 4			9	30.2	
2-Methylnaphthalene	µg/L	<2			< 10			<2		
2-Chloronaphthalene	µg/L	<2			< 10			<2		
Acenaphthylene	µg/L	<2	<1.0		< 1			<2	<1.0	
Acenaphthene	µg/L	<2	<1.0		< 1			<2	3.5	
Fluorene	µg/L	<2	<1.0		< 1			<2	2.1	
Phenanthrene	µg/L	<2	<1.0		< 1			3	6	
Anthracene	µg/L	<2	<1.0		< 1			<2	2.7	
Fluoranthene	µg/L	<2	<1.0		< 1			8	8.8	
Pyrene	µg/L	<2	1		< 1			7	8.7	
N-2-Fluorenyl Acetamide	µg/L	<2						<2		
Benz(a)anthracene	µg/L	<2	<1.0		< 1			7	9.2	
Chrysene	µg/L	<2	<1.0		< 1			7	8.4	
Benzo(b+j) & Benzo(k)fluoranthene	µg/L	<4			< 1			17		
Benzo(b&j)fluorantheneN07	µg/L		<1.0		< 1				12.3	
Benzo(k)fluoranthene	µg/L		<1.0		< 1				3.9	
7.12-Dimethylbenz(a)anthracene	µg/L	<2			< 10			<2		
Benzo(a)pyrene	µg/L	<2	<0.5		< 1			10	9.6	
3-Methylcholanthrene	µg/L	<2			< 10			<2		
Indeno(1.2.3.cd)pyrene	µg/L	<2	<1.0		< 1			5	7	
Dibenz(a.h)anthracene	µg/L	<2	<1.0		< 1			<2	1.7	
Benzo(g.h.i)perylene	µg/L	<2	<1.0		< 1			6	8.2	
Sum of PAHs	µg/L	<2	2.4					79	122	
Benzo(a)pyrene TEQ (zero)	µg/L	<2	<0.5					13	14.7	
Dibenz(a.j)acridine	µg/L				< 10					
Phthalate Esters										
Dimethyl phthalate	µg/L	<2			< 10			<2		
Diethyl phthalate	µg/L	<2			< 10			<2		
Di-n-butyl phthalate	µg/L	<2			< 10			<2		
Butyl benzyl phthalate	µg/L	<2			< 10			<2		
bis(2-ethylhexyl) phthalate	µg/L	<10			< 10			<10		

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
Di-n-octylphthalate	µg/L	<2			< 10			<2		
Nitrosamines										
N-Nitrosomethylethylamine	µg/L	<2						<2		
N-Nitrosodiethylamine	µg/L	<2						<2		
N-Nitrosopyrrolidine	µg/L	<4						<4		
N-Nitrosomorpholine	µg/L	<2						<2		
N-Nitrosodi-n-propylamine	µg/L	<2			< 10			<2		
N-Nitrosopiperidine	µg/L	<2			< 10			<2		
N-Nitrosodibutylamine	µg/L	<2			< 10			<2		
N-Nitrosodiphenyl & Diphenylamine	µg/L	<4						<4		
Methapyrilene	µg/L	<2						<2		
Diphenylamine	µg/L				< 10					
Nitroaromatics and Ketones										
2-Picoline	µg/L	<2			< 10			<2		
Acetophenone	µg/L	<2			< 10			<2		
Nitrobenzene	µg/L	<2			< 50			<2		
Isophorone	µg/L	<2						<2		
2.6-Dinitrotoluene	µg/L	<4			< 10			<4		
2.4-Dinitrotoluene	µg/L	<4			< 10			<4		
1-Naphthylamine	µg/L	<2			< 10			<2		
4-Nitroquinoline-N-oxide	µg/L	<2						<2		
5-Nitro-o-toluidine	µg/L	<2						<2		
Azobenzene	µg/L	<2						<2		
1.3.5-Trinitrobenzene	µg/L	<2						<2		
Phenacetin	µg/L	<2						<2		
4-Aminobiphenyl	µg/L	<2			< 10			<2		
Pentachloronitrobenzene	µg/L	<2			< 10			<2		
Pronamide	µg/L	<2			< 10			<2		
Dimethylaminoazobenzene	µg/L	<2			< 10			<2		
Chlorobenzilate	µg/L	<2						<2		
2-Naphthylamine	µg/L				< 10					
Haloethers										
Bis(2-chloroethyl) ether	µg/L	<2						<2		
Bis(2-chloroethoxy) methane	µg/L	<2			< 10			<2		
4-Chlorophenyl phenyl ether	µg/L	<2			< 10			<2		
4-Bromophenyl phenyl ether	µg/L	<2			< 10			<2		
Chlorinated Hydrocarbons										
1.4-Dichlorobenzene	µg/L	<2			< 10			<2		
1.3-Dichlorobenzene	µg/L	<2			< 10			<2		
1.2-Dichlorobenzene	µg/L	<2			< 10			<2		
Hexachloroethane	µg/L	<2			< 10			<2		
1.2.4-Trichlorobenzene	µg/L	<2						<2		
Hexachloropropylene	µg/L	<2						<2		
Hexachlorobutadiene	µg/L	<2			< 10			<2		
Hexachlorocyclopentadiene	µg/L	<10			< 10			<10		
Pentachlorobenzene	µg/L	<2			< 10			<2		
Hexachlorobenzene (HCB)	µg/L	<4			< 10			<4		
Anilines and Benzidines										
Aniline	µg/L	<2			< 10			<2		
4-Chloroaniline	µg/L	<2						<2		
2-Nitroaniline	µg/L	<4			< 10			<4		
3-Nitroaniline	µg/L	<4						<4		
Dibenzofuran	µg/L	<2			< 10			<2		
4-Nitroaniline	µg/L	<2						<2		
Carbazole	µg/L	<2						4		
3.3`-Dichlorobenzidine	µg/L	<2			< 10			<2		
Organochlorine Pesticides (OC)										
alpha-BHC	µg/L	<0.5						<0.5		
Hexachlorobenzene (HCB)	µg/L	<0.5						<0.5		
beta-BHC	µg/L	<0.5						<0.5		
gamma-BHC	µg/L	<0.5						<0.5		
delta-BHC	µg/L	<0.5						<0.5		
Heptachlor	µg/L	<0.5						<0.5		
Aldrin	µg/L	<0.5			< 10			<0.5		
Heptachlor epoxide	µg/L	<0.5						<0.5		
trans-Chlordane	µg/L	<0.5						<0.5		
alpha-Endosulfan	µg/L	<0.5						<0.5		
cis-Chlordane	µg/L	<0.5						<0.5		
Dieldrin	µg/L	<0.5			< 10			<0.5		
4.4`-DDE	µg/L	<0.5			< 10			<0.5		
Endrin	µg/L	<0.5			< 10			<0.5		
beta-Endosulfan	µg/L	<0.5						<0.5		
4.4`-DDD	µg/L	<0.5			< 10			<0.5		
Endrin aldehyde	µg/L	<0.5			< 10			<0.5		
Endosulfan sulfate	µg/L	<0.5			< 10			<0.5		
4.4`-DDT	µg/L	<2.0			< 10			<2.0		
Endrin ketone	µg/L	<0.5			< 10			<0.5		
Methoxychlor	µg/L	<2.0			< 10			<2.0		
Total Chlordane (sum)	µg/L	<0.5						<0.5		
Sum of DDD + DDE + DDT	µg/L	<0.5						<0.5		
Sum of Aldrin + Dieldrin	µg/L	<0.5						<0.5		
Endosulfan I	µg/L				< 10					
Endosulfan II	µg/L				< 10					
Organochlorine Pesticide Surrogate										
Dibromo-DDE	%	62.6						70.6		
Organochlorine Pesticides										
alpha-BHC	µg/L	<2			< 10			<2		
beta-BHC	µg/L	<2			< 10			<2		

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		**MW202 (Waste Level)**				**MW203 (Natural Ground)**	**MW204 (Natural Ground)**	**MW206 (Natural Ground)**		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
gamma-BHC	µg/L	<2			< 10			<2		
delta-BHC	µg/L	<2			< 10			<2		
Heptachlor	µg/L	<2			< 10			<2		
Aldrin	µg/L	<2						<2		
Heptachlor epoxide	µg/L	<2			< 10			<2		
alpha-Endosulfan	µg/L	<2						<2		
4.4`-DDE	µg/L	<2						<2		
Dieldrin	µg/L	<2						<2		
Endrin	µg/L	<2						<2		
beta-Endosulfan	µg/L	<2						<2		
4.4`-DDD	µg/L	<2						<2		
Endosulfan sulfate	µg/L	<2						<2		
4.4`-DDT	µg/L	<4						<4		
Sum of Aldrin + Dieldrin	µg/L	<4						<4		
Sum of DDD + DDE + DDT	µg/L	<4						<4		
Organophosphorus Pesticides (OP)										
Dichlorvos	µg/L	<0.5						<0.5		
Demeton-S-methyl	µg/L	<0.5						<0.5		
Monocrotophos	µg/L	<2.0						<2.0		
Dimethoate	µg/L	<0.5						<0.5		
Diazinon	µg/L	<0.5						<0.5		
Chlorpyrifos-methyl	µg/L	<0.5						<0.5		
Parathion-methyl	µg/L	<2.0						<2.0		
Malathion	µg/L	<0.5						<0.5		
Fenthion	µg/L	<0.5						<0.5		
Chlorpyrifos	µg/L	<0.5						<0.5		
Parathion	µg/L	<2.0						<2.0		
Pirimphos-ethyl	µg/L	<0.5						<0.5		
Chlorfenvinphos	µg/L	<0.5						<0.5		
Bromophos-ethyl	µg/L	<0.5						<0.5		
Fenamiphos	µg/L	<0.5						<0.5		
Prothiofos	µg/L	<0.5						<0.5		
Ethion	µg/L	<0.5						<0.5		
Carbophenothion	µg/L	<0.5						<0.5		
Azinphos Methyl	µg/L	<0.5						<0.5		
Organophosphorus Pesticide Surrogate										
DEF	%	62.7						68.9		
Organophosphorus Pesticides										
Dichlorvos	µg/L	<2						<2		
Dimethoate	µg/L	<2						<2		
Diazinon	µg/L	<2						<2		
Chlorpyrifos-methyl	µg/L	<2						<2		
Malathion	µg/L	<2						<2		
Fenthion	µg/L	<2						<2		
Chlorpyrifos	µg/L	<2						<2		
Pirimphos-ethyl	µg/L	<2						<2		
Chlorfenvinphos	µg/L	<2						<2		
Prothiofos	µg/L	<2						<2		
Ethion	µg/L	<2						<2		
OP Pesticides										
Azinphos-methyl	µg/L	<0.02						<0.02		
Azinphos-ethyl	µg/L	<0.02						<0.02		
Bromophos-ethyl	µg/L	<0.10						<0.10		
Carbofenothion	µg/L	<0.02						<0.02		
Chlorfenvinphos	µg/L	<0.02						<0.02		
Chlorpyrifos	µg/L	<0.02						<0.02		
Chlorpyrifos-methyl	µg/L	<0.2						<0.2		
Coumaphos	µg/L	<0.01						<0.01		
Demeton-O & Demeton-S	µg/L	<0.02						<0.02		
Demeton-S-methyl	µg/L	<0.02						<0.02		
Diazinon	µg/L	<0.01						<0.01		
Dichlorvos	µg/L	<0.20						<0.20		
Dimethoate	µg/L	<0.02						<0.02		
Disulfoton	µg/L	<0.05						<0.05		
EPN	µg/L	<0.05						<0.05		
Ethion	µg/L	<0.02						<0.02		
Ethoprophos	µg/L	<0.01						<0.01		
Fenamiphos	µg/L	<0.01						<0.01		
Fenchlorphos (Ronnel)	µg/L	<10						<10		
Fenitrothion	µg/L	<2						<2		
Fensulfothion	µg/L	<0.01						<0.01		
Fenthion	µg/L	<0.05						<0.05		
Malathion	µg/L	<0.02						<0.02		
Mevinphos	µg/L	<0.02						<0.02		
Monocrotophos	µg/L	<0.02						<0.02		
Omethoate	µg/L	<0.01						<0.01		
Parathion	µg/L	<0.2						<0.2		
Parathion-methyl	µg/L	<2.0						<2.0		
Phorate	µg/L	<0.1						<0.1		
Pirimiphos-ethyl	µg/L	<0.01						<0.01		
Pirimiphos-methyl	µg/L	<0.01						<0.01		
Profenofos	µg/L	<0.01						<0.01		
Prothiofos	µg/L	<0.1						<0.1		
Sulfotep	µg/L	<0.005						<0.005		
Sulprofos	µg/L	<0.05						<0.05		
Temephos	µg/L	<0.02						<0.02		
Terbufos	µg/L	<0.01						<0.01		
Tetrachlorvinphos	µg/L	<0.01						<0.01		

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
Triazophos	µg/L	<0.005						<0.005		
Trichlorfon	µg/L	<0.02						<0.02		
Trichloronate	µg/L	<0.5						<0.5		
Miscellaneous (ESI Positive Mode) Pesticides										
Diclofop-methyl	µg/L	<0.05						<0.05		
Fenarimol	µg/L	<0.02						<0.02		
Irgarol	µg/L	<0.002						<0.002		
Oxyfluorfen	µg/L	<1.0						<1.0		
Thiamethoxam	µg/L	<0.02						<0.02		
Acid Extractable Surrogates										
2-Fluorophenol	%	19.4						27.2		
Phenol-d6	%	23.5			27			26.5		
2-Chlorophenol-D4	%	32.3						18		
2.4.6-Tribromophenol	%	39.1			42			25.3		
Base/Neutral Extractable Surrogates										
Nitrobenzene-D5	%	38			56			53.6		
1.2-Dichlorobenzene-D4	%	31						44.2		
2-Fluorobiphenyl	%	36.1			53			61.8		
Anthracene-d10	%	76.7						113		
4-Terphenyl-d14	%	47.9						70.5		
Additional SVOC										
1,2-Diphenylhydrazine	µg/L				< 1					< 1
Surrogate Fluorobiphenyl	%				90					83
Total Petroleum Hydrocarbons										
C6 - C9 Fraction	µg/L	<100	110					<100	330	
C10 - C14 Fraction	µg/L	<50	<50					80	200	
C15 - C28 Fraction	µg/L	270	<100					380	540	
C29 - C36 Fraction	µg/L	240	120					50	100	
C10 - C36 Fraction (sum)	µg/L	510	120					510	840	
Total Recoverable Hydrocarbons - NEPM 2013 Fractions										
C6 - C10 Fraction	µg/L	<100	120					<100	330	
C6 - C10 Fraction minus BTEX (F1)	µg/L	<100	90					<100	320	
>C10 - C16 Fraction	µg/L	<100	<100					120	330	
>C16 - C34 Fraction	µg/L	340	460					430	540	
>C34 - C40 Fraction	µg/L	200	140					<100	<100	
>C10 - C40 Fraction (sum)	µg/L	540	600					550	870	
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	<100	<100					<100	280	
BTEXN										
Benzene	µg/L	44	23					<5	3	
Toluene	µg/L	10	6					<5	4	
Ethylbenzene	µg/L	<5	<2					<5	<2	
meta- & para-Xylene	µg/L	<5	<2					<5	3	
ortho-Xylene	µg/L	<5	<2					<5	<2	
Total Xylenes	µg/L	<5	<2					<5	3	
Sum of BTEX	µg/L	54	29					<5	10	
Naphthalene	µg/L	5	<5					48	48	
TPH(V)/BTEX Surrogates										
1.2-Dichloroethane-D4	%	111						107		
Toluene-D8	%	114						112		
4-Bromofluorobenzene	%	112						107		
Organotin Compounds (Soluble)										
Tributyltin	ngSn/L	<15						<15		
Organotin Surrogate										
Tripropyltin	%	83.9						67.1		
Nitrogenated Compounds										
Acrylonitrile	µg/L	<1						<1		
Aldehydes										
Formaldehyde	µg/L	168						423		
Acetaldehyde	µg/L	10.1						19		
Propionaldehyde	µg/L	<2.0						<2.0		
Acrolein (Propenal)	µg/L	<2.0						<2.0		
Butyraldehyde	µg/L	<2.0						2.7		
Phenolic Compounds										
Phenol	µg/L	<2			< 3			12		
2-Chlorophenol	µg/L	<2			< 3			<2		
2-Methylphenol	µg/L	<2			< 3			<2		
3- & 4-Methylphenol	µg/L	<4			< 6			8		
2-Nitrophenol	µg/L	<2			< 10			<2		
2.4-Dimethylphenol	µg/L	2			< 3			<2		
2.4-Dichlorophenol	µg/L	<2			< 3			<2		
2.6-Dichlorophenol	µg/L	<2			< 3			<2		
4-Chloro-3-methylphenol	µg/L	<2			< 10			<2		
2.4.6-Trichlorophenol	µg/L	<2			< 10			<2		
2.4.5-Trichlorophenol	µg/L	<2			< 10			<2		
Pentachlorophenol	µg/L	<4			< 10			<4		
1-Chloronaphthalene	µg/L				< 10					
Phenolic Compounds										
2-Chlorophenol	µg/L	<0.05						<0.05		
4-Chloro-3-methylphenol (Para-chloro-meta-cre	µg/L	<0.05						<0.05		
m-Cresol	µg/L	<0.1						21.6		
o-Cresol	µg/L	<0.1						10.4		
p-Cresol	µg/L	<0.1						26		
2.4-Dichlorophenol	µg/L	1.6						0.3		
2.6-Dichlorophenol	µg/L	0.5						0.3		
2.4-Dimethylphenol	µg/L	0.7						4.3		
Hexachlorophene	µg/L	<0.1						<0.1		
2-Nitrophenol	µg/L	<0.1						<0.1		

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
4-Nitrophenol	µg/L	<0.1			< 30			<0.1		
Pentachlorophenol	µg/L	<0.05						0.39		
Phenol	µg/L	<0.1						123		
2.3.4.6-Tetrachlorophenol	µg/L	<0.1			< 20			<0.1		
2.4.5-Trichlorophenol	µg/L	<0.1						0.1		
2.4.6-Trichlorophenol	µg/L	0.3						<0.1		
2-Methyl-4.6-dinitrophenol	µg/L				< 30					
2.4-Dinitrophenol	µg/L				< 30					
Acid Extractable Surrogates										
2-Fluorophenol	%	54.1						34.4		
Phenol-d6	%	58.4						76.8		
2-Chlorophenol-D4	%	58.4						62.6		
2.4.6-Tribromophenol	%	69.8						57		
Base/Neutral Extractable Surrogates										
2-Fluorobiphenyl	%	53.5						93.2		
Anthracene-d10	%	63.6						116		
4-Terphenyl-d14	%	56.8						107		
Phenoxyacetic Acid Herbicides by LCMS										
4-Chlorophenoxy acetic acid	µg/L	<10						<10		
2.4-DB	µg/L	<10						<10		
Dicamba	µg/L	<10						<10		
Mecoprop	µg/L	<10						<10		
MCPA	µg/L	<10						<10		
2.4-DP	µg/L	<10						<10		
2.4-D	µg/L	<10						<10		
Triclopyr	µg/L	<10						<10		
Silvex (2.4.5-TP/Fenoprop)	µg/L	<10						<10		
2.4.5-T	µg/L	<10						<10		
MCPB	µg/L	<10						<10		
Picloram	µg/L	<10						<10		
Clopyralid	µg/L	<10						<10		
Fluroxypyr	µg/L	<10						<10		
2.6-D	µg/L	<10						<10		
2.4.6-T	µg/L	<10						<10		
Phenoxyacetic Acid Herbicide Surrogate										
2.4-Dichlorophenyl Acetic Acid	%	69.9						72.4		
Explosives										
HMX	µg/L	<20						<20		
RDX	µg/L	<20						<20		
1.3.5-Trinitrobenzene	µg/L	<20						<20		
1.3-Dinitrobenzene	µg/L	<20						<20		
Tetryl	µg/L	<20						<20		
2.4.6-TNT	µg/L	<20						<20		
4-Amino.2.6-DNT	µg/L	<20						<20		
2-Amino-4.6-DNT	µg/L	<20						<20		
4-& 2-AM-DNT(Isomeric Mixture)	µg/L	<20						<20		
2.4-Dinitrotoluene	µg/L	<20						<20		
2.6-Dinitrotoluene	µg/L	<20						<20		
2.4-& 2.6-DNT(Isomeric Mixture)	µg/L	<20						<20		
Nitrobenzene	µg/L	<20						<20		
2-Nitrotoluene	µg/L	<20						<20		
3-Nitrotoluene	µg/L	<20						<20		
4-Nitrotoluene	µg/L	<20						<20		
Nitroglycerine	µg/L	<200						<200		
PETN	µg/L	<200						<200		
Explosives Surrogate										
o-Dinitrobenzene	%	114						97.2		
Perfluorinated Compounds										
PFOS	µg/L	<0.05						<0.05		
PFOA	µg/L	<0.05						<0.05		
6:2 Fluorotelomer sulfonate (6:2 FtS)	µg/L	<0.5						<0.5		
8:2 Fluorotelomer sulfonate	µg/L	<0.5						<0.5		
PFOSA	µg/L	<0.10						<0.10		
N-Me-FOSA	µg/L	<0.5						<0.5		
N-Et-FOSA	µg/L	<0.10						<0.10		
N-Me-FOSE	µg/L	<0.5						<0.5		
N-Et-FOSE	µg/L	<0.5						<0.5		
PFBS	µg/L	<0.10						<0.10		
PFHxS	µg/L	<0.10						<0.10		
PFDcS	µg/L	<0.10						<0.10		
PFHxA	µg/L	<0.10						<0.10		
PFHpA	µg/L	<0.10						<0.10		
PFNA	µg/L	<0.10						<0.10		
PFDcA	µg/L	<0.10						<0.10		
PFUnA	µg/L	<0.10						<0.10		
PFDoA	µg/L	<0.10						<0.10		
PFTriA	µg/L	<0.10						<0.10		
PFTeA	µg/L	<0.5						<0.5		
Thiocarbamates and Carbamates										
Aldicarb	µg/L	<0.05						<0.05		
Bendiocarb	µg/L	<0.10						<0.10		
Benomyl	µg/L	<0.01						<0.01		
Carbaryl	µg/L	<0.01						<0.01		
Carbofuran	µg/L	<0.01						<0.01		
3-Hydroxy Carbofuran	µg/L	<0.02						<0.02		
Methiocarb	µg/L	<0.01						<0.01		
Methomyl	µg/L	<0.01						<0.01		
Molinate	µg/L	<0.1						<0.1		

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
Oxamyl	µg/L	<0.01						<0.01		
Thiobencarb	µg/L	<0.01						<0.01		
Thiodicarb	µg/L	<0.01						<0.01		
Dinitroanilines										
Pendimethalin	µg/L	<0.05						<0.05		
Trifluralin	µg/L	<10.0			< 10			<10.0		
Triazinone Herbicides										
Hexazinone	µg/L	<0.02						<0.02		
Metribuzin	µg/L	<0.02						<0.02		
Conazole and Aminopyrimidine Fungicides										
Cyproconazole	µg/L	<0.02						<0.02		
Difenoconazole	µg/L	<0.02						<0.02		
Flusilazole	µg/L	<0.02						<0.02		
Hexaconazole	µg/L	<0.02						<0.02		
Paclobutrazole	µg/L	<0.05						<0.05		
Penconazole	µg/L	<0.01						<0.01		
Propiconazole	µg/L	<0.05						<0.05		
Tebuconazole	µg/L	<0.01						<0.01		
Cyprodinil	µg/L	<0.01						<0.01		
Pyrimethanil	µg/L	<0.02						<0.02		
Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides										
Diuron	µg/L	<0.02						<0.02		
Fluometuron	µg/L	<0.01						<0.01		
Tebuthiuron	µg/L	<0.02						<0.02		
Bromacil	µg/L	<0.02						<0.02		
Chlorsulfuron	µg/L	<0.2						<0.2		
Chloracetanilides										
Metolachlor	µg/L	<0.01						<0.01		
Triazine Herbicides										
Ametryn	µg/L	<0.01						<0.01		
Atrazine	µg/L	<0.01						<0.01		
Cyanazine	µg/L	<0.02						<0.02		
Cyromazine	µg/L	<0.05						<0.05		
Prometryn	µg/L	<0.01						<0.01		
Propazine	µg/L	<0.01						<0.01		
Simazine	µg/L	<0.02						<0.02		
Terbuthylazine	µg/L	<0.01						<0.01		
Terbutryn	µg/L	<0.01						<0.01		
Organic Mercaptans										
Methyl Mercaptan	mg/L				<0.05					
Ethyl Mercaptan	mg/L				<0.05					
Isobutyl Mercaptan	mg/L				<0.05					
Propyl Mercaptan	mg/L				<0.05					
Butyl Mercaptan	mg/L				<0.05					

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1535966**	Page	: 1 of 23
Amendment	: **1**		
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR DAVE BARRETT	Contact	:
Address	: PO BOX 5403 NEWCASTLE WEST NSW, AUSTRALIA 2302	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: dave.barrett@ghd.com.au	E-mail	:
Telephone	: +61 07 4972 6377	Telephone	: +61-2-8784 8555
Facsimile	: +61 07 4972 6236	Facsimile	: +61-2-8784 8500
Project	: LEACHATE ASSESSMENT	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: 2218015	Date Samples Received	: 11-Nov-2015 16:00
C-O-C number	: ----	Date Analysis Commenced	: 11-Nov-2015
Sampler	: JESSE SIMKUS	Issue Date	: 04-Dec-2015 12:19
Site	: ----		
		No. of samples received	: 2
Quote number	: ----	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Dian Dao		Sydney Inorganics
Dianne Blane	Laboratory Coordinator (2IC)	Newcastle - Inorganics
Matt Frost	Senior Organic Chemist	Brisbane Organics
Pabi Subba	Senior Organic Chemist	Sydney Organics
Phalak Inthakesone	Laboratory Manager - Organics	Sydney Organics
Titus Vimalasiri	Senior Scientist	Radionuclides

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- EG020: Bromine & Iodine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.
- EG020: Sample ES1535966-001 was diluted and rerun due to matrix interference and LOR's have been raised accordingly. (High Total Dissolved Solids)
- EG020:It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EP202: Poor matrix spike recoveries for Clopyralid due to matrix effects.
- Sampling time not provided. For operational reasons an assumed date/time (3pm on date of receipt) is used. Sample results may be affected if the analysis falls outside of actual holding time.
- Gross Alpha and Beta Activity analyses are performed by ALS Fyshwick (NATA Accreditation number 992).
- EK085: LOR has been raised for sample ID MW202 for sulphide due to sample matrix interference.
- EG050G-F: LOR raised for Hexavalent Chromium analysis on a few samples due to matrix interferences.
- EK087 : LOR was raised for Thiosulfate due to sample matrix.
- EK010 : LOR was raised for Chlorine due to sample matrix.
- EP010 : LOR was raised for Formaldehyde due to sample matrix.
- EP121: Poor matrix spike recovery due to sample matrix effects. This has been confirmed by re-analysis.
- EK028SF:LOR raised for Weak Acid Dissociable Cyanide analysis on sample ID(MW206) due to sample matrix.
- LOR for gross alpha and beta raised due to the high amount of solid present.
- EP231: Particular samples required dilution due to matrix interferences. LOR values have been adjusted accordingly.
- EP090S: Samples 'MW206' and 'MW202' required dilution prior to extraction due to matrix interferences. LOR values have been adjusted accordingly.
- EP050: The MBAS reported is calculated as LAS, mol wt 342.
- EP074/80: Particular samples required dilution due to sample matrix . LOR values have been adjusted accordingly.
- Total PAH reported as the sum of Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene and Benzo(g,h,i)perylene.
- EP075: 'Sum of PAH' is the sum of the USEPA 16 priority PAHs
- EA250 LSC : LOR for Gross Alpha and Beta raised due to high solid content
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- PFOS and PFOA results are reported as an aggregate of linear and branched isomers.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			*Client sample ID*	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	*CAS Number*	*LOR*	*Unit*	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EA005: pH													
pH Value	----	0.01	pH Unit	**10.8**		----		----		----		----	
EA010P: Conductivity by PC Titrator													
Electrical Conductivity @ 25°C	----	1	µS/cm	**48400**		----		----		----		----	
EA017: TDS (Calc)													
Total Dissolved Solids (Calc.)	----	1	mg/L	**44800**		----		----		----		----	
EA025: Total Suspended Solids dried at 104 ± 2°C													
Suspended Solids (SS)	----	5	mg/L	**375**		----		----		----		----	
EA030: Total Solids dried at 104 ± 2°C													
Total Solids	----	10	mg/L	**58000**		----		----		----		----	
EA036: Fixed/Volatile Suspended Solids													
Volatile Suspended Solids @ 550°C	----	5	mg/L	**50**		----		----		----		----	
Fixed Suspended Solids @ 550 C (Fraction of Suspended S)	----	0.1	%	**87**		----		----		----		----	
Volatile Suspended Solids @ 550 C (Fraction of Suspended S)	----	0.1	%	**13**		----		----		----		----	
EA040: Colour (Apparent)													
Colour (Apparent)	----	1	PCU	**5000**		----		----		----		----	
pH Colour	----	0.01	pH Unit	**11.1**		----		----		----		----	
EA041: Colour (True)													
Colour (True)	----	1	PCU	**4500**		----		----		----		----	
pH Colour	----	0.01	pH Unit	**11.1**		----		----		----		----	
EA250: Gross Alpha and Beta Activity													
Gross alpha	----	0.05	Bq/L	<0.74	--	<0.42	--	----		----		----	
Gross beta activity - 40K	----	0.1	Bq/L	<1.47	--	<0.83	--	----		----		----	
ED037P: Alkalinity by PC Titrator													
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1		----		----		----		----	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	**26200**		----		----		----		----	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**1210**		----		----		----		----	
Total Alkalinity as CaCO3	----	1	mg/L	**27400**		----		----		----		----	
ED040F: Dissolved Major Anions													
Silicon as SiO2	14464-46-1	0.1	mg/L	**47.5**		----		----		----		----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA													
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**7660**		----		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Compound	CAS Number	LOR	Unit	MW206 Result	MW206 MU	MW202 Result	MW202 MU	---- Result	---- MU	---- Result	---- MU	---- Result	---- MU
Client sampling date / time				[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Lab ID				ES1535966-001		ES1535966-002		--------		--------		--------	
ED045G: Chloride by Discrete Analyser													
Chloride	16887-00-6	1	mg/L	**564**		----		----		----		----	
ED093F: Dissolved Major Cations													
Calcium	7440-70-2	1	mg/L	**2**		----		----		----		----	
Magnesium	7439-95-4	1	mg/L	<1		----		----		----		----	
Sodium	7440-23-5	1	mg/L	**20100**		----		----		----		----	
Potassium	7440-09-7	1	mg/L	**93**		----		----		----		----	
ED093F: SAR and Hardness Calculations													
Sodium Adsorption Ratio	----	0.01	-	**3910**		----		----		----		----	
EG020F: Dissolved Metals by ICP-MS													
Aluminium	7429-90-5	0.01	mg/L	**7.76**		----		----		----		----	
Antimony	7440-36-0	0.001	mg/L	<0.010		----		----		----		----	
Arsenic	7440-38-2	0.001	mg/L	**0.509**		----		----		----		----	
Boron	7440-42-8	0.05	mg/L	**3.51**		----		----		----		----	
Barium	7440-39-3	0.001	mg/L	**0.034**		----		----		----		----	
Beryllium	7440-41-7	0.001	mg/L	<0.010		----		----		----		----	
Cadmium	7440-43-9	0.0001	mg/L	<0.0010		----		----		----		----	
Cobalt	7440-48-4	0.001	mg/L	**0.238**		----		----		----		----	
Chromium	7440-47-3	0.001	mg/L	**0.060**		----		----		----		----	
Copper	7440-50-8	0.001	mg/L	<0.010		----		----		----		----	
Manganese	7439-96-5	0.001	mg/L	**0.020**		----		----		----		----	
Nickel	7440-02-0	0.001	mg/L	**0.115**		----		----		----		----	
Lead	7439-92-1	0.001	mg/L	<0.010		----		----		----		----	
Selenium	7782-49-2	0.01	mg/L	<0.10		----		----		----		----	
Vanadium	7440-62-2	0.01	mg/L	**0.25**		----		----		----		----	
Zinc	7440-66-6	0.005	mg/L	<0.050		----		----		----		----	
Lithium	7439-93-2	0.001	mg/L	<0.010		----		----		----		----	
Molybdenum	7439-98-7	0.001	mg/L	**1.14**		----		----		----		----	
Silver	7440-22-4	0.001	mg/L	<0.010		----		----		----		----	
Strontium	7440-24-6	0.001	mg/L	**0.038**		----		----		----		----	
Thallium	7440-28-0	0.001	mg/L	<0.010		----		----		----		----	
Tin	7440-31-5	0.001	mg/L	**0.012**		----		----		----		----	
Titanium	7440-32-6	0.01	mg/L	<0.10		----		----		----		----	
Iron	7439-89-6	0.05	mg/L	**30.3**		----		----		----		----	
Bromine	7726-95-6	0.1	mg/L	**4.7**		----		----		----		----	

Work Order : ES1535966 Amendment 1
Client : GHD PTY LTD
Project : LEACHATE ASSESSMENT

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EG020F: Dissolved Metals by ICP-MS - Continued													
Iodine	7553-56-2	0.1	mg/L	**2.9**		----		----		----		----	
EG020T: Total Metals by ICP-MS													
Aluminium	7429-90-5	0.01	mg/L	**7.01**		----		----		----		----	
Antimony	7440-36-0	0.001	mg/L	<0.010		----		----		----		----	
Arsenic	7440-38-2	0.001	mg/L	**0.428**		----		----		----		----	
Boron	7440-42-8	0.05	mg/L	**3.87**		----		----		----		----	
Barium	7440-39-3	0.001	mg/L	**0.043**		----		----		----		----	
Beryllium	7440-41-7	0.001	mg/L	<0.010		----		----		----		----	
Cadmium	7440-43-9	0.0001	mg/L	<0.0010		----		----		----		----	
Cobalt	7440-48-4	0.001	mg/L	**0.263**		----		----		----		----	
Chromium	7440-47-3	0.001	mg/L	**0.057**		----		----		----		----	
Copper	7440-50-8	0.001	mg/L	<0.010		----		----		----		----	
Manganese	7439-96-5	0.001	mg/L	**0.021**		----		----		----		----	
Nickel	7440-02-0	0.001	mg/L	**0.146**		----		----		----		----	
Lead	7439-92-1	0.001	mg/L	<0.010		----		----		----		----	
Selenium	7782-49-2	0.01	mg/L	<0.10		----		----		----		----	
Vanadium	7440-62-2	0.01	mg/L	**0.39**		----		----		----		----	
Zinc	7440-66-6	0.005	mg/L	<0.052		----		----		----		----	
Lithium	7439-93-2	0.001	mg/L	<0.010		----		----		----		----	
Molybdenum	7439-98-7	0.001	mg/L	**1.46**		----		----		----		----	
Silver	7440-22-4	0.001	mg/L	<0.010		----		----		----		----	
Strontium	7440-24-6	0.001	mg/L	**0.042**		----		----		----		----	
Thallium	7440-28-0	0.001	mg/L	<0.010		----		----		----		----	
Tin	7440-31-5	0.001	mg/L	**0.023**		----		----		----		----	
Titanium	7440-32-6	0.01	mg/L	<0.10		----		----		----		----	
Iron	7439-89-6	0.05	mg/L	**44.3**		----		----		----		----	
EG020U: Unfiltered Metals by ICP-MS													
Bromine	7726-95-6	0.05	mg/L	**4.19**		----		----		----		----	
Iodine	7553-56-2	0.05	mg/L	**2.56**		----		----		----		----	
EG032: Arsenic Speciation by LC-ICPMS													
Arsenious Acid, As (III)	----	0.5	µg/L	<0.5		<0.5		----		----		----	
Arsenic Acid, As (V)	----	0.5	µg/L	**310**		**72.0**		----		----		----	
EG035F: Dissolved Mercury by FIMS													
Mercury	7439-97-6	0.0001	mg/L	<0.0001		----		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EG035T: Total Recoverable Mercury by FIMS													
Mercury	7439-97-6	0.0001	mg/L	<0.0001		----		----		----		----	
EG050F: Dissolved Hexavalent Chromium													
Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.50		<0.50		----		----		----	
EK010/011: Chlorine													
Chlorine - Free	----	0.2	mg/L	<1.0		----		----		----		----	
Chlorine - Total Residual	----	0.2	mg/L	<1.0		----		----		----		----	
EK026SF: Total CN by Segmented Flow Analyser													
Total Cyanide	57-12-5	0.004	mg/L	**205**		----		----		----		----	
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser													
Weak Acid Dissociable Cyanide	----	0.004	mg/L	<0.400		----		----		----		----	
EK040P: Fluoride by PC Titrator													
Fluoride	16984-48-8	0.1	mg/L	**1700**		----		----		----		----	
EK055G: Ammonia as N by Discrete Analyser													
Ammonia as N	7664-41-7	0.01	mg/L	**529**		----		----		----		----	
EK057G: Nitrite as N by Discrete Analyser													
Nitrite as N	14797-65-0	0.01	mg/L	<0.01		----		----		----		----	
EK058G: Nitrate as N by Discrete Analyser													
Nitrate as N	14797-55-8	0.01	mg/L	**0.55**		----		----		----		----	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser													
Nitrite + Nitrate as N	----	0.01	mg/L	**0.55**		----		----		----		----	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser													
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**593**		----		----		----		----	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser													
^ Total Nitrogen as N	----	0.1	mg/L	**594**		----		----		----		----	
EK067G: Total Phosphorus as P by Discrete Analyser													
Total Phosphorus as P	----	0.01	mg/L	**8.60**		----		----		----		----	
EK071G: Reactive Phosphorus as P by discrete analyser													
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**3.91**		----		----		----		----	
EK085M: Sulfide as S2-													
Sulfide as S2-	18496-25-8	0.1	mg/L	**1.5**		<1.0		----		----		----	
EK086: Sulfite as SO3 2-													
Sulfite as SO3 2-	14265-45-3	2	mg/L	<2		<2		----		----		----	
EK087: Thiosulfate as S2O3 2-													

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EK087: Thiosulfate as S2O3 2- - Continued													
Thiosulfate as S2O3 2-	----	2	mg/L	<20		<20		----		----		----	
EN055: Ionic Balance													
Total Anions	----	0.01	meq/L	**723**		----		----		----		----	
Total Cations	----	0.01	meq/L	**877**		----		----		----		----	
Ionic Balance	----	0.01	%	**9.56**		----		----		----		----	
EP005: Total Organic Carbon (TOC)													
Total Organic Carbon	----	1	mg/L	**1890**		**2570**		----		----		----	
EP010: Formaldehyde													
Formaldehyde	50-00-0	0.1	mg/L	<0.5		----		----		----		----	
EP020: Oil and Grease (O&G)													
Oil & Grease	----	5	mg/L	**6**		**13**		----		----		----	
EP026SP: Chemical Oxygen Demand (Spectrophotometric)													
Chemical Oxygen Demand	----	10	mg/L	**1700**		----		----		----		----	
EP041A: Nonionic Surfactants													
Nonionic Surfactants as CTAS	----	5	mg/L	<5		----		----		----		----	
EP050: Anionic Surfactants as MBAS													
Anionic Surfactants as MBAS	----	0.1	mg/L	**0.1**		----		----		----		----	
EP066: Polychlorinated Biphenyls (PCB)													
Aroclor 1016	12674-11-2	1	µg/L	<1		<1		----		----		----	
Aroclor 1221	11104-28-2	1	µg/L	<1		<1		----		----		----	
Aroclor 1232	11141-16-5	1	µg/L	<1		<1		----		----		----	
Aroclor 1242	53469-21-9	1	µg/L	<1		<1		----		----		----	
Aroclor 1248	12672-29-6	1	µg/L	<1		<1		----		----		----	
Aroclor 1254	11097-69-1	1	µg/L	<1		<1		----		----		----	
Aroclor 1260	11096-82-5	1	µg/L	<1		<1		----		----		----	
Aroclor 1262	37324-23-5	1	µg/L	<1		<1		----		----		----	
Total Polychlorinated biphenyls	----	1	µg/L	<1		<1		----		----		----	
EP068A: Organochlorine Pesticides (OC)													
alpha-BHC	319-84-6	0.5	µg/L	<0.5		<0.5		----		----		----	
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5		<0.5		----		----		----	
beta-BHC	319-85-7	0.5	µg/L	<0.5		<0.5		----		----		----	
gamma-BHC	58-89-9	0.5	µg/L	<0.5		<0.5		----		----		----	
delta-BHC	319-86-8	0.5	µg/L	<0.5		<0.5		----		----		----	
Heptachlor	76-44-8	0.5	µg/L	<0.5		<0.5		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP068A: Organochlorine Pesticides (OC) - Continued													
Aldrin	309-00-2	0.5	µg/L	<0.5		<0.5		----		----		----	
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5		<0.5		----		----		----	
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5		<0.5		----		----		----	
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5		<0.5		----		----		----	
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5		<0.5		----		----		----	
Dieldrin	60-57-1	0.5	µg/L	<0.5		<0.5		----		----		----	
4.4`-DDE	72-55-9	0.5	µg/L	<0.5		<0.5		----		----		----	
Endrin	72-20-8	0.5	µg/L	<0.5		<0.5		----		----		----	
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5		<0.5		----		----		----	
4.4`-DDD	72-54-8	0.5	µg/L	<0.5		<0.5		----		----		----	
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5		<0.5		----		----		----	
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5		<0.5		----		----		----	
4.4`-DDT	50-29-3	2	µg/L	<2.0		<2.0		----		----		----	
Endrin ketone	53494-70-5	0.5	µg/L	<0.5		<0.5		----		----		----	
Methoxychlor	72-43-5	2	µg/L	<2.0		<2.0		----		----		----	
^ Total Chlordane (sum)	----	0.5	µg/L	<0.5		<0.5		----		----		----	
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L	<0.5		<0.5		----		----		----	
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L	<0.5		<0.5		----		----		----	
EP068B: Organophosphorus Pesticides (OP)													
Dichlorvos	62-73-7	0.5	µg/L	<0.5		<0.5		----		----		----	
Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5		<0.5		----		----		----	
Monocrotophos	6923-22-4	2	µg/L	<2.0		<2.0		----		----		----	
Dimethoate	60-51-5	0.5	µg/L	<0.5		<0.5		----		----		----	
Diazinon	333-41-5	0.5	µg/L	<0.5		<0.5		----		----		----	
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5		<0.5		----		----		----	
Parathion-methyl	298-00-0	2	µg/L	<2.0		<2.0		----		----		----	
Malathion	121-75-5	0.5	µg/L	<0.5		<0.5		----		----		----	
Fenthion	55-38-9	0.5	µg/L	<0.5		<0.5		----		----		----	
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5		<0.5		----		----		----	
Parathion	56-38-2	2	µg/L	<2.0		<2.0		----		----		----	
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5		<0.5		----		----		----	
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5		<0.5		----		----		----	
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5		<0.5		----		----		----	
Fenamiphos	22224-92-6	0.5	µg/L	<0.5		<0.5		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP068B: Organophosphorus Pesticides (OP) - Continued													
Prothiofos	34643-46-4	0.5	µg/L	<0.5		<0.5		----		----		----	
Ethion	563-12-2	0.5	µg/L	<0.5		<0.5		----		----		----	
Carbophenothion	786-19-6	0.5	µg/L	<0.5		<0.5		----		----		----	
Azinphos Methyl	86-50-0	0.5	µg/L	<0.5		<0.5		----		----		----	
EP074A: Monocyclic Aromatic Hydrocarbons													
Benzene	71-43-2	1	µg/L	<5		**42**		----		----		----	
Toluene	108-88-3	2	µg/L	**5**		**11**		----		----		----	
Ethylbenzene	100-41-4	2	µg/L	<5		<5		----		----		----	
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<10		<10		----		----		----	
Styrene	100-42-5	5	µg/L	<5		<5		----		----		----	
ortho-Xylene	95-47-6	2	µg/L	<5		<5		----		----		----	
Isopropylbenzene	98-82-8	5	µg/L	<5		<5		----		----		----	
n-Propylbenzene	103-65-1	5	µg/L	<5		<5		----		----		----	
1.3.5-Trimethylbenzene	108-67-8	5	µg/L	<5		<5		----		----		----	
sec-Butylbenzene	135-98-8	5	µg/L	<5		<5		----		----		----	
1.2.4-Trimethylbenzene	95-63-6	5	µg/L	<5		<5		----		----		----	
tert-Butylbenzene	98-06-6	5	µg/L	<5		<5		----		----		----	
p-Isopropyltoluene	99-87-6	5	µg/L	<5		<5		----		----		----	
n-Butylbenzene	104-51-8	5	µg/L	<5		<5		----		----		----	
EP074B: Oxygenated Compounds													
2-Propanone (Acetone)	67-64-1	50	µg/L	**340**		<50		----		----		----	
Vinyl Acetate	108-05-4	50	µg/L	<50		<50		----		----		----	
2-Butanone (MEK)	78-93-3	50	µg/L	<50		<50		----		----		----	
4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L	<50		<50		----		----		----	
2-Hexanone (MBK)	591-78-6	50	µg/L	<50		<50		----		----		----	
EP074C: Sulfonated Compounds													
Carbon disulfide	75-15-0	5	µg/L	<5		<5		----		----		----	
EP074D: Fumigants													
2.2-Dichloropropane	594-20-7	5	µg/L	<5		<5		----		----		----	
1.2-Dichloropropane	78-87-5	5	µg/L	<5		<5		----		----		----	
cis-1.3-Dichloropropylene	10061-01-5	5	µg/L	<5		<5		----		----		----	
trans-1.3-Dichloropropylene	10061-02-6	5	µg/L	<5		<5		----		----		----	
1.2-Dibromoethane (EDB)	106-93-4	5	µg/L	<5		<5		----		----		----	
EP074E: Halogenated Aliphatic Compounds													

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP074E: Halogenated Aliphatic Compounds - Continued													
Dichlorodifluoromethane	75-71-8	50	µg/L	<50		<50		----		----		----	
Chloromethane	74-87-3	50	µg/L	<50		<50		----		----		----	
Vinyl chloride	75-01-4	50	µg/L	<50		<50		----		----		----	
Bromomethane	74-83-9	50	µg/L	<50		<50		----		----		----	
Chloroethane	75-00-3	50	µg/L	<50		<50		----		----		----	
Trichlorofluoromethane	75-69-4	50	µg/L	<50		<50		----		----		----	
1.1-Dichloroethene	75-35-4	5	µg/L	<5		<5		----		----		----	
Iodomethane	74-88-4	5	µg/L	<5		<5		----		----		----	
Methylene chloride	75-09-2	5	µg/L	<5		<5		----		----		----	
trans-1.2-Dichloroethene	156-60-5	5	µg/L	<5		<5		----		----		----	
1.1-Dichloroethane	75-34-3	5	µg/L	<5		<5		----		----		----	
cis-1.2-Dichloroethene	156-59-2	5	µg/L	<5		<5		----		----		----	
1.1.1-Trichloroethane	71-55-6	5	µg/L	<5		<5		----		----		----	
1.1-Dichloropropylene	563-58-6	5	µg/L	<5		<5		----		----		----	
Carbon Tetrachloride	56-23-5	5	µg/L	<5		<5		----		----		----	
1.2-Dichloroethane	107-06-2	5	µg/L	<5		<5		----		----		----	
Trichloroethene	79-01-6	5	µg/L	<5		<5		----		----		----	
Dibromomethane	74-95-3	5	µg/L	<5		<5		----		----		----	
1.1.2-Trichloroethane	79-00-5	5	µg/L	<5		<5		----		----		----	
1.3-Dichloropropane	142-28-9	5	µg/L	<5		<5		----		----		----	
Tetrachloroethene	127-18-4	5	µg/L	<5		<5		----		----		----	
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L	<5		<5		----		----		----	
trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L	<5		<5		----		----		----	
cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L	<5		<5		----		----		----	
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L	<5		<5		----		----		----	
1.2.3-Trichloropropane	96-18-4	5	µg/L	<5		<5		----		----		----	
Pentachloroethane	76-01-7	5	µg/L	<5		<5		----		----		----	
1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L	<5		<5		----		----		----	
Hexachlorobutadiene	87-68-3	5	µg/L	<5		<5		----		----		----	
EP074F: Halogenated Aromatic Compounds													
Chlorobenzene	108-90-7	5	µg/L	<5		<5		----		----		----	
Bromobenzene	108-86-1	5	µg/L	<5		<5		----		----		----	
2-Chlorotoluene	95-49-8	5	µg/L	<5		<5		----		----		----	
4-Chlorotoluene	106-43-4	5	µg/L	<5		<5		----		----		----	
1.3-Dichlorobenzene	541-73-1	5	µg/L	<5		<5		----		----		----	

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	MW206 Result	MW206 MU	MW202 Result	MW202 MU	---- Result	---- MU	---- Result	---- MU	---- Result	---- MU
Client sampling date / time				[11-Nov-2015]		[11-Nov-2015]		----		----		----	
				ES1535966-001		ES1535966-002		--------		--------		--------	
EP074F: Halogenated Aromatic Compounds - Continued													
1.4-Dichlorobenzene	106-46-7	5	µg/L	<5		<5		----		----		----	
1.2-Dichlorobenzene	95-50-1	5	µg/L	<5		<5		----		----		----	
1.2.4-Trichlorobenzene	120-82-1	5	µg/L	<5		<5		----		----		----	
1.2.3-Trichlorobenzene	87-61-6	5	µg/L	<5		<5		----		----		----	
EP074G: Trihalomethanes													
Chloroform	67-66-3	5	µg/L	**8**		**19**		----		----		----	
Bromodichloromethane	75-27-4	5	µg/L	<5		<5		----		----		----	
Dibromochloromethane	124-48-1	5	µg/L	<5		<5		----		----		----	
Bromoform	75-25-2	5	µg/L	<5		<5		----		----		----	
EP075A: Phenolic Compounds													
Phenol	108-95-2	2	µg/L	**12**		<2		----		----		----	
2-Chlorophenol	95-57-8	2	µg/L	<2		<2		----		----		----	
2-Methylphenol	95-48-7	2	µg/L	<2		<2		----		----		----	
3- & 4-Methylphenol	1319-77-3	4	µg/L	**8**		<4		----		----		----	
2-Nitrophenol	88-75-5	2	µg/L	<2		<2		----		----		----	
2.4-Dimethylphenol	105-67-9	2	µg/L	<2		**2**		----		----		----	
2.4-Dichlorophenol	120-83-2	2	µg/L	<2		<2		----		----		----	
2.6-Dichlorophenol	87-65-0	2	µg/L	<2		<2		----		----		----	
4-Chloro-3-methylphenol	59-50-7	2	µg/L	<2		<2		----		----		----	
2.4.6-Trichlorophenol	88-06-2	2	µg/L	<2		<2		----		----		----	
2.4.5-Trichlorophenol	95-95-4	2	µg/L	<2		<2		----		----		----	
Pentachlorophenol	87-86-5	4	µg/L	<4		<4		----		----		----	
EP075B: Polynuclear Aromatic Hydrocarbons													
Naphthalene	91-20-3	2	µg/L	**9**		<2		----		----		----	
2-Methylnaphthalene	91-57-6	2	µg/L	<2		<2		----		----		----	
2-Chloronaphthalene	91-58-7	2	µg/L	<2		<2		----		----		----	
Acenaphthylene	208-96-8	2	µg/L	<2		<2		----		----		----	
Acenaphthene	83-32-9	2	µg/L	<2		<2		----		----		----	
Fluorene	86-73-7	2	µg/L	<2		<2		----		----		----	
Phenanthrene	85-01-8	2	µg/L	**3**		<2		----		----		----	
Anthracene	120-12-7	2	µg/L	<2		<2		----		----		----	
Fluoranthene	206-44-0	2	µg/L	**8**		<2		----		----		----	
Pyrene	129-00-0	2	µg/L	**7**		<2		----		----		----	
N-2-Fluorenyl Acetamide	53-96-3	2	µg/L	<2		<2		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP075B: Polynuclear Aromatic Hydrocarbons - Continued													
Benz(a)anthracene	56-55-3	2	µg/L	**7**		<2		----		----		----	
Chrysene	218-01-9	2	µg/L	**7**		<2		----		----		----	
Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	4	µg/L	**17**		<4		----		----		----	
7.12-Dimethylbenz(a)anthracene	57-97-6	2	µg/L	<2		<2		----		----		----	
Benzo(a)pyrene	50-32-8	2	µg/L	**10**		<2		----		----		----	
3-Methylcholanthrene	56-49-5	2	µg/L	<2		<2		----		----		----	
Indeno(1.2.3.cd)pyrene	193-39-5	2	µg/L	**5**		<2		----		----		----	
Dibenz(a.h)anthracene	53-70-3	2	µg/L	<2		<2		----		----		----	
Benzo(g.h.i)perylene	191-24-2	2	µg/L	**6**		<2		----		----		----	
^ Sum of PAHs	----	2	µg/L	**79**		<2		----		----		----	
^ Benzo(a)pyrene TEQ (zero)	----	2	µg/L	**13**		<2		----		----		----	
EP075C: Phthalate Esters													
Dimethyl phthalate	131-11-3	2	µg/L	<2		<2		----		----		----	
Diethyl phthalate	84-66-2	2	µg/L	<2		<2		----		----		----	
Di-n-butyl phthalate	84-74-2	2	µg/L	<2		<2		----		----		----	
Butyl benzyl phthalate	85-68-7	2	µg/L	<2		<2		----		----		----	
bis(2-ethylhexyl) phthalate	117-81-7	10	µg/L	<10		<10		----		----		----	
Di-n-octylphthalate	117-84-0	2	µg/L	<2		<2		----		----		----	
EP075D: Nitrosamines													
N-Nitrosomethylethylamine	10595-95-6	2	µg/L	<2		<2		----		----		----	
N-Nitrosodiethylamine	55-18-5	2	µg/L	<2		<2		----		----		----	
N-Nitrosopyrrolidine	930-55-2	4	µg/L	<4		<4		----		----		----	
N-Nitrosomorpholine	59-89-2	2	µg/L	<2		<2		----		----		----	
N-Nitrosodi-n-propylamine	621-64-7	2	µg/L	<2		<2		----		----		----	
N-Nitrosopiperidine	100-75-4	2	µg/L	<2		<2		----		----		----	
N-Nitrosodibutylamine	924-16-3	2	µg/L	<2		<2		----		----		----	
N-Nitrosodiphenyl & Diphenylamine	86-30-6 122-39-4	4	µg/L	<4		<4		----		----		----	
Methapyrilene	91-80-5	2	µg/L	<2		<2		----		----		----	
EP075E: Nitroaromatics and Ketones													
2-Picoline	109-06-8	2	µg/L	<2		<2		----		----		----	
Acetophenone	98-86-2	2	µg/L	<2		<2		----		----		----	
Nitrobenzene	98-95-3	2	µg/L	<2		<2		----		----		----	
Isophorone	78-59-1	2	µg/L	<2		<2		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP075E: Nitroaromatics and Ketones - Continued													
2.6-Dinitrotoluene	606-20-2	4	µg/L	<4		<4		----		----		----	
2.4-Dinitrotoluene	121-14-2	4	µg/L	<4		<4		----		----		----	
1-Naphthylamine	134-32-7	2	µg/L	<2		<2		----		----		----	
4-Nitroquinoline-N-oxide	56-57-5	2	µg/L	<2		<2		----		----		----	
5-Nitro-o-toluidine	99-55-8	2	µg/L	<2		<2		----		----		----	
Azobenzene	103-33-3	2	µg/L	<2		<2		----		----		----	
1.3.5-Trinitrobenzene	99-35-4	2	µg/L	<2		<2		----		----		----	
Phenacetin	62-44-2	2	µg/L	<2		<2		----		----		----	
4-Aminobiphenyl	92-67-1	2	µg/L	<2		<2		----		----		----	
Pentachloronitrobenzene	82-68-8	2	µg/L	<2		<2		----		----		----	
Pronamide	23950-58-5	2	µg/L	<2		<2		----		----		----	
Dimethylaminoazobenzene	60-11-7	2	µg/L	<2		<2		----		----		----	
Chlorobenzilate	510-15-6	2	µg/L	<2		<2		----		----		----	
EP075F: Haloethers													
Bis(2-chloroethyl) ether	111-44-4	2	µg/L	<2		<2		----		----		----	
Bis(2-chloroethoxy) methane	111-91-1	2	µg/L	<2		<2		----		----		----	
4-Chlorophenyl phenyl ether	7005-72-3	2	µg/L	<2		<2		----		----		----	
4-Bromophenyl phenyl ether	101-55-3	2	µg/L	<2		<2		----		----		----	
EP075G: Chlorinated Hydrocarbons													
1.3-Dichlorobenzene	541-73-1	2	µg/L	<2		<2		----		----		----	
1.4-Dichlorobenzene	106-46-7	2	µg/L	<2		<2		----		----		----	
1.2-Dichlorobenzene	95-50-1	2	µg/L	<2		<2		----		----		----	
Hexachloroethane	67-72-1	2	µg/L	<2		<2		----		----		----	
1.2.4-Trichlorobenzene	120-82-1	2	µg/L	<2		<2		----		----		----	
Hexachloropropylene	1888-71-7	2	µg/L	<2		<2		----		----		----	
Hexachlorobutadiene	87-68-3	2	µg/L	<2		<2		----		----		----	
Hexachlorocyclopentadiene	77-47-4	10	µg/L	<10		<10		----		----		----	
Pentachlorobenzene	608-93-5	2	µg/L	<2		<2		----		----		----	
Hexachlorobenzene (HCB)	118-74-1	4	µg/L	<4		<4		----		----		----	
EP075H: Anilines and Benzidines													
Aniline	62-53-3	2	µg/L	<2		<2		----		----		----	
4-Chloroaniline	106-47-8	2	µg/L	<2		<2		----		----		----	
2-Nitroaniline	88-74-4	4	µg/L	<4		<4		----		----		----	
3-Nitroaniline	99-09-2	4	µg/L	<4		<4		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP075H: Anilines and Benzidines - Continued													
Dibenzofuran	132-64-9	2	µg/L	<2		<2		----		----		----	
4-Nitroaniline	100-01-6	2	µg/L	<2		<2		----		----		----	
Carbazole	86-74-8	2	µg/L	**4**		<2		----		----		----	
3.3`-Dichlorobenzidine	91-94-1	2	µg/L	<2		<2		----		----		----	
EP075I: Organochlorine Pesticides													
alpha-BHC	319-84-6	2	µg/L	<2		<2		----		----		----	
beta-BHC	319-85-7	2	µg/L	<2		<2		----		----		----	
gamma-BHC	58-89-9	2	µg/L	<2		<2		----		----		----	
delta-BHC	319-86-8	2	µg/L	<2		<2		----		----		----	
Heptachlor	76-44-8	2	µg/L	<2		<2		----		----		----	
Aldrin	309-00-2	2	µg/L	<2		<2		----		----		----	
Heptachlor epoxide	1024-57-3	2	µg/L	<2		<2		----		----		----	
alpha-Endosulfan	959-98-8	2	µg/L	<2		<2		----		----		----	
4.4`-DDE	72-55-9	2	µg/L	<2		<2		----		----		----	
Dieldrin	60-57-1	2	µg/L	<2		<2		----		----		----	
Endrin	72-20-8	2	µg/L	<2		<2		----		----		----	
beta-Endosulfan	33213-65-9	2	µg/L	<2		<2		----		----		----	
4.4`-DDD	72-54-8	2	µg/L	<2		<2		----		----		----	
Endosulfan sulfate	1031-07-8	2	µg/L	<2		<2		----		----		----	
4.4`-DDT	50-29-3	4	µg/L	<4		<4		----		----		----	
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	4	µg/L	<4		<4		----		----		----	
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	4	µg/L	<4		<4		----		----		----	
EP075J: Organophosphorus Pesticides													
Dichlorvos	62-73-7	2	µg/L	<2		<2		----		----		----	
Dimethoate	60-51-5	2	µg/L	<2		<2		----		----		----	
Diazinon	333-41-5	2	µg/L	<2		<2		----		----		----	
Chlorpyrifos-methyl	5598-13-0	2	µg/L	<2		<2		----		----		----	
Malathion	121-75-5	2	µg/L	<2		<2		----		----		----	
Fenthion	55-38-9	2	µg/L	<2		<2		----		----		----	
Chlorpyrifos	2921-88-2	2	µg/L	<2		<2		----		----		----	
Pirimphos-ethyl	23505-41-1	2	µg/L	<2		<2		----		----		----	
Chlorfenvinphos	470-90-6	2	µg/L	<2		<2		----		----		----	
Prothiofos	34643-46-4	2	µg/L	<2		<2		----		----		----	
Ethion	563-12-2	2	µg/L	<2		<2		----		----		----	

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	MW206 Result	MW206 MU	MW202 Result	MW202 MU	---- Result	---- MU	---- Result	---- MU	---- Result	---- MU
Client sampling date / time				[11-Nov-2015]		[11-Nov-2015]		----		----		----	
				ES1535966-001		ES1535966-002		--------		--------		--------	
EP075J: Organophosphorus Pesticides - Continued													
EP080/071: Total Petroleum Hydrocarbons													
C6 - C9 Fraction	----	20	µg/L	<100		<100		----		----		----	
C10 - C14 Fraction	----	50	µg/L	**80**		<50		----		----		----	
C15 - C28 Fraction	----	100	µg/L	**380**		**270**		----		----		----	
C29 - C36 Fraction	----	50	µg/L	**50**		**240**		----		----		----	
^ **C10 - C36 Fraction (sum)**	----	50	µg/L	**510**		**510**		----		----		----	
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions													
C6 - C10 Fraction	C6_C10	20	µg/L	<100		<100		----		----		----	
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L	<100		<100		----		----		----	
>C10 - C16 Fraction	----	100	µg/L	**120**		<100		----		----		----	
>C16 - C34 Fraction	----	100	µg/L	**430**		**340**		----		----		----	
>C34 - C40 Fraction	----	100	µg/L	<100		**200**		----		----		----	
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L	**550**		**540**		----		----		----	
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L	<100		<100		----		----		----	
EP080: BTEXN													
Benzene	71-43-2	1	µg/L	<5		**44**		----		----		----	
Toluene	108-88-3	2	µg/L	<5		**10**		----		----		----	
Ethylbenzene	100-41-4	2	µg/L	<5		<5		----		----		----	
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<5		<5		----		----		----	
ortho-Xylene	95-47-6	2	µg/L	<5		<5		----		----		----	
^ **Total Xylenes**	1330-20-7	2	µg/L	<5		<5		----		----		----	
^ **Sum of BTEX**	----	1	µg/L	<5		**54**		----		----		----	
Naphthalene	91-20-3	5	µg/L	**48**		**5**		----		----		----	
EP090: Organotin Compounds (Soluble)													
Tributyltin	56573-85-4	2	ngSn/L	<15		<15		----		----		----	
EP118: Nitrogenated Compounds													
Acrylonitrile	107-13-1	1	µg/L	<1		<1		----		----		----	
EP121: Aldehydes													
Formaldehyde	50-00-0	2	µg/L	**423**		**168**		----		----		----	
Acetaldehyde	75-07-0	2	µg/L	**19.0**		**10.1**		----		----		----	
Propionaldehyde	123-38-6	2	µg/L	<2.0		<2.0		----		----		----	
Acrolein (Propenal)	107-02-8	2	µg/L	<2.0		<2.0		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP121: Aldehydes - Continued													
Butyraldehyde	123-72-8	2	µg/L	**2.7**		<2.0		----		----		----	
EP132A: Phenolic Compounds													
2-Chlorophenol	95-57-8	0.05	µg/L	<0.05		<0.05		----		----		----	
4-Chloro-3-methylphenol	59-50-7	0.05	µg/L	<0.05		<0.05		----		----		----	
m-Cresol	108-39-4	0.1	µg/L	**21.6**		<0.1		----		----		----	
o-Cresol	95-48-7	0.1	µg/L	**10.4**		<0.1		----		----		----	
p-Cresol	106-44-5	0.1	µg/L	**26.0**		<0.1		----		----		----	
2.4-Dichlorophenol	120-83-2	0.1	µg/L	**0.3**		**1.6**		----		----		----	
2.6-Dichlorophenol	87-65-0	0.1	µg/L	**0.3**		**0.5**		----		----		----	
2.4-Dimethylphenol	105-67-9	0.1	µg/L	**4.3**		**0.7**		----		----		----	
Hexachlorophene	70-30-4	0.1	µg/L	<0.1		<0.1		----		----		----	
2-Nitrophenol	88-75-5	0.1	µg/L	<0.1		<0.1		----		----		----	
4-Nitrophenol	100-02-7	0.1	µg/L	<0.1		<0.1		----		----		----	
Pentachlorophenol	87-86-5	0.05	µg/L	**0.39**		<0.05		----		----		----	
Phenol	108-95-2	0.1	µg/L	**123**		<0.1		----		----		----	
2.3.4.6-Tetrachlorophenol	58-90-2	0.1	µg/L	<0.1		<0.1		----		----		----	
2.4.5-Trichlorophenol	95-95-4	0.1	µg/L	**0.1**		<0.1		----		----		----	
2.4.6-Trichlorophenol	88-06-2	0.1	µg/L	<0.1		**0.3**		----		----		----	
EP202A: Phenoxyacetic Acid Herbicides by LCMS													
4-Chlorophenoxy acetic acid	122-88-3	10	µg/L	<10		<10		----		----		----	
2.4-DB	94-82-6	10	µg/L	<10		<10		----		----		----	
Dicamba	1918-00-9	10	µg/L	<10		<10		----		----		----	
Mecoprop	93-65-2	10	µg/L	<10		<10		----		----		----	
MCPA	94-74-6	10	µg/L	<10		<10		----		----		----	
2.4-DP	120-36-5	10	µg/L	<10		<10		----		----		----	
2.4-D	94-75-7	10	µg/L	<10		<10		----		----		----	
Triclopyr	55335-06-3	10	µg/L	<10		<10		----		----		----	
Silvex (2.4.5-TP/Fenoprop)	93-72-1	10	µg/L	<10		<10		----		----		----	
2.4.5-T	93-76-5	10	µg/L	<10		<10		----		----		----	
MCPB	94-81-5	10	µg/L	<10		<10		----		----		----	
Picloram	1918-02-1	10	µg/L	<10		<10		----		----		----	
Clopyralid	1702-17-6	10	µg/L	<10		<10		----		----		----	
Fluroxypyr	69377-81-7	10	µg/L	<10		<10		----		----		----	
2.6-D	575-90-6	10	µg/L	<10		<10		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP202A: Phenoxyacetic Acid Herbicides by LCMS - Continued													
2.4.6-T	575-89-3	10	µg/L	<10		<10		----		----		----	
EP203A: Explosives													
HMX	2691-41-0	20	µg/L	<20		<20		----		----		----	
RDX	----	20	µg/L	<20		<20		----		----		----	
1.3.5-Trinitrobenzene	99-35-4	20	µg/L	<20		<20		----		----		----	
1.3-Dinitrobenzene	99-65-0	20	µg/L	<20		<20		----		----		----	
Tetryl	479-45-8	20	µg/L	<20		<20		----		----		----	
2.4.6-TNT	118-96-7	20	µg/L	<20		<20		----		----		----	
4-Amino.2.6-DNT	19406-51-0	20	µg/L	<20		<20		----		----		----	
2-Amino-4.6-DNT	35572-78-2	20	µg/L	<20		<20		----		----		----	
4-& 2-AM-DNT(Isomeric Mixture)	----	20	µg/L	<20		<20		----		----		----	
2.4-Dinitrotoluene	121-14-2	20	µg/L	<20		<20		----		----		----	
2.6-Dinitrotoluene	606-20-2	20	µg/L	<20		<20		----		----		----	
2.4-& 2.6-DNT(Isomeric Mixture)	51-28-5/606-20-2	20	µg/L	<20		<20		----		----		----	
Nitrobenzene	98-95-3	20	µg/L	<20		<20		----		----		----	
2-Nitrotoluene	88-72-2	20	µg/L	<20		<20		----		----		----	
3-Nitrotoluene	99-08-1	20	µg/L	<20		<20		----		----		----	
4-Nitrotoluene	99-99-0	20	µg/L	<20		<20		----		----		----	
Nitroglycerine	55-63-0	200	µg/L	<200		<200		----		----		----	
PETN	78-11-5	200	µg/L	<200		<200		----		----		----	
EP231: Perfluorinated Compounds													
PFOS	1763-23-1	0.01	µg/L	<0.05		<0.05		----		----		----	
PFOA	335-67-1	0.01	µg/L	<0.05		<0.05		----		----		----	
6:2 Fluorotelomer sulfonate (6:2 FtS)	27619-97-2	0.1	µg/L	<0.5		<0.5		----		----		----	
8:2 Fluorotelomer sulfonate	39108-34-4	0.1	µg/L	<0.5		<0.5		----		----		----	
PFOSA	754-91-6	0.02	µg/L	<0.10		<0.10		----		----		----	
N-Me-FOSA	31506-32-8	0.5	µg/L	<0.5		<0.5		----		----		----	
N-Et-FOSA	4151-50-2	0.05	µg/L	<0.10		<0.10		----		----		----	
N-Me-FOSE	2448-09-7	0.5	µg/L	<0.5		<0.5		----		----		----	
N-Et-FOSE	1691-99-2	0.5	µg/L	<0.5		<0.5		----		----		----	
PFBS	375-73-5	0.02	µg/L	<0.10		<0.10		----		----		----	
PFHxS	355-46-4	0.02	µg/L	<0.10		<0.10		----		----		----	
PFDcS	67906-42-7	0.02	µg/L	<0.10		<0.10		----		----		----	
PFHxA	307-24-4	0.02	µg/L	<0.10		<0.10		----		----		----	

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	MW206		MW202		----		----		----	
Client sample ID				MW206		MW202		----		----		----	
Client sampling date / time				[11-Nov-2015]		[11-Nov-2015]		----		----		----	
				ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP231: Perfluorinated Compounds - Continued													
PFHpA	375-85-9	0.02	µg/L	<0.10		<0.10		----		----		----	
PFNA	375-95-1	0.02	µg/L	<0.10		<0.10		----		----		----	
PFDcA	335-76-2	0.02	µg/L	<0.10		<0.10		----		----		----	
PFUnA	2058-94-8	0.05	µg/L	<0.10		<0.10		----		----		----	
PFDoA	307-55-1	0.05	µg/L	<0.10		<0.10		----		----		----	
PFTriA	72629-94-8	0.05	µg/L	<0.10		<0.10		----		----		----	
PFTeA	376-06-7	0.5	µg/L	<0.5		<0.5		----		----		----	
EP234A: OP Pesticides													
Azinphos-ethyl	2642-71-9	0.02	µg/L	<0.02		<0.02		----		----		----	
Azinphos-methyl	86-50-0	0.02	µg/L	<0.02		<0.02		----		----		----	
Bromophos-ethyl	4824-78-6	0.1	µg/L	<0.10		<0.10		----		----		----	
Carbofenothion	786-19-6	0.02	µg/L	<0.02		<0.02		----		----		----	
Chlorfenvinphos	470-90-6	0.02	µg/L	<0.02		<0.02		----		----		----	
Chlorpyrifos	2921-88-2	0.02	µg/L	<0.02		<0.02		----		----		----	
Chlorpyrifos-methyl	5598-13-0	0.2	µg/L	<0.2		<0.2		----		----		----	
Coumaphos	56-72-4	0.01	µg/L	<0.01		<0.01		----		----		----	
Demeton-O & Demeton-S	298-03-3/126-75-0	0.02	µg/L	<0.02		<0.02		----		----		----	
Demeton-S-methyl	919-86-8	0.02	µg/L	<0.02		<0.02		----		----		----	
Diazinon	333-41-5	0.01	µg/L	<0.01		<0.01		----		----		----	
Dichlorvos	62-73-7	0.2	µg/L	<0.20		<0.20		----		----		----	
Dimethoate	60-51-5	0.02	µg/L	<0.02		<0.02		----		----		----	
Disulfoton	298-04-4	0.05	µg/L	<0.05		<0.05		----		----		----	
Ethion	563-12-2	0.02	µg/L	<0.02		<0.02		----		----		----	
EPN	2104-64-5	0.05	µg/L	<0.05		<0.05		----		----		----	
Ethoprophos	13194-48-4	0.01	µg/L	<0.01		<0.01		----		----		----	
Fenamiphos	22224-92-6	0.01	µg/L	<0.01		<0.01		----		----		----	
Fenchlorphos (Ronnel)	299-84-3	10	µg/L	<10		<10		----		----		----	
Fenitrothion	122-14-5	2	µg/L	<2		<2		----		----		----	
Fensulfothion	115-90-2	0.01	µg/L	<0.01		<0.01		----		----		----	
Fenthion	55-38-9	0.05	µg/L	<0.05		<0.05		----		----		----	
Malathion	121-75-5	0.02	µg/L	<0.02		<0.02		----		----		----	
Mevinphos	7786-34-7	0.02	µg/L	<0.02		<0.02		----		----		----	
Monocrotophos	6923-22-4	0.02	µg/L	<0.02		<0.02		----		----		----	
Omethoate	1113-02-6	0.01	µg/L	<0.01		<0.01		----		----		----	
Parathion	56-38-2	0.2	µg/L	<0.2		<0.2		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP234A: OP Pesticides - Continued													
Parathion-methyl	298-00-0	2	µg/L	<2.0		<2.0		----		----		----	
Phorate	298-02-2	0.1	µg/L	<0.1		<0.1		----		----		----	
Pirimiphos-ethyl	23505-41-1	0.01	µg/L	<0.01		<0.01		----		----		----	
Pirimiphos-methyl	29232-93-7	0.01	µg/L	<0.01		<0.01		----		----		----	
Profenofos	41198-08-7	0.01	µg/L	<0.01		<0.01		----		----		----	
Prothiofos	34643-46-4	0.1	µg/L	<0.1		<0.1		----		----		----	
Sulfotep	3689-24-5	0.005	µg/L	<0.005		<0.005		----		----		----	
Sulprofos	35400-43-2	0.05	µg/L	<0.05		<0.05		----		----		----	
Terbufos	13071-79-9	0.01	µg/L	<0.01		<0.01		----		----		----	
Temephos	3383-96-8	0.02	µg/L	<0.02		<0.02		----		----		----	
Tetrachlorvinphos	22248-79-9	0.01	µg/L	<0.01		<0.01		----		----		----	
Triazophos	24017-47-8	0.005	µg/L	<0.005		<0.005		----		----		----	
Trichlorfon	52-68-6	0.02	µg/L	<0.02		<0.02		----		----		----	
Trichloronate	327-98-0	0.5	µg/L	<0.5		<0.5		----		----		----	
EP234B: Thiocarbamates and Carbamates													
Aldicarb	116-06-3	0.05	µg/L	<0.05		<0.05		----		----		----	
Bendiocarb	22781-23-3	0.1	µg/L	<0.10		<0.10		----		----		----	
Benomyl	17804-35-2	0.01	µg/L	<0.01		<0.01		----		----		----	
Carbaryl	63-25-2	0.01	µg/L	<0.01		<0.01		----		----		----	
Carbofuran	1563-66-2	0.01	µg/L	<0.01		<0.01		----		----		----	
3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L	<0.02		<0.02		----		----		----	
Methiocarb	2032-65-7	0.01	µg/L	<0.01		<0.01		----		----		----	
Methomyl	16752-77-5	0.01	µg/L	<0.01		<0.01		----		----		----	
Molinate	2212-67-1	0.1	µg/L	<0.1		<0.1		----		----		----	
Oxamyl	23135-22-0	0.01	µg/L	<0.01		<0.01		----		----		----	
Thiobencarb	28249-77-6	0.01	µg/L	<0.01		<0.01		----		----		----	
Thiodicarb	59669-26-0	0.01	µg/L	<0.01		<0.01		----		----		----	
EP234C: Dinitroanilines													
Pendimethalin	40487-42-1	0.05	µg/L	<0.05		<0.05		----		----		----	
Trifluralin	1582-09-8	10	µg/L	<10.0		<10.0		----		----		----	
EP234D: Triazinone Herbicides													
Hexazinone	51235-04-2	0.02	µg/L	<0.02		<0.02		----		----		----	
Metribuzin	21087-64-9	0.02	µg/L	<0.02		<0.02		----		----		----	
EP234E: Conazole and Aminopyrimidine Fungicides													

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP234E: Conazole and Aminopyrimidine Fungicides - Continued													
Cyproconazole	94361-06-5	0.02	µg/L	<0.02		<0.02		----		----		----	
Difenoconazole	119446-68-3	0.02	µg/L	<0.02		<0.02		----		----		----	
Flusilazole	85509-19-9	0.02	µg/L	<0.02		<0.02		----		----		----	
Hexaconazole	79983-71-4	0.02	µg/L	<0.02		<0.02		----		----		----	
Paclobutrazole	76738-62-0	0.05	µg/L	<0.05		<0.05		----		----		----	
Penconazole	66246-88-6	0.01	µg/L	<0.01		<0.01		----		----		----	
Propiconazole	60207-90-1	0.05	µg/L	<0.05		<0.05		----		----		----	
Tebuconazole	107534-96-3	0.01	µg/L	<0.01		<0.01		----		----		----	
Cyprodinil	121552-61-2	0.01	µg/L	<0.01		<0.01		----		----		----	
Pyrimethanil	53112-28-0	0.02	µg/L	<0.02		<0.02		----		----		----	
EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides													
Diuron	330-54-1	0.02	µg/L	<0.02		<0.02		----		----		----	
Fluometuron	2164-17-2	0.01	µg/L	<0.01		<0.01		----		----		----	
Tebuthiuron	34014-18-1	0.02	µg/L	<0.02		<0.02		----		----		----	
Bromacil	314-40-9	0.02	µg/L	<0.02		<0.02		----		----		----	
Chlorsulfuron	64902-72-3	0.2	µg/L	<0.2		<0.2		----		----		----	
EP234G: Chloracetanilides													
Metolachlor	51218-45-2	0.01	µg/L	<0.01		<0.01		----		----		----	
EP234H: Triazine Herbicides													
Ametryn	834-12-8	0.01	µg/L	<0.01		<0.01		----		----		----	
Atrazine	1912-24-9	0.01	µg/L	<0.01		<0.01		----		----		----	
Cyanazine	21725-46-2	0.02	µg/L	<0.02		<0.02		----		----		----	
Cyromazine	66215-27-8	0.05	µg/L	<0.05		<0.05		----		----		----	
Prometryn	7287-19-6	0.01	µg/L	<0.01		<0.01		----		----		----	
Propazine	139-40-2	0.01	µg/L	<0.01		<0.01		----		----		----	
Simazine	122-34-9	0.02	µg/L	<0.02		<0.02		----		----		----	
Terbuthylazine	5915-41-3	0.01	µg/L	<0.01		<0.01		----		----		----	
Terbutryn	886-50-0	0.01	µg/L	<0.01		<0.01		----		----		----	
EP234I: Miscellaneous (ESI Positive Mode) Pesticides													
Diclofop-methyl	51338-27-3	0.05	µg/L	<0.05		<0.05		----		----		----	
Fenarimol	60168-88-9	0.02	µg/L	<0.02		<0.02		----		----		----	
Irgarol	28159-98-0	0.002	µg/L	<0.002		<0.002		----		----		----	
Oxyfluorfen	42874-03-3	1	µg/L	<1.0		<1.0		----		----		----	
Thiamethoxam	153719-23-4	0.02	µg/L	<0.02		<0.02		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP066S: PCB Surrogate													
Decachlorobiphenyl	2051-24-3	1	%	70.0		61.0		----		----		----	
EP068S: Organochlorine Pesticide Surrogate													
Dibromo-DDE	21655-73-2	0.5	%	70.6		62.6		----		----		----	
EP068T: Organophosphorus Pesticide Surrogate													
DEF	78-48-8	0.5	%	68.9		62.7		----		----		----	
EP074S: VOC Surrogates													
1.2-Dichloroethane-D4	17060-07-0	5	%	104		108		----		----		----	
Toluene-D8	2037-26-5	5	%	121		123		----		----		----	
4-Bromofluorobenzene	460-00-4	5	%	107		111		----		----		----	
EP075S: Acid Extractable Surrogates													
2-Fluorophenol	367-12-4	2	%	27.2		19.4		----		----		----	
Phenol-d6	13127-88-3	2	%	26.5		23.5		----		----		----	
2-Chlorophenol-D4	93951-73-6	2	%	18.0		32.3		----		----		----	
2.4.6-Tribromophenol	118-79-6	2	%	25.3		39.1		----		----		----	
EP075T: Base/Neutral Extractable Surrogates													
Nitrobenzene-D5	4165-60-0	2	%	53.6		38.0		----		----		----	
1.2-Dichlorobenzene-D4	2199-69-1	2	%	44.2		31.0		----		----		----	
2-Fluorobiphenyl	321-60-8	2	%	61.8		36.1		----		----		----	
Anthracene-d10	1719-06-8	2	%	113		76.7		----		----		----	
4-Terphenyl-d14	1718-51-0	2	%	70.5		47.9		----		----		----	
EP080S: TPH(V)/BTEX Surrogates													
1.2-Dichloroethane-D4	17060-07-0	2	%	107		111		----		----		----	
Toluene-D8	2037-26-5	2	%	112		114		----		----		----	
4-Bromofluorobenzene	460-00-4	2	%	107		112		----		----		----	
EP090S: Organotin Surrogate													
Tripropyltin	----	5	%	67.1		83.9		----		----		----	
EP132S: Acid Extractable Surrogates													
2-Fluorophenol	367-12-4	0.1	%	34.4		54.1		----		----		----	
Phenol-d6	13127-88-3	0.1	%	76.8		58.4		----		----		----	
2-Chlorophenol-D4	93951-73-6	0.1	%	62.6		58.4		----		----		----	
2.4.6-Tribromophenol	118-79-6	0.1	%	57.0		69.8		----		----		----	
EP132T: Base/Neutral Extractable Surrogates													
2-Fluorobiphenyl	321-60-8	0.1	%	93.2		53.5		----		----		----	
Anthracene-d10	1719-06-8	0.1	%	116		63.6		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP132T: Base/Neutral Extractable Surrogates - Continued													
4-Terphenyl-d14	1718-51-0	0.1	%	**107**		**56.8**		----		----		----	
EP202S: Phenoxyacetic Acid Herbicide Surrogate													
2.4-Dichlorophenyl Acetic Acid	19719-28-9	10	%	**72.4**		**69.9**		----		----		----	
EP203S: Explosives Surrogate													
o-Dinitrobenzene	528-29-0	20	%	**97.2**		**114**		----		----		----	

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **ES1535966**	Page	: 1 of 39
Amendment	: **1**		
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR DAVE BARRETT	Contact	:
Address	: PO BOX 5403 NEWCASTLE WEST NSW, AUSTRALIA 2302	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: dave.barrett@ghd.com.au	E-mail	:
Telephone	: +61 07 4972 6377	Telephone	: +61-2-8784 8555
Facsimile	: +61 07 4972 6236	Facsimile	: +61-2-8784 8500
Project	: LEACHATE ASSESSMENT	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: 2218015	Date Samples Received	: 11-Nov-2015
C-O-C number	: ----	Date Analysis Commenced	: 11-Nov-2015
Sampler	: JESSE SIMKUS	Issue Date	: 04-Dec-2015
Site	: ----	No. of samples received	: 2
Quote number	: ----	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
RPD = Relative Percentage Difference
# = Indicates failed QC

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Dian Dao		Sydney Inorganics
Dianne Blane	Laboratory Coordinator (2IC)	Newcastle - Inorganics
Matt Frost	Senior Organic Chemist	Brisbane Organics
Pabi Subba	Senior Organic Chemist	Sydney Organics
Phalak Inthakesone	Laboratory Manager - Organics	Sydney Organics
Titus Vimalasiri	Senior Scientist	Radionuclides

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EA005: pH (QC Lot: 275594)									
EN1513842-001	Anonymous	EA005: pH Value	----	0.01	pH Unit	7.77	7.79	0.257	0% - 20%
EN1513850-001	Anonymous	EA005: pH Value	----	0.01	pH Unit	7.09	7.11	0.282	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 275166)									
ES1535895-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	6230	6230	0.00	0% - 20%
ES1535912-002	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1050	1040	0.291	0% - 20%
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 279024)									
ES1536075-012	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	13	12	8.16	No Limit
ES1535966-001	MW206	EA025H: Suspended Solids (SS)	----	5	mg/L	375	396	5.45	0% - 20%
EA036: Fixed/Volatile Suspended Solids (QC Lot: 279026)									
ES1535966-001	MW206	EA036H: Fixed Suspended Solids @ 550 C (Fraction of Suspended S)	----	1	%	87	90	3.39	0% - 20%
		EA036H: Volatile Suspended Solids @ 550 C (Fraction of Suspended S)	----	1	%	13	10	26.1	0% - 50%
		EA036H: Volatile Suspended Solids @ 550°C	----	5	mg/L	50	41	19.8	0% - 50%
EA040: Colour (Apparent) (QC Lot: 277282)									
ES1535966-001	MW206	EA040: Colour (Apparent)	----	1	PCU	5000	5000	0.00	0% - 20%
EA041: Colour (True) (QC Lot: 277283)									
ES1535966-001	MW206	EA041: Colour (True)	----	1	PCU	4500	4500	0.00	0% - 20%
		EA041: pH Colour	----	0.01	pH Unit	11.1	11.1	0.00	0% - 20%
EA250: Gross Alpha and Beta Activity (QC Lot: 278277)									
EB1532684-001	Anonymous	EA250-LSC: Gross alpha	----	0.05	Bq/L	<0.05	<0.05	0.00	No Limit
		EA250-LSC: Gross beta activity - 40K	----	0.1	Bq/L	<0.10	<0.10	0.00	No Limit
ED037P: Alkalinity by PC Titrator (QC Lot: 275164)									
ES1535895-001	Anonymous	ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	607	602	0.731	0% - 20%
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	29	31	6.56	0% - 20%
		ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	636	633	0.388	0% - 20%
ES1535912-002	Anonymous	ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	426	419	1.61	0% - 20%
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	24	24	0.00	0% - 20%
		ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	449	443	1.44	0% - 20%
ED040F: Dissolved Major Anions (QC Lot: 275139)									
ES1535912-001	Anonymous	ED040F: Silicon as SiO2	14464-46-1	0.1	mg/L	41.5	41.5	0.00	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 275135)									

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 275135) - continued									
ES1535912-002	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	0.00	No Limit
ES1535912-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	32	35	7.50	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 275136)									
ES1535912-002	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	46	45	0.00	0% - 20%
ES1535912-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	47	47	0.00	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 277441)									
ES1535933-016	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	33	33	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	32	32	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	7	7	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	459	460	0.00	0% - 20%
ES1535912-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	44	47	6.71	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	23	24	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	2	2	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	34	35	0.00	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 277437)									
ES1535912-001	Anonymous	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-F: Strontium	7440-24-6	0.001	mg/L	0.423	0.429	1.46	0% - 20%
		EG020B-F: Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 277439)									
ES1536010-003	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0004	0.0004	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.028	0.028	0.00	0% - 20%
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	0.007	0.007	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	0.216	0.219	1.65	0% - 20%
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.005	0.005	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-F: Lithium	7439-93-2	0.001	mg/L	0.028	0.028	0.00	0% - 20%
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	6.09	6.05	0.638	0% - 20%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.272	0.276	1.07	0% - 20%
		EG020A-F: Thallium	7440-28-0	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.960	0.996	3.69	0% - 20%
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	8.44	8.67	2.76	0% - 20%
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory Duplicate (DUP) Report

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020F: Dissolved Metals by ICP-MS (QC Lot: 277439) - continued									
ES1536010-003	Anonymous	EG020A-F: Iron	7439-89-6	0.05	mg/L	47.8	48.9	2.22	0% - 20%
		EG020A-F: Bromine	7726-95-6	0.1	mg/L	0.6	0.6	0.00	No Limit
		EG020A-F: Iodine	7553-56-2	0.1	mg/L	0.2	0.2	0.00	No Limit
ES1535912-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.005	0.005	0.00	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lithium	7439-93-2	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Bromine	7726-95-6	0.1	mg/L	0.3	0.3	0.00	No Limit
		EG020A-F: Iodine	7553-56-2	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 277693)									
ES1535987-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.002	<0.001	74.7	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.210	0.213	1.01	0% - 20%
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.002	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lithium	7439-93-2	0.001	mg/L	0.250	0.257	2.59	0% - 20%
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.015	0.016	7.40	0% - 50%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	0.014	0.011	22.2	0% - 50%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020T: Total Metals by ICP-MS (QC Lot: 277693) - continued									
ES1535987-001	Anonymous	EG020A-T: Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.010	0.014	39.8	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.10	0.09	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	0.07	0.07	0.00	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	0.25	0.18	31.3	No Limit
EP1515744-024	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.003	<0.001	92.4	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lithium	7439-93-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Tin	7440-31-5	0.001	mg/L	0.002	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.01	<0.01	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 277694)									
EP1515744-024	Anonymous	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-T: Strontium	7440-24-6	0.001	mg/L	0.002	<0.001	0.00	No Limit
		EG020B-T: Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020U: Unfiltered Metals by ICP-MS (QC Lot: 280184)									
ES1535966-001	MW206	EG020A-U: Bromine	7726-95-6	0.05	mg/L	4.19	4.85	14.6	0% - 20%
		EG020A-U: Iodine	7553-56-2	0.05	mg/L	2.56	2.63	2.58	0% - 20%
EG032: Arsenic Speciation by LC-ICPMS (QC Lot: 276684)									
EB1533734-001	Anonymous	EG032: Arsenic Acid, As (V)	----	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EG032: Arsenious Acid, As (III)	----	0.5	µg/L	<1.0	<1.0	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory Duplicate (DUP) Report

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG035F: Dissolved Mercury by FIMS (QC Lot: 277438)									
ES1535912-002	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
ES1536156-003	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 279772)									
ES1535904-034	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
ES1535942-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG050F: Dissolved Hexavalent Chromium (QC Lot: 277273)									
ES1535705-014	Anonymous	EG050G-F: Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.01	<0.01	0.00	No Limit
ES1536061-001	Anonymous	EG050G-F: Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK010/011: Chlorine (QC Lot: 276830)									
ES1536055-001	Anonymous	EK010: Chlorine - Free	----	0.2	mg/L	1.0	1.0	0.00	No Limit
		EK010: Chlorine - Total Residual	----	0.2	mg/L	1.0	1.0	0.00	No Limit
ME1510760-001	Anonymous	EK010: Chlorine - Free	----	0.2	mg/L	<0.2	<0.2	0.00	No Limit
		EK010: Chlorine - Total Residual	----	0.2	mg/L	<0.2	<0.2	0.00	No Limit
EK026SF: Total CN by Segmented Flow Analyser (QC Lot: 275210)									
ES1535924-001	Anonymous	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	20.5	20.8	1.59	0% - 20%
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser (QC Lot: 275209)									
ES1535924-001	Anonymous	EK028SF: Weak Acid Dissociable Cyanide	----	0.004	mg/L	2.06	2.09	1.52	0% - 20%
EK040P: Fluoride by PC Titrator (QC Lot: 275163)									
ES1535895-001	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.9	0.8	0.00	No Limit
ES1535912-002	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.7	0.8	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 276957)									
ES1535918-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.04	0.03	0.00	No Limit
ES1535966-001	MW206	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	529	516	2.56	0% - 20%
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 275137)									
ES1535912-002	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
ES1535912-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 276958)									
ES1535918-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.06	0.06	0.00	No Limit
ES1535966-001	MW206	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.55	0.58	5.31	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 276935)									
ES1535918-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	2.0	1.8	12.4	0% - 20%
ES1535966-001	MW206	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	593	622	4.77	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 276934)									
ES1535918-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.10	0.12	21.8	0% - 50%
ES1535966-001	MW206	EK067G: Total Phosphorus as P	----	0.01	mg/L	8.60	7.07	19.5	0% - 20%
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 275138)									
ES1535912-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.12	0.12	0.00	0% - 50%
EK085M: Sulfide as S2- (QC Lot: 279129)									

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EK085M: Sulfide as S2- (QC Lot: 279129) - continued									
ES1535966-001	MW206	EK085: Sulfide as S2-	18496-25-8	0.1	mg/L	1.5	1.6	8.41	No Limit
ES1536197-001	Anonymous	EK085: Sulfide as S2-	18496-25-8	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EK086: Sulfite as SO3 2- (QC Lot: 277284)									
ES1535966-001	MW206	EK086: Sulfite as SO3 2-	14265-45-3	2	mg/L	<2	<2	0.00	No Limit
EK087: Thiosulfate as S2O3 2- (QC Lot: 277285)									
ES1535966-001	MW206	EK087: Thiosulfate as S2O3 2-	----	2	mg/L	<20	<20	0.00	No Limit
EP005: Total Organic Carbon (TOC) (QC Lot: 274591)									
ES1535878-001	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	12	12	0.00	0% - 50%
ES1535893-002	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	3	3	0.00	No Limit
EP010: Formaldehyde (QC Lot: 277026)									
ES1535925-001	Anonymous	EP010: Formaldehyde	50-00-0	0.1	mg/L	0.4	0.4	0.00	No Limit
EP026SP: Chemical Oxygen Demand (Spectrophotometric) (QC Lot: 279509)									
EP1515806-001	Anonymous	EP026SP: Chemical Oxygen Demand	----	10	mg/L	<10	<10	0.00	No Limit
ES1535904-038	Anonymous	EP026SP: Chemical Oxygen Demand	----	10	mg/L	94	81	14.8	No Limit
EP041A: Nonionic Surfactants (QC Lot: 275763)									
ES1535966-001	MW206	EP041A: Nonionic Surfactants as CTAS	----	5	mg/L	<5	<5	0.00	No Limit
EP050: Anionic Surfactants as MBAS (QC Lot: 277603)									
ES1535966-001	MW206	EP050: Anionic Surfactants as MBAS		0.1	mg/L	0.1	<0.1	0.00	No Limit
EP074A: Monocyclic Aromatic Hydrocarbons (QC Lot: 274938)									
ES1535986-001	Anonymous	EP074: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP074: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP074: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP074: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP074: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP074: 1.2.4-Trimethylbenzene	95-63-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.3.5-Trimethylbenzene	108-67-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: Isopropylbenzene	98-82-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: n-Butylbenzene	104-51-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: n-Propylbenzene	103-65-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: p-Isopropyltoluene	99-87-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: sec-Butylbenzene	135-98-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: Styrene	100-42-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: tert-Butylbenzene	98-06-6	5	µg/L	<5	<5	0.00	No Limit
ES1535912-001	Anonymous	EP074: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP074: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP074: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP074: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP074A: Monocyclic Aromatic Hydrocarbons (QC Lot: 274938) - continued									
ES1535912-001	Anonymous	EP074: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP074: 1.2.4-Trimethylbenzene	95-63-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.3.5-Trimethylbenzene	108-67-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: Isopropylbenzene	98-82-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: n-Butylbenzene	104-51-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: n-Propylbenzene	103-65-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: p-Isopropyltoluene	99-87-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: sec-Butylbenzene	135-98-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: Styrene	100-42-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: tert-Butylbenzene	98-06-6	5	µg/L	<5	<5	0.00	No Limit
EP074B: Oxygenated Compounds (QC Lot: 274938)									
ES1535986-001	Anonymous	EP074: 2-Butanone (MEK)	78-93-3	50	µg/L	<50	<50	0.00	No Limit
		EP074: 2-Hexanone (MBK)	591-78-6	50	µg/L	<50	<50	0.00	No Limit
		EP074: 2-Propanone (Acetone)	67-64-1	50	µg/L	<50	<50	0.00	No Limit
		EP074: 4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L	<50	<50	0.00	No Limit
		EP074: Vinyl Acetate	108-05-4	50	µg/L	<50	<50	0.00	No Limit
ES1535912-001	Anonymous	EP074: 2-Butanone (MEK)	78-93-3	50	µg/L	<50	<50	0.00	No Limit
		EP074: 2-Hexanone (MBK)	591-78-6	50	µg/L	<50	<50	0.00	No Limit
		EP074: 2-Propanone (Acetone)	67-64-1	50	µg/L	<50	<50	0.00	No Limit
		EP074: 4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L	<50	<50	0.00	No Limit
		EP074: Vinyl Acetate	108-05-4	50	µg/L	<50	<50	0.00	No Limit
EP074C: Sulfonated Compounds (QC Lot: 274938)									
ES1535986-001	Anonymous	EP074: Carbon disulfide	75-15-0	5	µg/L	<5	<5	0.00	No Limit
ES1535912-001	Anonymous	EP074: Carbon disulfide	75-15-0	5	µg/L	<5	<5	0.00	No Limit
EP074D: Fumigants (QC Lot: 274938)									
ES1535986-001	Anonymous	EP074: 1.2-Dibromoethane (EDB)	106-93-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dichloropropane	78-87-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: 2.2-Dichloropropane	594-20-7	5	µg/L	<5	<5	0.00	No Limit
		EP074: cis-1.3-Dichloropropylene	10061-01-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: trans-1.3-Dichloropropylene	10061-02-6	5	µg/L	<5	<5	0.00	No Limit
ES1535912-001	Anonymous	EP074: 1.2-Dibromoethane (EDB)	106-93-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dichloropropane	78-87-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: 2.2-Dichloropropane	594-20-7	5	µg/L	<5	<5	0.00	No Limit
		EP074: cis-1.3-Dichloropropylene	10061-01-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: trans-1.3-Dichloropropylene	10061-02-6	5	µg/L	<5	<5	0.00	No Limit
EP074E: Halogenated Aliphatic Compounds (QC Lot: 274938)									
ES1535986-001	Anonymous	EP074: 1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1.1-Trichloroethane	71-55-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L	<5	<5	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP074E: Halogenated Aliphatic Compounds (QC Lot: 274938) - continued									
ES1535986-001	Anonymous	EP074: 1.1.2-Trichloroethane	79-00-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1-Dichloroethane	75-34-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1-Dichloroethene	75-35-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1-Dichloropropylene	563-58-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2.3-Trichloropropane	96-18-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dichloroethane	107-06-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.3-Dichloropropane	142-28-9	5	µg/L	<5	<5	0.00	No Limit
		EP074: Carbon Tetrachloride	56-23-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: cis-1.2-Dichloroethene	156-59-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: Dibromomethane	74-95-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: Hexachlorobutadiene	87-68-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: Iodomethane	74-88-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: Methylene chloride	75-09-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: Pentachloroethane	76-01-7	5	µg/L	<5	<5	0.00	No Limit
		EP074: Tetrachloroethene	127-18-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: trans-1.2-Dichloroethene	156-60-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: Trichloroethene	79-01-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: Bromomethane	74-83-9	50	µg/L	<50	<50	0.00	No Limit
		EP074: Chloroethane	75-00-3	50	µg/L	<50	<50	0.00	No Limit
		EP074: Chloromethane	74-87-3	50	µg/L	<50	<50	0.00	No Limit
		EP074: Dichlorodifluoromethane	75-71-8	50	µg/L	<50	<50	0.00	No Limit
		EP074: Trichlorofluoromethane	75-69-4	50	µg/L	<50	<50	0.00	No Limit
		EP074: Vinyl chloride	75-01-4	50	µg/L	<50	<50	0.00	No Limit
ES1535912-001	Anonymous	EP074: 1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1.1-Trichloroethane	71-55-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1.2-Trichloroethane	79-00-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1-Dichloroethane	75-34-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1-Dichloroethene	75-35-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1-Dichloropropylene	563-58-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2.3-Trichloropropane	96-18-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dichloroethane	107-06-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.3-Dichloropropane	142-28-9	5	µg/L	<5	<5	0.00	No Limit
		EP074: Carbon Tetrachloride	56-23-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: cis-1.2-Dichloroethene	156-59-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L	<5	<5	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP074E: Halogenated Aliphatic Compounds (QC Lot: 274938) - continued									
ES1535912-001	Anonymous	EP074: Dibromomethane	74-95-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: Hexachlorobutadiene	87-68-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: Iodomethane	74-88-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: Methylene chloride	75-09-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: Pentachloroethane	76-01-7	5	µg/L	<5	<5	0.00	No Limit
		EP074: Tetrachloroethene	127-18-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: trans-1.2-Dichloroethene	156-60-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: Trichloroethene	79-01-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: Bromomethane	74-83-9	50	µg/L	<50	<50	0.00	No Limit
		EP074: Chloroethane	75-00-3	50	µg/L	<50	<50	0.00	No Limit
		EP074: Chloromethane	74-87-3	50	µg/L	<50	<50	0.00	No Limit
		EP074: Dichlorodifluoromethane	75-71-8	50	µg/L	<50	<50	0.00	No Limit
		EP074: Trichlorofluoromethane	75-69-4	50	µg/L	<50	<50	0.00	No Limit
		EP074: Vinyl chloride	75-01-4	50	µg/L	<50	<50	0.00	No Limit
EP074F: Halogenated Aromatic Compounds (QC Lot: 274938)									
ES1535986-001	Anonymous	EP074: 1.2.3-Trichlorobenzene	87-61-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2.4-Trichlorobenzene	120-82-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dichlorobenzene	95-50-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.3-Dichlorobenzene	541-73-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.4-Dichlorobenzene	106-46-7	5	µg/L	<5	<5	0.00	No Limit
		EP074: 2-Chlorotoluene	95-49-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: 4-Chlorotoluene	106-43-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: Bromobenzene	108-86-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: Chlorobenzene	108-90-7	5	µg/L	<5	<5	0.00	No Limit
ES1535912-001	Anonymous	EP074: 1.2.3-Trichlorobenzene	87-61-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2.4-Trichlorobenzene	120-82-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dichlorobenzene	95-50-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.3-Dichlorobenzene	541-73-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.4-Dichlorobenzene	106-46-7	5	µg/L	<5	<5	0.00	No Limit
		EP074: 2-Chlorotoluene	95-49-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: 4-Chlorotoluene	106-43-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: Bromobenzene	108-86-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: Chlorobenzene	108-90-7	5	µg/L	<5	<5	0.00	No Limit
EP074G: Trihalomethanes (QC Lot: 274938)									
ES1535986-001	Anonymous	EP074: Bromodichloromethane	75-27-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: Bromoform	75-25-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: Chloroform	67-66-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: Dibromochloromethane	124-48-1	5	µg/L	<5	<5	0.00	No Limit
ES1535912-001	Anonymous	EP074: Bromodichloromethane	75-27-4	5	µg/L	<5	<5	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP074G: Trihalomethanes (QC Lot: 274938) - continued									
ES1535912-001	Anonymous	EP074: Bromoform	75-25-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: Chloroform	67-66-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: Dibromochloromethane	124-48-1	5	µg/L	<5	<5	0.00	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 274940)									
ES1535912-001	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.00	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 274940)									
ES1535912-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EP080: BTEXN (QC Lot: 274940)									
ES1535912-001	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit
EP118: Nitrogenated Compounds (QC Lot: 275422)									
ES1535966-001	MW206	EP118-1: Acrylonitrile	107-13-1	1	µg/L	<1	<1	0.00	No Limit
EP121: Aldehydes (QC Lot: 275068)									
ES1535966-001	MW206	EP121: Acetaldehyde	75-07-0	2	µg/L	19.0	18.2	4.00	No Limit
		EP121: Acrolein (Propenal)	107-02-8	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP121: Butyraldehyde	123-72-8	2	µg/L	2.7	3.0	9.35	No Limit
		EP121: Formaldehyde	50-00-0	2	µg/L	423	413	2.51	0% - 20%
		EP121: Propionaldehyde	123-38-6	2	µg/L	<2.0	<2.0	0.00	No Limit
EP202A: Phenoxyacetic Acid Herbicides by LCMS (QC Lot: 277738)									
EB1534277-001	Anonymous	EP202-SL: 2.4.5-T	93-76-5	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 2.4-D	94-75-7	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 2.4-DB	94-82-6	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 2.4-DP	120-36-5	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 4-Chlorophenoxy acetic acid	122-88-3	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Clopyralid	1702-17-6	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Dicamba	1918-00-9	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Fluroxypyr	69377-81-7	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: MCPA	94-74-6	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: MCPB	94-81-5	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Mecoprop	93-65-2	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Picloram	1918-02-1	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Silvex (2.4.5-TP/Fenoprop)	93-72-1	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Triclopyr	55335-06-3	10	µg/L	<10	<10	0.00	No Limit
EP203A: Explosives (QC Lot: 274448)									

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EP203A: Explosives (QC Lot: 274448) - continued									
ES1535966-001	MW206	EP203-SL: 1.3.5-Trinitrobenzene	99-35-4	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 1.3-Dinitrobenzene	99-65-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2.4.6-TNT	118-96-7	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2.4-Dinitrotoluene	121-14-2	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2.6-Dinitrotoluene	606-20-2	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2-Amino-4.6-DNT	35572-78-2	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2-Nitrotoluene	88-72-2	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 3-Nitrotoluene	99-08-1	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 4-Amino.2.6-DNT	19406-51-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 4-Nitrotoluene	99-99-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: HMX	2691-41-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: Nitrobenzene	98-95-3	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: RDX	----	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: Tetryl	479-45-8	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: Nitroglycerine	55-63-0	200	µg/L	<200	<200	0.00	No Limit
		EP203-SL: PETN	78-11-5	200	µg/L	<200	<200	0.00	No Limit
EP231: Perfluorinated Compounds (QC Lot: 274411)									
EB1534037-003	Anonymous	EP231: PFOA	335-67-1	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP231: PFOS	1763-23-1	0.01	µg/L	0.07	0.07	0.00	No Limit
		EP231: 6:2 Fluorotelomer sulfonate (6:2 FtS)	27619-97-2	0.1	µg/L	<0.1	<0.1	0.00	No Limit
		EP231: 8:2 Fluorotelomer sulfonate	39108-34-4	0.1	µg/L	<0.1	<0.1	0.00	No Limit
EP231: Perfluorinated Compounds (QC Lot: 274412)									
EB1534037-003	Anonymous	EP231PFC: PFBS	375-73-5	0.02	µg/L	0.03	0.03	0.00	No Limit
		EP231PFC: PFDcA	335-76-2	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP231PFC: PFHpA	375-85-9	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP231PFC: PFHxA	307-24-4	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP231PFC: PFHxS	355-46-4	0.02	µg/L	0.11	0.11	0.00	No Limit
		EP231PFC: PFNA	375-95-1	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP231PFC: PFOSA	754-91-6	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP231PFC: N-Et-FOSA	4151-50-2	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP231PFC: PFDcS	67906-42-7	0.05	µg/L	<0.02	<0.02	85.7	No Limit
		EP231PFC: PFDoA	307-55-1	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP231PFC: PFTriA	72629-94-8	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP231PFC: PFUnA	2058-94-8	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP231PFC: N-Me-FOSA	31506-32-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP231PFC: PFTeA	376-06-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP231PFC: N-Et-FOSE	1691-99-2	1	µg/L	<0.5	<0.5	66.7	No Limit
		EP231PFC: N-Me-FOSE	2448-09-7	1	µg/L	<0.5	<0.5	66.7	No Limit
EP234A: OP Pesticides (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Sulfotep	3689-24-5	0.005	µg/L	<0.005	<0.005	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP234A: OP Pesticides (QC Lot: 276928) - continued									
ES1535894-016	Anonymous	EP234-1: Triazophos	24017-47-8	0.005	µg/L	<0.005	<0.005	0.00	No Limit
		EP234-1: Coumaphos	56-72-4	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Diazinon	333-41-5	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Ethoprophos	13194-48-4	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Fenamiphos	22224-92-6	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Fensulfothion	115-90-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Omethoate	1113-02-6	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Pirimiphos-ethyl	23505-41-1	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Pirimiphos-methyl	29232-93-7	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Profenofos	41198-08-7	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Terbufos	13071-79-9	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Tetrachlorvinphos	22248-79-9	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Azinphos-ethyl	2642-71-9	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Azinphos-methyl	86-50-0	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Carbofenothion	786-19-6	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Chlorfenvinphos	470-90-6	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Chlorpyrifos	2921-88-2	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Demeton-O & Demeton-S	298-03-3/126-75-0	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Demeton-S-methyl	919-86-8	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Dimethoate	60-51-5	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Ethion	563-12-2	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Malathion	121-75-5	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Mevinphos	7786-34-7	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Monocrotophos	6923-22-4	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Temephos	3383-96-8	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Trichlorfon	52-68-6	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Disulfoton	298-04-4	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: EPN	2104-64-5	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Fenthion	55-38-9	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Sulprofos	35400-43-2	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Bromophos-ethyl	4824-78-6	0.1	µg/L	<0.10	<0.10	0.00	No Limit
		EP234-1: Phorate	298-02-2	0.1	µg/L	<0.1	<0.1	0.00	No Limit
		EP234-1: Prothiofos	34643-46-4	0.1	µg/L	<0.1	<0.1	0.00	No Limit
		EP234-1: Chlorpyrifos-methyl	5598-13-0	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EP234-1: Dichlorvos	62-73-7	0.2	µg/L	<0.20	<0.20	0.00	No Limit
		EP234-1: Parathion	56-38-2	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EP234-1: Parathion-methyl	298-00-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP234-1: Trichloronate	327-98-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP234-1: Fenchlorphos (Ronnel)	299-84-3	10	µg/L	<10	<10	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP234A: OP Pesticides (QC Lot: 276928) - continued									
ES1535894-016	Anonymous	EP234-1: Fenitrothion	122-14-5	2	µg/L	<2	<2	0.00	No Limit
EP234B: Thiocarbamates and Carbamates (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Benomyl	17804-35-2	0.01	µg/L	0.06	0.06	0.00	No Limit
		EP234-1: Carbaryl	63-25-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Carbofuran	1563-66-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Methiocarb	2032-65-7	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Methomyl	16752-77-5	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Oxamyl	23135-22-0	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Thiobencarb	28249-77-6	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Thiodicarb	59669-26-0	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: 3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Aldicarb	116-06-3	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Bendiocarb	22781-23-3	0.1	µg/L	<0.10	<0.10	0.00	No Limit
		EP234-1: Molinate	2212-67-1	0.1	µg/L	<0.1	<0.1	0.00	No Limit
EP234C: Dinitroanilines (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Pendimethalin	40487-42-1	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Trifluralin	1582-09-8	10	µg/L	<10.0	<10.0	0.00	No Limit
EP234D: Triazinone Herbicides (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Hexazinone	51235-04-2	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Metribuzin	21087-64-9	0.02	µg/L	<0.02	<0.02	0.00	No Limit
EP234E: Conazole and Aminopyrimidine Fungicides (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Cyprodinil	121552-61-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Penconazole	66246-88-6	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Tebuconazole	107534-96-3	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Cyproconazole	94361-06-5	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Difenoconazole	119446-68-3	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Flusilazole	85509-19-9	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Hexaconazole	79983-71-4	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Pyrimethanil	53112-28-0	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Paclobutrazole	76738-62-0	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Propiconazole	60207-90-1	0.05	µg/L	<0.05	<0.05	0.00	No Limit
EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Fluometuron	2164-17-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Bromacil	314-40-9	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Diuron	330-54-1	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Tebuthiuron	34014-18-1	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Chlorsulfuron	64902-72-3	0.2	µg/L	<0.2	<0.2	0.00	No Limit
EP234G: Chloracetanilides (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Metolachlor	51218-45-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	*Client sample ID*	*Method: Compound*	*CAS Number*	*LOR*	*Unit*	*Original Result*	*Duplicate Result*	*RPD (%)*	*Recovery Limits (%)*
EP234H: Triazine Herbicides (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Ametryn	834-12-8	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Atrazine	1912-24-9	0.01	µg/L	0.06	0.06	0.00	No Limit
		EP234-1: Prometryn	7287-19-6	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Propazine	139-40-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Terbuthylazine	5915-41-3	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Terbutryn	886-50-0	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Cyanazine	21725-46-2	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Simazine	122-34-9	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Cyromazine	66215-27-8	0.05	µg/L	<0.05	<0.05	0.00	No Limit
EP234I: Miscellaneous (ESI Positive Mode) Pesticides (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Irgarol	28159-98-0	0.002	µg/L	<0.002	<0.002	0.00	No Limit
		EP234-1: Fenarimol	60168-88-9	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Thiamethoxam	153719-23-4	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Diclofop-methyl	51338-27-3	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Oxyfluorfen	42874-03-3	1	µg/L	<1.0	<1.0	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	*CAS Number*	*LOR*	*Unit*	*Result*	*Concentration*	*LCS*	*Low*	*High*
EA010P: Conductivity by PC Titrator (QCLot: 275166)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2000 µS/cm	108	95	113
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 279024)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	103	83	129
				<5	1000 mg/L	104	82	110
EA036: Fixed/Volatile Suspended Solids (QCLot: 279026)								
EA036H: Fixed Suspended Solids @ 550 C (Fraction of Suspended S)	----	1	%	<1	----	----	----	----
EA036H: Volatile Suspended Solids @ 550 C (Fraction of Suspended S)	----	1	%	<1	----	----	----	----
EA036H: Volatile Suspended Solids @ 550°C	----	5	mg/L	<5	----	----	----	----
EA040: Colour (Apparent) (QCLot: 277282)								
EA040: Colour (Apparent)	----	1	PCU	<1	20 PCU	100	90	110
EA041: Colour (True) (QCLot: 277283)								
EA041: Colour (True)	----	1	PCU	<1	20 PCU	100	90	110
EA250: Gross Alpha and Beta Activity (QCLot: 278277)								
EA250-LSC: Gross alpha	----	0.05	Bq/L	<0.05	1751 Bq/L	98.7	70	130
EA250-LSC: Gross beta activity - 40K	----	0.1	Bq/L	<0.10	3342 Bq/L	99.3	70	130
ED037P: Alkalinity by PC Titrator (QCLot: 275164)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	92.9	81	111
ED040F: Dissolved Major Anions (QCLot: 275139)								
ED040F: Silicon as SiO2	14464-46-1	0.1	mg/L	<0.1	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 275135)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	99.8	82	122
ED045G: Chloride by Discrete Analyser (QCLot: 275136)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	95.4	75	123
				<1	1000 mg/L	97.3	78	128
ED093F: Dissolved Major Cations (QCLot: 277441)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	95.5	80	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	99.0	90	116
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	96.5	85	113
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	93.5	82	120
EG020F: Dissolved Metals by ICP-MS (QCLot: 277437)								
EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	Recovery Limits (%) High
EG020F: Dissolved Metals by ICP-MS (QCLot: 277437) - continued								
EG020B-F: Strontium	7440-24-6	0.001	mg/L	<0.001	0.1 mg/L	86.8	81	113
EG020B-F: Titanium	7440-32-6	0.01	mg/L	<0.01	0.1 mg/L	78.5	77	119
EG020F: Dissolved Metals by ICP-MS (QCLot: 277439)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	91.9	80	116
EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	0.01 mg/L	102	85	115
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.8	85	114
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	93.1	82	110
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	98.1	85	115
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.1 mg/L	96.3	85	115
EG020A-F: Bromine	7726-95-6	0.1	mg/L	<0.1	----	----	----	----
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	94.7	84	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	85.3	85	111
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	89.2	82	112
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	91.2	81	111
EG020A-F: Iodine	7553-56-2	0.1	mg/L	<0.1	----	----	----	----
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	90.2	82	112
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	92.9	83	111
EG020A-F: Lithium	7439-93-2	0.001	mg/L	<0.001	0.1 mg/L	98.6	79	117
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	93.4	82	110
EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	90.7	79	113
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	86.4	82	112
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	87.2	85	115
EG020A-F: Thallium	7440-28-0	0.001	mg/L	<0.001	0.1 mg/L	90.9	85	111
EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	96.3	77	115
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	90.7	83	109
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	88.5	81	117
EG020T: Total Metals by ICP-MS (QCLot: 277693)								
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	104	82	120
EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	97.9	82	114
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	95.3	84	116
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	93.7	79	119
EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	0.1 mg/L	95.5	75	129
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	96.1	84	112
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	100	86	116
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	99.8	84	116
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	97.2	83	118
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	103	85	117
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	100	85	115

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 277693) - continued								
EG020A-T: Lithium	7439-93-2	0.001	mg/L	<0.001	0.1 mg/L	98.9	82	122
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	96.4	85	113
EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	105	83	121
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	96.4	84	116
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	105	68	126
EG020A-T: Thallium	7440-28-0	0.001	mg/L	<0.001	0.1 mg/L	99.6	87	117
EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	110	83	123
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	100	85	113
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	94.2	79	117
EG020T: Total Metals by ICP-MS (QCLot: 277694)								
EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----
EG020B-T: Strontium	7440-24-6	0.001	mg/L	<0.001	0.1 mg/L	94.7	84	118
EG020B-T: Titanium	7440-32-6	0.01	mg/L	<0.01	0.1 mg/L	88.5	80	124
EG020U: Unfiltered Metals by ICP-MS (QCLot: 280184)								
EG020A-U: Bromine	7726-95-6	0.05	mg/L	<0.05	----	----	----	----
EG020A-U: Iodine	7553-56-2	0.05	mg/L	<0.05	----	----	----	----
EG032: Arsenic Speciation by LC-ICPMS (QCLot: 276684)								
EG032: Arsenic Acid, As (V)	----	0.5	µg/L	<0.5	10 µg/L	99.1	79	121
EG032: Arsenious Acid, As (III)	----	0.5	µg/L	<0.5	10 µg/L	109	79	125
EG035F: Dissolved Mercury by FIMS (QCLot: 277438)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	95.2	83	105
EG035T: Total Recoverable Mercury by FIMS (QCLot: 279772)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	91.5	77	111
EG050F: Dissolved Hexavalent Chromium (QCLot: 277273)								
EG050G-F: Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.01	0.5 mg/L	108	86	112
EK010/011: Chlorine (QCLot: 276830)								
EK010: Chlorine - Free	----	0.2	mg/L	<0.2	----	----	----	----
EK010: Chlorine - Total Residual	----	0.2	mg/L	<0.2	----	----	----	----
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 275210)								
EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	0.2 mg/L	112	73	133
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser (QCLot: 275209)								
EK028SF: Weak Acid Dissociable Cyanide	----	0.004	mg/L	<0.004	0.2 mg/L	105	93	127
EK040P: Fluoride by PC Titrator (QCLot: 275163)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	5 mg/L	101	82	116
EK055G: Ammonia as N by Discrete Analyser (QCLot: 276957)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	97.9	90	114
EK057G: Nitrite as N by Discrete Analyser (QCLot: 275137)								

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EK057G: Nitrite as N by Discrete Analyser (QCLot: 275137) - continued								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	97.4	82	114
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 276958)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	101	91	113
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 276935)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	90.4	69	101
				<0.1	1 mg/L	90.2	70	118
				<0.1	5 mg/L	93.3	74	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 276934)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	87.8	71	101
				<0.01	0.442 mg/L	90.6	72	108
				<0.01	1 mg/L	91.3	78	118
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 275138)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	99.1	85	117
EK085M: Sulfide as S2- (QCLot: 279129)								
EK085: Sulfide as S2-	18496-25-8	0.1	mg/L	<0.1	0.5 mg/L	95.8	76	116
EK086: Sulfite as SO3 2- (QCLot: 277284)								
EK086: Sulfite as SO3 2-	14265-45-3	2	mg/L	<2	50 mg/L	102	80	108
EK087: Thiosulfate as S2O3 2- (QCLot: 277285)								
EK087: Thiosulfate as S2O3 2-	----	2	mg/L	<2	50 mg/L	95.2	88	120
EP005: Total Organic Carbon (TOC) (QCLot: 274591)								
EP005: Total Organic Carbon	----	1	mg/L	<1	10 mg/L	106	72	120
EP010: Formaldehyde (QCLot: 277026)								
EP010: Formaldehyde	50-00-0	0.1	mg/L	<0.1	2 mg/L	103	83	111
EP020: Oil and Grease (O&G) (QCLot: 280242)								
EP020: Oil & Grease	----	5	mg/L	<5	5000 mg/L	98.2	81	121
EP026SP: Chemical Oxygen Demand (Spectrophotometric) (QCLot: 279509)								
EP026SP: Chemical Oxygen Demand	----	10	mg/L	<10	50 mg/L	100	82	112
				<10	500 mg/L	97.2	83	113
EP041A: Nonionic Surfactants (QCLot: 275763)								
EP041A: Nonionic Surfactants as CTAS	----	5	mg/L	<5	5 mg/L	117	78	124
EP050: Anionic Surfactants as MBAS (QCLot: 277603)								
EP050: Anionic Surfactants as MBAS		0.1	mg/L	<0.1	2 mg/L	90.0	74	118
EP066: Polychlorinated Biphenyls (PCB) (QCLot: 276810)								
EP066: Total Polychlorinated biphenyls	----	1	µg/L	<1	10 µg/L	102	62	107
EP068A: Organochlorine Pesticides (OC) (QCLot: 276811)								
EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	5 µg/L	78.8	72	122
EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	5 µg/L	80.8	67	119

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP068A: Organochlorine Pesticides (OC) (QCLot: 276811) - continued								
EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	5 µg/L	81.1	60	122
EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	5 µg/L	85.8	66	116
EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	5 µg/L	85.2	65	113
EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	5 µg/L	89.6	66	120
EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	5 µg/L	87.7	69	117
EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	5 µg/L	99.8	71	119
EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	5 µg/L	85.8	64	120
EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	5 µg/L	93.6	67	117
EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	5 µg/L	97.0	66	120
EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	5 µg/L	74.9	60	126
EP068: Endrin	72-20-8	0.5	µg/L	<0.5	5 µg/L	87.6	66	122
EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	5 µg/L	97.4	64	116
EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	5 µg/L	74.6	62	124
EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	5 µg/L	87.2	70	112
EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	5 µg/L	81.0	63	113
EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	5 µg/L	87.6	59	123
EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	5 µg/L	75.5	54	114
EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	5 µg/L	83.2	53	127
EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	5 µg/L	75.9	61	121
EP068B: Organophosphorus Pesticides (OP) (QCLot: 276811)								
EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	5 µg/L	77.9	44	130
EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	5 µg/L	80.0	63	125
EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	5 µg/L	85.8	68	124
EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	5 µg/L	84.3	69	119
EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	5 µg/L	92.8	75	1196
EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	5 µg/L	82.8	77	119
EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	5 µg/L	85.5	62	124
EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	5 µg/L	90.6	70	120
EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	5 µg/L	91.4	69	119
EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	5 µg/L	103	65	121
EP068: Ethion	563-12-2	0.5	µg/L	<0.5	5 µg/L	87.4	74	120
EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	5 µg/L	82.5	69	125
EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	5 µg/L	79.6	68	122
EP068: Malathion	121-75-5	0.5	µg/L	<0.5	5 µg/L	91.6	70	124
EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	5 µg/L	26.2	20	48
EP068: Parathion	56-38-2	2	µg/L	<2.0	5 µg/L	78.8	67	121
EP068: Parathion-methyl	298-00-0	2	µg/L	<2.0	5 µg/L	78.9	70	124
EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	5 µg/L	90.7	69	121
EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	5 µg/L	82.9	61	111231

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP074A: Monocyclic Aromatic Hydrocarbons (QCLot: 274938)								
EP074: 1.2.4-Trimethylbenzene	95-63-6	5	µg/L	<5	10 µg/L	103	74	116
EP074: 1.3.5-Trimethylbenzene	108-67-8	5	µg/L	<5	10 µg/L	101	74	116
EP074: Benzene	71-43-2	1	µg/L	<1	10 µg/L	104	77	119
EP074: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	102	76	118
EP074: Isopropylbenzene	98-82-8	5	µg/L	<5	10 µg/L	104	76	118
EP074: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	20 µg/L	108	77	119
EP074: n-Butylbenzene	104-51-8	5	µg/L	<5	10 µg/L	97.0	65	123
EP074: n-Propylbenzene	103-65-1	5	µg/L	<5	10 µg/L	98.9	69	119
EP074: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	110	79	117
EP074: p-Isopropyltoluene	99-87-6	5	µg/L	<5	10 µg/L	100	71	119
EP074: sec-Butylbenzene	135-98-8	5	µg/L	<5	10 µg/L	102	73	119
EP074: Styrene	100-42-5	5	µg/L	<5	10 µg/L	106	73	119
EP074: tert-Butylbenzene	98-06-6	5	µg/L	<5	10 µg/L	101	72	116
EP074: Toluene	108-88-3	2	µg/L	<2	10 µg/L	103	69	129
EP074B: Oxygenated Compounds (QCLot: 274938)								
EP074: 2-Butanone (MEK)	78-93-3	50	µg/L	<50	100 µg/L	74.0	74	130
EP074: 2-Hexanone (MBK)	591-78-6	50	µg/L	<50	100 µg/L	84.5	65	137
EP074: 2-Propanone (Acetone)	67-64-1	50	µg/L	<50	100 µg/L	66.3	65	137
EP074: 4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L	<50	100 µg/L	106	66	132
EP074: Vinyl Acetate	108-05-4	50	µg/L	<50	100 µg/L	99.3	61	134
EP074C: Sulfonated Compounds (QCLot: 274938)								
EP074: Carbon disulfide	75-15-0	5	µg/L	<5	10 µg/L	116	73	127
EP074D: Fumigants (QCLot: 274938)								
EP074: 1.2-Dibromoethane (EDB)	106-93-4	5	µg/L	<5	10 µg/L	96.0	69	117
EP074: 1.2-Dichloropropane	78-87-5	5	µg/L	<5	10 µg/L	102	76	118
EP074: 2.2-Dichloropropane	594-20-7	5	µg/L	<5	10 µg/L	88.0	68	122
EP074: cis-1.3-Dichloropropylene	10061-01-5	5	µg/L	<5	10 µg/L	116	62	120
EP074: trans-1.3-Dichloropropylene	10061-02-6	5	µg/L	<5	10 µg/L	94.3	60	114
EP074E: Halogenated Aliphatic Compounds (QCLot: 274938)								
EP074: 1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L	<5	10 µg/L	98.1	66	114
EP074: 1.1.1-Trichloroethane	71-55-6	5	µg/L	<5	10 µg/L	89.0	67	119
EP074: 1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L	<5	10 µg/L	106	70	124
EP074: 1.1.2-Trichloroethane	79-00-5	5	µg/L	<5	10 µg/L	105	72	126
EP074: 1.1-Dichloroethane	75-34-3	5	µg/L	<5	10 µg/L	102	74	120
EP074: 1.1-Dichloroethene	75-35-4	5	µg/L	<5	10 µg/L	101	70	124
EP074: 1.1-Dichloropropylene	563-58-6	5	µg/L	<5	10 µg/L	100	73	119
EP074: 1.2.3-Trichloropropane	96-18-4	5	µg/L	<5	10 µg/L	105	74	126

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP074E: Halogenated Aliphatic Compounds (QCLot: 274938) - continued								
EP074: 1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L	<5	10 µg/L	114	66	136
EP074: 1.2-Dichloroethane	107-06-2	5	µg/L	<5	10 µg/L	105	73	123
EP074: 1.3-Dichloropropane	142-28-9	5	µg/L	<5	10 µg/L	104	71	129
EP074: Bromomethane	74-83-9	50	µg/L	<50	100 µg/L	102	56	140
EP074: Carbon Tetrachloride	56-23-5	5	µg/L	<5	10 µg/L	107	62	120
EP074: Chloroethane	75-00-3	50	µg/L	<50	100 µg/L	108	61	139
EP074: Chloromethane	74-87-3	50	µg/L	<50	100 µg/L	83.9	67	130
EP074: cis-1.2-Dichloroethene	156-59-2	5	µg/L	<5	10 µg/L	104	77	119
EP074: cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L	<5	10 µg/L	93.5	71	128
EP074: Dibromomethane	74-95-3	5	µg/L	<5	10 µg/L	99.2	73	119
EP074: Dichlorodifluoromethane	75-71-8	50	µg/L	<50	100 µg/L	73.6	61	138
EP074: Hexachlorobutadiene	87-68-3	5	µg/L	<5	10 µg/L	96.5	58	130
EP074: Iodomethane	74-88-4	5	µg/L	<5	10 µg/L	92.4	70	128
EP074: Methylene chloride	75-09-2	5	µg/L	<5	10 µg/L	98.9	69	133
EP074: Pentachloroethane	76-01-7	5	µg/L	<5	10 µg/L	112	72	126
EP074: Tetrachloroethene	127-18-4	5	µg/L	<5	10 µg/L	101	72	124
EP074: trans-1.2-Dichloroethene	156-60-5	5	µg/L	<5	10 µg/L	102	74	118
EP074: trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L	<5	10 µg/L	95.5	60	120
EP074: Trichloroethene	79-01-6	5	µg/L	<5	10 µg/L	104	76	118
EP074: Trichlorofluoromethane	75-69-4	50	µg/L	<50	100 µg/L	106	69	131
EP074: Vinyl chloride	75-01-4	50	µg/L	<50	100 µg/L	108	69	129
EP074F: Halogenated Aromatic Compounds (QCLot: 274938)								
EP074: 1.2.3-Trichlorobenzene	87-61-6	5	µg/L	<5	10 µg/L	100	67	123
EP074: 1.2.4-Trichlorobenzene	120-82-1	5	µg/L	<5	10 µg/L	95.1	61	125
EP074: 1.2-Dichlorobenzene	95-50-1	5	µg/L	<5	10 µg/L	102	75	117
EP074: 1.3-Dichlorobenzene	541-73-1	5	µg/L	<5	10 µg/L	102	75	117
EP074: 1.4-Dichlorobenzene	106-46-7	5	µg/L	<5	10 µg/L	102	74	118
EP074: 2-Chlorotoluene	95-49-8	5	µg/L	<5	10 µg/L	102	73	119
EP074: 4-Chlorotoluene	106-43-4	5	µg/L	<5	10 µg/L	102	73	119
EP074: Bromobenzene	108-86-1	5	µg/L	<5	10 µg/L	104	76	116
EP074: Chlorobenzene	108-90-7	5	µg/L	<5	10 µg/L	105	79	117
EP074G: Trihalomethanes (QCLot: 274938)								
EP074: Bromodichloromethane	75-27-4	5	µg/L	<5	10 µg/L	97.6	64	118
EP074: Bromoform	75-25-2	5	µg/L	<5	10 µg/L	107	74	126
EP074: Chloroform	67-66-3	5	µg/L	<5	10 µg/L	106	72	120
EP074: Dibromochloromethane	124-48-1	5	µg/L	<5	10 µg/L	109	65	115
EP075A: Phenolic Compounds (QCLot: 276812)								
EP075: 2.4.5-Trichlorophenol	95-95-4	2	µg/L	<2	5 µg/L	78.0	58	110

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP075A: Phenolic Compounds (QCLot: 276812) - continued								
EP075: 2.4.6-Trichlorophenol	88-06-2	2	µg/L	<2	5 µg/L	68.6	58	112
EP075: 2.4-Dichlorophenol	120-83-2	2	µg/L	<2	5 µg/L	69.1	62	109
EP075: 2.4-Dimethylphenol	105-67-9	2	µg/L	<2	5 µg/L	65.1	50	94
EP075: 2.6-Dichlorophenol	87-65-0	2	µg/L	<2	5 µg/L	70.6	62	108
EP075: 2-Chlorophenol	95-57-8	2	µg/L	<2	5 µg/L	63.6	52	88
EP075: 2-Methylphenol	95-48-7	2	µg/L	<2	5 µg/L	62.2	50	94
EP075: 2-Nitrophenol	88-75-5	2	µg/L	<2	5 µg/L	67.3	48	98
EP075: 3- & 4-Methylphenol	1319-77-3	4	µg/L	<4	10 µg/L	48.9	45	96
EP075: 4-Chloro-3-methylphenol	59-50-7	2	µg/L	<2	5 µg/L	71.3	61	107
EP075: Pentachlorophenol	87-86-5	4	µg/L	<4	10 µg/L	45.2	13	95
EP075: Phenol	108-95-2	2	µg/L	<2	5 µg/L	47.2	26	64
EP075B: Polynuclear Aromatic Hydrocarbons (QCLot: 276812)								
EP075: 2-Chloronaphthalene	91-58-7	2	µg/L	<2	5 µg/L	69.4	61	106
EP075: 2-Methylnaphthalene	91-57-6	2	µg/L	<2	5 µg/L	68.6	59	108
EP075: 3-Methylcholanthrene	56-49-5	2	µg/L	<2	5 µg/L	87.7	60	110
EP075: 7.12-Dimethylbenz(a)anthracene	57-97-6	2	µg/L	<2	5 µg/L	92.1	50	108
EP075: Acenaphthene	83-32-9	2	µg/L	<2	5 µg/L	75.7	65	108
EP075: Acenaphthylene	208-96-8	2	µg/L	<2	5 µg/L	75.8	64	108
EP075: Anthracene	120-12-7	2	µg/L	<2	5 µg/L	82.7	66	108
EP075: Benz(a)anthracene	56-55-3	2	µg/L	<2	5 µg/L	82.2	62	112
EP075: Benzo(a)pyrene	50-32-8	2	µg/L	<2	5 µg/L	89.8	59	112
EP075: Benzo(a)pyrene TEQ (zero)	----	2	µg/L	<2	----	----	----	----
EP075: Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	4	µg/L	<4	10 µg/L	89.1	60	111
EP075: Benzo(g.h.i)perylene	191-24-2	2	µg/L	<2	5 µg/L	86.0	61	110
EP075: Chrysene	218-01-9	2	µg/L	<2	5 µg/L	86.2	59	114
EP075: Dibenz(a.h)anthracene	53-70-3	2	µg/L	<2	5 µg/L	82.1	57	109
EP075: Fluoranthene	206-44-0	2	µg/L	<2	5 µg/L	86.3	65	109
EP075: Fluorene	86-73-7	2	µg/L	<2	5 µg/L	77.9	65	107
EP075: Indeno(1.2.3.cd)pyrene	193-39-5	2	µg/L	<2	5 µg/L	84.2	60	110
EP075: N-2-Fluorenyl Acetamide	53-96-3	2	µg/L	<2	5 µg/L	82.8	60	110
EP075: Naphthalene	91-20-3	2	µg/L	<2	5 µg/L	66.6	51	95
EP075: Phenanthrene	85-01-8	2	µg/L	<2	5 µg/L	82.2	67	108
EP075: Pyrene	129-00-0	2	µg/L	<2	5 µg/L	83.9	60	111
EP075C: Phthalate Esters (QCLot: 276812)								
EP075: bis(2-ethylhexyl) phthalate	117-81-7	----	µg/L	----	5 µg/L	96.1	60	132
EP075: Butyl benzyl phthalate	85-68-7	2	µg/L	<2	5 µg/L	88.3	61	114
EP075: Diethyl phthalate	84-66-2	2	µg/L	<2	5 µg/L	89.5	67	111
EP075: Dimethyl phthalate	131-11-3	2	µg/L	<2	5 µg/L	85.5	64	112

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP075C: Phthalate Esters (QCLot: 276812) - continued								
EP075: Di-n-butyl phthalate	84-74-2	2	µg/L	<2	5 µg/L	91.0	68	122
EP075: Di-n-octylphthalate	117-84-0	2	µg/L	<2	5 µg/L	92.6	62	115
EP075D: Nitrosamines (QCLot: 276812)								
EP075: Methapyrilene	91-80-5	2	µg/L	<2	5 µg/L	92.2	23	125
EP075: N-Nitrosodibutylamine	924-16-3	2	µg/L	<2	5 µg/L	72.5	63	108
EP075: N-Nitrosodiethylamine	55-18-5	2	µg/L	<2	5 µg/L	87.1	61	113
EP075: N-Nitrosodi-n-propylamine	621-64-7	2	µg/L	<2	5 µg/L	76.3	64	108
EP075: N-Nitrosodiphenyl & Diphenylamine	86-30-6 122-39-4	4	µg/L	<4	10 µg/L	84.2	65	112
EP075: N-Nitrosomethylethylamine	10595-95-6	2	µg/L	<2	5 µg/L	95.8	46	110
EP075: N-Nitrosomorpholine	59-89-2	2	µg/L	<2	5 µg/L	64.0	42	100
EP075: N-Nitrosopiperidine	100-75-4	2	µg/L	<2	5 µg/L	66.4	62	107
EP075: N-Nitrosopyrrolidine	930-55-2	4	µg/L	<4	5 µg/L	74.4	45	91
EP075E: Nitroaromatics and Ketones (QCLot: 276812)								
EP075: 1.3.5-Trinitrobenzene	99-35-4	2	µg/L	<2	5 µg/L	62.9	46	108
EP075: 1-Naphthylamine	134-32-7	2	µg/L	<2	5 µg/L	59.4	47	102
EP075: 2.4-Dinitrotoluene	121-14-2	4	µg/L	<4	5 µg/L	81.9	60	109
EP075: 2.6-Dinitrotoluene	606-20-2	4	µg/L	<4	5 µg/L	80.0	64	113
EP075: 2-Picoline	109-06-8	2	µg/L	<2	5 µg/L	51.4	41	109
EP075: 4-Aminobiphenyl	92-67-1	2	µg/L	<2	5 µg/L	64.9	60	112
EP075: 4-Nitroquinoline-N-oxide	56-57-5	2	µg/L	<2	5 µg/L	45.6	40	96
EP075: 5-Nitro-o-toluidine	99-55-8	2	µg/L	<2	5 µg/L	78.4	58	106
EP075: Acetophenone	98-86-2	2	µg/L	<2	5 µg/L	# 67.2	68	112
EP075: Azobenzene	103-33-3	2	µg/L	<2	5 µg/L	83.3	66	112
EP075: Chlorobenzilate	510-15-6	2	µg/L	<2	5 µg/L	92.5	58	110
EP075: Dimethylaminoazobenzene	60-11-7	2	µg/L	<2	5 µg/L	79.1	59	108
EP075: Isophorone	78-59-1	2	µg/L	<2	5 µg/L	76.2	68	111
EP075: Nitrobenzene	98-95-3	2	µg/L	<2	5 µg/L	# 66.3	68	112
EP075: Pentachloronitrobenzene	82-68-8	2	µg/L	<2	5 µg/L	81.8	59	109
EP075: Phenacetin	62-44-2	2	µg/L	<2	5 µg/L	74.0	58	101
EP075: Pronamide	23950-58-5	2	µg/L	<2	5 µg/L	89.0	63	109
EP075F: Haloethers (QCLot: 276812)								
EP075: 4-Bromophenyl phenyl ether	101-55-3	2	µg/L	<2	5 µg/L	83.7	62	108
EP075: 4-Chlorophenyl phenyl ether	7005-72-3	2	µg/L	<2	5 µg/L	75.3	65	109
EP075: Bis(2-chloroethoxy) methane	111-91-1	2	µg/L	<2	5 µg/L	72.5	66	111
EP075: Bis(2-chloroethyl) ether	111-44-4	2	µg/L	<2	5 µg/L	# 68.4	69	112
EP075G: Chlorinated Hydrocarbons (QCLot: 276812)								
EP075: 1.2.4-Trichlorobenzene	120-82-1	2	µg/L	<2	5 µg/L	61.0	46	96

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP075G: Chlorinated Hydrocarbons (QCLot: 276812) - continued								
EP075: 1.2-Dichlorobenzene	95-50-1	2	µg/L	<2	5 µg/L	56.0	41	95
EP075: 1.3-Dichlorobenzene	541-73-1	2	µg/L	<2	5 µg/L	57.1	40	96
EP075: 1.4-Dichlorobenzene	106-46-7	2	µg/L	<2	5 µg/L	57.1	41	97
EP075: Hexachlorobenzene (HCB)	118-74-1	4	µg/L	<4	5 µg/L	79.9	66	110
EP075: Hexachlorobutadiene	87-68-3	2	µg/L	<2	5 µg/L	61.5	37	100
EP075: Hexachlorocyclopentadiene	77-47-4	10	µg/L	<10	5 µg/L	# 19.3	24	107
EP075: Hexachloroethane	67-72-1	2	µg/L	<2	5 µg/L	59.2	46	88
EP075: Hexachloropropylene	1888-71-7	2	µg/L	<2	5 µg/L	60.6	34	96
EP075: Pentachlorobenzene	608-93-5	2	µg/L	<2	5 µg/L	74.4	65	107
EP075H: Anilines and Benzidines (QCLot: 276812)								
EP075: 2-Nitroaniline	88-74-4	4	µg/L	<4	5 µg/L	72.4	61	110
EP075: 3.3`-Dichlorobenzidine	91-94-1	2	µg/L	<2	5 µg/L	90.6	60	119
EP075: 3-Nitroaniline	99-09-2	4	µg/L	<4	5 µg/L	71.9	52	97
EP075: 4-Chloroaniline	106-47-8	2	µg/L	<2	5 µg/L	70.3	42	106
EP075: 4-Nitroaniline	100-01-6	2	µg/L	<2	5 µg/L	84.2	49	100
EP075: Aniline	62-53-3	2	µg/L	<2	5 µg/L	69.0	50	104
EP075: Carbazole	86-74-8	2	µg/L	<2	5 µg/L	84.1	64	107
EP075: Dibenzofuran	132-64-9	2	µg/L	<2	5 µg/L	76.4	65	108
EP075I: Organochlorine Pesticides (QCLot: 276812)								
EP075: 4.4`-DDD	72-54-8	2	µg/L	<2	5 µg/L	88.4	55	115
EP075: 4.4`-DDE	72-55-9	2	µg/L	<2	5 µg/L	89.1	53	115
EP075: 4.4`-DDT	50-29-3	4	µg/L	<4	5 µg/L	84.7	56	114
EP075: Aldrin	309-00-2	2	µg/L	<2	5 µg/L	83.6	56	112
EP075: alpha-BHC	319-84-6	2	µg/L	<2	5 µg/L	84.3	64	110
EP075: alpha-Endosulfan	959-98-8	2	µg/L	<2	5 µg/L	91.0	59	111
EP075: beta-BHC	319-85-7	2	µg/L	<2	5 µg/L	76.7	53	107
EP075: beta-Endosulfan	33213-65-9	2	µg/L	<2	5 µg/L	96.6	54	116
EP075: delta-BHC	319-86-8	2	µg/L	<2	5 µg/L	87.2	57	111
EP075: Dieldrin	60-57-1	2	µg/L	<2	5 µg/L	84.8	59	115
EP075: Endosulfan sulfate	1031-07-8	2	µg/L	<2	5 µg/L	94.6	53	114
EP075: Endrin	72-20-8	2	µg/L	<2	5 µg/L	88.5	58	114
EP075: gamma-BHC	58-89-9	2	µg/L	<2	5 µg/L	82.4	51	111
EP075: Heptachlor	76-44-8	2	µg/L	<2	5 µg/L	81.3	58	108
EP075: Heptachlor epoxide	1024-57-3	2	µg/L	<2	5 µg/L	83.6	50	118
EP075: Sum of Aldrin + Dieldrin	309-00-2/60-57-1	4	µg/L	<4	----	----	----	----
EP075: Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	4	µg/L	<4	----	----	----	----
EP075J: Organophosphorus Pesticides (QCLot: 276812)								

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP075J: Organophosphorus Pesticides (QCLot: 276812) - continued								
EP075: Chlorfenvinphos	470-90-6	2	µg/L	<2	5 µg/L	82.4	50	116
EP075: Chlorpyrifos	2921-88-2	2	µg/L	<2	5 µg/L	91.3	53	109
EP075: Chlorpyrifos-methyl	5598-13-0	2	µg/L	<2	5 µg/L	82.7	54	116
EP075: Diazinon	333-41-5	2	µg/L	<2	5 µg/L	90.4	49	113
EP075: Dichlorvos	62-73-7	2	µg/L	<2	5 µg/L	82.0	51	113
EP075: Dimethoate	60-51-5	2	µg/L	<2	5 µg/L	80.2	43	109
EP075: Ethion	563-12-2	2	µg/L	<2	5 µg/L	92.6	51	117
EP075: Fenthion	55-38-9	2	µg/L	<2	5 µg/L	86.6	57	115
EP075: Malathion	121-75-5	2	µg/L	<2	5 µg/L	106	54	1254
EP075: Pirimphos-ethyl	23505-41-1	2	µg/L	<2	5 µg/L	87.8	55	111
EP075: Prothiofos	34643-46-4	2	µg/L	<2	5 µg/L	87.5	54	118
EP080/071: Total Petroleum Hydrocarbons (QCLot: 274940)								
EP080: C6 - C9 Fraction	----	20	µg/L	<20	260 µg/L	88.3	75	127
EP080/071: Total Petroleum Hydrocarbons (QCLot: 276813)								
EP071: C10 - C14 Fraction	----	50	µg/L	<50	2000 µg/L	99.0	76	116
EP071: C15 - C28 Fraction	----	100	µg/L	<100	3000 µg/L	99.2	83	109
EP071: C29 - C36 Fraction	----	50	µg/L	<50	2000 µg/L	91.3	75	113
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 274940)								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	310 µg/L	89.0	75	127
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 276813)								
EP071: >C10 - C16 Fraction	----	100	µg/L	<100	2500 µg/L	93.5	76	114
EP071: >C16 - C34 Fraction	----	100	µg/L	<100	3500 µg/L	94.8	81	111
EP071: >C34 - C40 Fraction	----	100	µg/L	<100	1500 µg/L	100	77	119
EP080: BTEXN (QCLot: 274940)								
EP080: Benzene	71-43-2	1	µg/L	<1	10 µg/L	100	70	122
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	91.8	70	120
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	10 µg/L	92.1	69	121
EP080: Naphthalene	91-20-3	5	µg/L	<5	10 µg/L	95.3	70	120
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	94.8	72	122
EP080: Toluene	108-88-3	2	µg/L	<2	10 µg/L	91.8	69	123
EP090: Organotin Compounds (Soluble) (QCLot: 277897)								
EP090S: Tributyltin	56573-85-4	2	ngSn/L	<2	147 ngSn/L	77.0	20	125
EP118: Nitrogenated Compounds (QCLot: 275422)								
EP118-1: Acrylonitrile	107-13-1	1	µg/L	<1	10 µg/L	107	72	130
EP121: Aldehydes (QCLot: 275068)								
EP121: Acetaldehyde	75-07-0	2	µg/L	<2.0	20 µg/L	103	79	117
EP121: Acrolein (Propenal)	107-02-8	2	µg/L	<2.0	20 µg/L	81.0	70	130

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	High
EP121: Aldehydes (QCLot: 275068) - continued								
EP121: Butyraldehyde	123-72-8	2	µg/L	<2.0	20 µg/L	97.1	72	118
EP121: Formaldehyde	50-00-0	2	µg/L	<2.0	20 µg/L	103	80	116
EP121: Propionaldehyde	123-38-6	2	µg/L	<2.0	20 µg/L	96.5	77	111
EP132A: Phenolic Compounds (QCLot: 276717)								
EP132: 2.3.4.6-Tetrachlorophenol	58-90-2	0.1	µg/L	<0.1	2 µg/L	106	52	132
EP132: 2.4.5-Trichlorophenol	95-95-4	0.1	µg/L	<0.1	2 µg/L	98.6	68	130
EP132: 2.4.6-Trichlorophenol	88-06-2	0.1	µg/L	<0.1	2 µg/L	86.6	63	129
EP132: 2.4-Dichlorophenol	120-83-2	0.1	µg/L	<0.1	2 µg/L	72.3	64	128
EP132: 2.4-Dimethylphenol	105-67-9	0.1	µg/L	<0.1	2 µg/L	77.3	55	131
EP132: 2.6-Dichlorophenol	87-65-0	0.1	µg/L	<0.1	2 µg/L	70.1	63	127
EP132: 2-Chlorophenol	95-57-8	0.05	µg/L	<0.05	2 µg/L	70.9	61	125
EP132: 2-Nitrophenol	88-75-5	0.1	µg/L	<0.1	2 µg/L	106	50	154
EP132: 4-Chloro-3-methylphenol	59-50-7	0.05	µg/L	<0.05	2 µg/L	69.4	61	125
EP132: 4-Nitrophenol	100-02-7	0.1	µg/L	<0.1	2 µg/L	87.7	22	142
EP132: Hexachlorophene	70-30-4	0.1	µg/L	<0.1	2 µg/L	90.4	34	138
EP132: m-Cresol	108-39-4	0.1	µg/L	<0.1	2 µg/L	51.1	42	118
EP132: o-Cresol	95-48-7	0.1	µg/L	<0.1	2 µg/L	55.3	50	122
EP132: p-Cresol	106-44-5	0.1	µg/L	<0.1	2 µg/L	44.0	38	124
EP132: Pentachlorophenol	87-86-5	0.05	µg/L	<0.05	2 µg/L	51.5	32	138
EP132: Phenol	108-95-2	0.1	µg/L	<0.1	2 µg/L	36.0	26	74
EP202A: Phenoxyacetic Acid Herbicides by LCMS (QCLot: 277738)								
EP202-SL: 2.4.5-T	93-76-5	10	µg/L	<10	100 µg/L	97.6	78	140
EP202-SL: 2.4-D	94-75-7	10	µg/L	<10	100 µg/L	99.5	77	139
EP202-SL: 2.4-DB	94-82-6	10	µg/L	<10	100 µg/L	101	65	147
EP202-SL: 2.4-DP	120-36-5	10	µg/L	<10	100 µg/L	99.7	76	144
EP202-SL: 4-Chlorophenoxy acetic acid	122-88-3	10	µg/L	<10	100 µg/L	102	82	136
EP202-SL: Clopyralid	1702-17-6	10	µg/L	<10	100 µg/L	85.5	70	145
EP202-SL: Dicamba	1918-00-9	10	µg/L	<10	100 µg/L	106	83	137
EP202-SL: Fluroxypyr	69377-81-7	10	µg/L	<10	100 µg/L	99.8	77	145
EP202-SL: MCPA	94-74-6	10	µg/L	<10	100 µg/L	95.6	76	140
EP202-SL: MCPB	94-81-5	10	µg/L	<10	100 µg/L	107	69	139
EP202-SL: Mecoprop	93-65-2	10	µg/L	<10	100 µg/L	97.3	75	143
EP202-SL: Picloram	1918-02-1	10	µg/L	<10	100 µg/L	103	70	144
EP202-SL: Silvex (2.4.5-TP/Fenoprop)	93-72-1	10	µg/L	<10	100 µg/L	102	75	143
EP202-SL: Triclopyr	55335-06-3	10	µg/L	<10	100 µg/L	99.4	77	141
EP203A: Explosives (QCLot: 274448)								
EP203-SL: 1.3.5-Trinitrobenzene	99-35-4	20	µg/L	<20	----	----	----	----
EP203-SL: 1.3-Dinitrobenzene	99-65-0	20	µg/L	<20	----	----	----	----

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP203A: Explosives (QCLot: 274448) - continued								
EP203-SL: 2.4.6-TNT	118-96-7	20	µg/L	<20	200 µg/L	112	63	145
EP203-SL: 2.4-Dinitrotoluene	121-14-2	20	µg/L	<20	200 µg/L	108	59	131
EP203-SL: 2.6-Dinitrotoluene	606-20-2	20	µg/L	<20	----	----	----	----
EP203-SL: 2-Amino-4.6-DNT	35572-78-2	20	µg/L	<20	----	----	----	----
EP203-SL: 2-Nitrotoluene	88-72-2	20	µg/L	<20	----	----	----	----
EP203-SL: 3-Nitrotoluene	99-08-1	20	µg/L	<20	----	----	----	----
EP203-SL: 4-Amino.2.6-DNT	19406-51-0	20	µg/L	<20	200 µg/L	100	59	135
EP203-SL: 4-Nitrotoluene	99-99-0	20	µg/L	<20	----	----	----	----
EP203-SL: HMX	2691-41-0	20	µg/L	<20	200 µg/L	98.6	53	147
EP203-SL: Nitrobenzene	98-95-3	20	µg/L	<20	200 µg/L	110	52	140
EP203-SL: Nitroglycerine	55-63-0	200	µg/L	<200	----	----	----	----
EP203-SL: PETN	78-11-5	200	µg/L	<200	200 µg/L	109	75	143
EP203-SL: RDX	----	20	µg/L	<20	----	----	----	----
EP203-SL: Tetryl	479-45-8	20	µg/L	<20	----	----	----	----
EP231: Perfluorinated Compounds (QCLot: 274411)								
EP231: 6:2 Fluorotelomer sulfonate (6:2 FtS)	27619-97-2	0.1	µg/L	<0.1	2.5 µg/L	112	61	145
EP231: 8:2 Fluorotelomer sulfonate	39108-34-4	0.1	µg/L	<0.1	2.5 µg/L	96.0	70	130
EP231: PFOA	335-67-1	0.01	µg/L	<0.01	0.5 µg/L	119	72	134
EP231: PFOS	1763-23-1	0.01	µg/L	<0.01	0.5 µg/L	89.2	70	136
EP231: Perfluorinated Compounds (QCLot: 274412)								
EP231PFC: N-Et-FOSA	4151-50-2	0.05	µg/L	<0.05	2.5 µg/L	96.0	56	130
EP231PFC: N-Et-FOSE	1691-99-2	1	µg/L	<1.0	2.5 µg/L	110	64	130
EP231PFC: N-Me-FOSA	31506-32-8	0.5	µg/L	<0.5	2.5 µg/L	118	53	130
EP231PFC: N-Me-FOSE	2448-09-7	1	µg/L	<1.0	2.5 µg/L	97.5	63	130
EP231PFC: PFBS	375-73-5	0.02	µg/L	<0.02	0.5 µg/L	122	54	130
EP231PFC: PFDcA	335-76-2	0.02	µg/L	<0.02	0.5 µg/L	72.8	50	130
EP231PFC: PFDcS	67906-42-7	0.05	µg/L	<0.05	0.5 µg/L	79.8	50	130
EP231PFC: PFDoA	307-55-1	0.05	µg/L	<0.05	0.5 µg/L	117	50	130
EP231PFC: PFHpA	375-85-9	0.02	µg/L	<0.02	0.5 µg/L	118	50	130
EP231PFC: PFHxA	307-24-4	0.02	µg/L	<0.02	0.5 µg/L	112	52	130
EP231PFC: PFHxS	355-46-4	0.02	µg/L	<0.02	0.5 µg/L	88.6	54	130
EP231PFC: PFNA	375-95-1	0.02	µg/L	<0.02	0.5 µg/L	86.4	51	130
EP231PFC: PFOSA	754-91-6	0.02	µg/L	<0.02	0.5 µg/L	122	57	130
EP231PFC: PFTeA	376-06-7	0.5	µg/L	<0.5	2.5 µg/L	85.3	30	130
EP231PFC: PFTriA	72629-94-8	0.05	µg/L	<0.05	0.5 µg/L	87.4	30	130
EP231PFC: PFUnA	2058-94-8	0.05	µg/L	<0.05	0.5 µg/L	73.6	50	130
EP234A: OP Pesticides (QCLot: 276928)								
EP234-1: Azinphos-ethyl	2642-71-9	0.02	µg/L	<0.02	0.2 µg/L	91.0	75	135

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP234A: OP Pesticides (QCLot: 276928) - continued								
EP234-1: Azinphos-methyl	86-50-0	0.02	µg/L	<0.02	0.2 µg/L	92.5	77	129
EP234-1: Bromophos-ethyl	4824-78-6	0.1	µg/L	<0.10	1 µg/L	97.7	70	130
EP234-1: Carbofenothion	786-19-6	0.02	µg/L	<0.02	0.2 µg/L	90.5	70	130
EP234-1: Chlorfenvinphos	470-90-6	0.02	µg/L	<0.02	0.4 µg/L	89.5	74	134
EP234-1: Chlorpyrifos	2921-88-2	0.02	µg/L	<0.02	0.2 µg/L	89.0	70	130
EP234-1: Chlorpyrifos-methyl	5598-13-0	0.2	µg/L	<0.2	2 µg/L	95.8	70	130
EP234-1: Coumaphos	56-72-4	0.01	µg/L	<0.01	0.1 µg/L	91.0	70	130
EP234-1: Demeton-O & Demeton-S	298-03-3/12 6-75-0	0.02	µg/L	<0.02	0.2 µg/L	90.5	79	127
EP234-1: Demeton-S-methyl	919-86-8	0.02	µg/L	<0.02	0.2 µg/L	99.0	70	128
EP234-1: Diazinon	333-41-5	0.01	µg/L	<0.01	0.1 µg/L	91.0	68	138
EP234-1: Dichlorvos	62-73-7	0.2	µg/L	<0.20	2 µg/L	102	76	128
EP234-1: Dimethoate	60-51-5	0.02	µg/L	<0.02	0.2 µg/L	101	75	127
EP234-1: Disulfoton	298-04-4	0.05	µg/L	<0.05	0.5 µg/L	89.2	72	134
EP234-1: EPN	2104-64-5	0.05	µg/L	<0.05	0.5 µg/L	103	70	130
EP234-1: Ethion	563-12-2	0.02	µg/L	<0.02	0.2 µg/L	95.0	70	130
EP234-1: Ethoprophos	13194-48-4	0.01	µg/L	<0.01	0.1 µg/L	96.0	78	128
EP234-1: Fenamiphos	22224-92-6	0.01	µg/L	<0.01	0.1 µg/L	94.0	71	135
EP234-1: Fenchlorphos (Ronnel)	299-84-3	10	µg/L	<10	100 µg/L	90.1	70	130
EP234-1: Fenitrothion	122-14-5	2	µg/L	<2	20 µg/L	90.2	64	136
EP234-1: Fensulfothion	115-90-2	0.01	µg/L	<0.01	0.1 µg/L	93.0	79	125
EP234-1: Fenthion	55-38-9	0.05	µg/L	<0.05	0.5 µg/L	90.8	70	130
EP234-1: Malathion	121-75-5	0.02	µg/L	<0.02	0.2 µg/L	110	70	130
EP234-1: Mevinphos	7786-34-7	0.02	µg/L	<0.02	0.4 µg/L	97.5	77	123
EP234-1: Monocrotophos	6923-22-4	0.02	µg/L	<0.02	0.2 µg/L	97.5	75	129
EP234-1: Omethoate	1113-02-6	0.01	µg/L	<0.01	0.1 µg/L	97.0	74	130
EP234-1: Parathion	56-38-2	0.2	µg/L	<0.2	2 µg/L	87.4	69	139
EP234-1: Parathion-methyl	298-00-0	0.5	µg/L	<0.5	20 µg/L	89.3	66	140
EP234-1: Phorate	298-02-2	0.1	µg/L	<0.1	1 µg/L	103	68	136
EP234-1: Pirimiphos-ethyl	23505-41-1	0.01	µg/L	<0.01	0.1 µg/L	86.0	70	130
EP234-1: Pirimiphos-methyl	29232-93-7	0.01	µg/L	<0.01	0.1 µg/L	106	71	137
EP234-1: Profenofos	41198-08-7	0.01	µg/L	<0.01	0.1 µg/L	90.0	70	130
EP234-1: Prothiofos	34643-46-4	0.1	µg/L	<0.1	1 µg/L	91.8	70	130
EP234-1: Sulfotep	3689-24-5	0.005	µg/L	<0.005	0.05 µg/L	90.0	71	137
EP234-1: Sulprofos	35400-43-2	0.05	µg/L	<0.05	0.5 µg/L	92.2	70	130
EP234-1: Temephos	3383-96-8	0.02	µg/L	<0.02	0.2 µg/L	82.5	70	130
EP234-1: Terbufos	13071-79-9	0.01	µg/L	<0.01	0.1 µg/L	95.0	70	130
EP234-1: Tetrachlorvinphos	22248-79-9	0.01	µg/L	<0.01	0.1 µg/L	92.0	74	128
EP234-1: Triazophos	24017-47-8	0.005	µg/L	<0.005	0.05 µg/L	90.0	77	131

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	High
EP234A: OP Pesticides (QCLot: 276928) - continued								
EP234-1: Trichlorfon	52-68-6	0.02	µg/L	<0.02	0.2 µg/L	94.5	70	130
EP234-1: Trichloronate	327-98-0	0.5	µg/L	<0.5	5 µg/L	99.2	63	139
EP234B: Thiocarbamates and Carbamates (QCLot: 276928)								
EP234-1: 3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L	<0.02	0.2 µg/L	99.0	68	134
EP234-1: Aldicarb	116-06-3	0.05	µg/L	<0.05	0.5 µg/L	89.0	75	123
EP234-1: Bendiocarb	22781-23-3	0.1	µg/L	<0.10	1 µg/L	95.0	70	130
EP234-1: Benomyl	17804-35-2	0.01	µg/L	<0.01	0.1 µg/L	93.0	73	129
EP234-1: Carbaryl	63-25-2	0.01	µg/L	<0.01	0.1 µg/L	108	68	134
EP234-1: Carbofuran	1563-66-2	0.01	µg/L	<0.01	0.1 µg/L	106	77	127
EP234-1: Methiocarb	2032-65-7	0.01	µg/L	<0.01	0.1 µg/L	97.0	70	130
EP234-1: Methomyl	16752-77-5	0.01	µg/L	<0.01	0.1 µg/L	94.0	79	127
EP234-1: Molinate	2212-67-1	0.1	µg/L	<0.1	1 µg/L	93.3	75	127
EP234-1: Oxamyl	23135-22-0	0.01	µg/L	<0.01	0.1 µg/L	100	70	130
EP234-1: Thiobencarb	28249-77-6	0.01	µg/L	<0.01	0.1 µg/L	84.0	79	131
EP234-1: Thiodicarb	59669-26-0	0.01	µg/L	<0.01	0.1 µg/L	104	74	132
EP234C: Dinitroanilines (QCLot: 276928)								
EP234-1: Pendimethalin	40487-42-1	0.05	µg/L	<0.05	0.5 µg/L	92.0	70	130
EP234-1: Trifluralin	1582-09-8	10	µg/L	<10.0	100 µg/L	85.3	70	130
EP234D: Triazinone Herbicides (QCLot: 276928)								
EP234-1: Hexazinone	51235-04-2	0.02	µg/L	<0.02	0.2 µg/L	91.5	73	127
EP234-1: Metribuzin	21087-64-9	0.02	µg/L	<0.02	0.2 µg/L	89.0	65	133
EP234E: Conazole and Aminopyrimidine Fungicides (QCLot: 276928)								
EP234-1: Cyproconazole	94361-06-5	0.02	µg/L	<0.02	0.4 µg/L	103	78	128
EP234-1: Cyprodinil	121552-61-2	0.01	µg/L	<0.01	0.1 µg/L	94.0	77	131
EP234-1: Difenoconazole	119446-68-3	0.02	µg/L	<0.02	0.2 µg/L	87.5	76	144
EP234-1: Flusilazole	85509-19-9	0.02	µg/L	<0.02	0.2 µg/L	94.5	76	140
EP234-1: Hexaconazole	79983-71-4	0.02	µg/L	<0.02	0.2 µg/L	96.5	78	130
EP234-1: Paclobutrazole	76738-62-0	0.05	µg/L	<0.05	0.5 µg/L	96.6	78	130
EP234-1: Penconazole	66246-88-6	0.01	µg/L	<0.01	0.1 µg/L	92.0	75	133
EP234-1: Propiconazole	60207-90-1	0.05	µg/L	<0.05	0.5 µg/L	86.0	66	138
EP234-1: Pyrimethanil	53112-28-0	0.02	µg/L	<0.02	0.2 µg/L	92.0	79	123
EP234-1: Tebuconazole	107534-96-3	0.01	µg/L	<0.01	0.1 µg/L	92.0	69	135
EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides (QCLot: 276928)								
EP234-1: Bromacil	314-40-9	0.02	µg/L	<0.02	0.2 µg/L	90.5	71	129
EP234-1: Chlorsulfuron	64902-72-3	0.2	µg/L	<0.2	2 µg/L	88.2	66	136
EP234-1: Diuron	330-54-1	0.02	µg/L	<0.02	0.2 µg/L	97.0	65	137
EP234-1: Fluometuron	2164-17-2	0.01	µg/L	<0.01	0.2 µg/L	102	80	124
EP234-1: Tebuthiuron	34014-18-1	0.02	µg/L	<0.02	0.2 µg/L	95.0	75	127

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP234G: Chloracetanilides (QCLot: 276928)								
EP234-1: Metolachlor	51218-45-2	0.01	µg/L	<0.01	0.1 µg/L	86.0	76	128
EP234H: Triazine Herbicides (QCLot: 276928)								
EP234-1: Ametryn	834-12-8	0.01	µg/L	<0.01	0.1 µg/L	95.0	81	125
EP234-1: Atrazine	1912-24-9	0.01	µg/L	<0.01	0.1 µg/L	98.0	75	123
EP234-1: Cyanazine	21725-46-2	0.02	µg/L	<0.02	0.2 µg/L	90.5	76	130
EP234-1: Cyromazine	66215-27-8	0.05	µg/L	<0.05	0.5 µg/L	95.8	79	123
EP234-1: Prometryn	7287-19-6	0.01	µg/L	<0.01	0.1 µg/L	92.0	81	123
EP234-1: Propazine	139-40-2	0.01	µg/L	<0.01	0.1 µg/L	92.0	84	124
EP234-1: Simazine	122-34-9	0.02	µg/L	<0.02	0.2 µg/L	90.0	73	127
EP234-1: Terbuthylazine	5915-41-3	0.01	µg/L	<0.01	0.1 µg/L	93.0	79	125
EP234-1: Terbutryn	886-50-0	0.01	µg/L	<0.01	0.1 µg/L	96.0	76	130
EP234I: Miscellaneous (ESI Positive Mode) Pesticides (QCLot: 276928)								
EP234-1: Diclofop-methyl	51338-27-3	0.05	µg/L	<0.05	0.5 µg/L	111	70	130
EP234-1: Fenarimol	60168-88-9	0.02	µg/L	<0.02	0.2 µg/L	92.5	68	138
EP234-1: Irgarol	28159-98-0	0.002	µg/L	<0.002	0.02 µg/L	95.0	73	129
EP234-1: Oxyfluorfen	42874-03-3	1	µg/L	<1.0	10 µg/L	89.5	66	144
EP234-1: Thiamethoxam	153719-23-4	0.02	µg/L	<0.02	0.2 µg/L	93.5	71	127

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 275135)							
ES1535912-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	125	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 275136)							
ES1535912-001	Anonymous	ED045G: Chloride	16887-00-6	250 mg/L	117	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 277439)							
ES1535912-002	Anonymous	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	101	70	130
		EG020A-F: Barium	7440-39-3	0.2 mg/L	100	70	130
		EG020A-F: Beryllium	7440-41-7	0.2 mg/L	103	70	130
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	106	70	130
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	91.0	70	130
		EG020A-F: Cobalt	7440-48-4	0.2 mg/L	93.5	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	93.8	70	130
		EG020A-F: Lead	7439-92-1	0.2 mg/L	97.2	70	130

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 277439) - continued							
ES1535912-002	Anonymous	EG020A-F: Manganese	7439-96-5	0.2 mg/L	97.6	70	130
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	90.9	70	130
		EG020A-F: Vanadium	7440-62-2	0.2 mg/L	97.8	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	95.0	70	130
EG020T: Total Metals by ICP-MS (QCLot: 277693)							
EP1515746-001	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	103	70	130
		EG020A-T: Barium	7440-39-3	1 mg/L	94.6	70	130
		EG020A-T: Beryllium	7440-41-7	1 mg/L	94.3	70	130
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	96.6	70	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	97.8	70	130
		EG020A-T: Cobalt	7440-48-4	1 mg/L	97.6	70	130
		EG020A-T: Copper	7440-50-8	1 mg/L	102	70	130
		EG020A-T: Lead	7439-92-1	1 mg/L	96.1	70	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	89.6	70	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	98.0	70	130
		EG020A-T: Vanadium	7440-62-2	1 mg/L	99.4	70	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	# Not Determined	70	130
EG032: Arsenic Speciation by LC-ICPMS (QCLot: 276684)							
EB1533734-001	Anonymous	EG032: Arsenic Acid, As (V)	----	10 µg/L	105	70	130
		EG032: Arsenious Acid, As (III)	----	10 µg/L	102	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 277438)							
ES1535912-001	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	92.7	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 279772)							
ES1535904-038	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	78.9	70	130
EG050F: Dissolved Hexavalent Chromium (QCLot: 277273)							
ES1535705-014	Anonymous	EG050G-F: Hexavalent Chromium	18540-29-9	0.5 mg/L	101	70	130
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 275210)							
ES1535924-001	Anonymous	EK026SF: Total Cyanide	57-12-5	0.2 mg/L	# Not Determined	70	130
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser (QCLot: 275209)							
ES1535924-001	Anonymous	EK028SF: Weak Acid Dissociable Cyanide	----	0.2 mg/L	# Not Determined	70	130
EK040P: Fluoride by PC Titrator (QCLot: 275163)							
ES1535895-001	Anonymous	EK040P: Fluoride	16984-48-8	5 mg/L	108	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 276957)							

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EK055G: Ammonia as N by Discrete Analyser (QCLot: 276957) - continued							
ES1535918-001	Anonymous	EK055G: Ammonia as N	7664-41-7	1 mg/L	83.6	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 275137)							
ES1535912-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	106	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 276958)							
ES1535918-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	94.2	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 276935)							
ES1535918-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	93.9	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 276934)							
ES1535918-002	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	94.3	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 275138)							
ES1535912-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.5 mg/L	103	70	130
EK085M: Sulfide as S2- (QCLot: 279129)							
ES1535966-001	MW206	EK085: Sulfide as S2-	18496-25-8	0.33 mg/L	# Not Determined	70	130
EP005: Total Organic Carbon (TOC) (QCLot: 274591)							
ES1535878-002	Anonymous	EP005: Total Organic Carbon	----	100 mg/L	92.4	70	130
EP010: Formaldehyde (QCLot: 277026)							
ES1535925-001	Anonymous	EP010: Formaldehyde	50-00-0	2.5 mg/L	98.8	70	130
EP026SP: Chemical Oxygen Demand (Spectrophotometric) (QCLot: 279509)							
EP1515806-001	Anonymous	EP026SP: Chemical Oxygen Demand	----	47.6 mg/L	113	70	130
EP041A: Nonionic Surfactants (QCLot: 275763)							
ES1535966-001	MW206	EP041A: Nonionic Surfactants as CTAS	----	5 mg/L	93.0	70	130
EP050: Anionic Surfactants as MBAS (QCLot: 277603)							
ES1535933-018	Anonymous	EP050: Anionic Surfactants as MBAS		1 mg/L	80.0	70	130
EP074A: Monocyclic Aromatic Hydrocarbons (QCLot: 274938)							
ES1535912-001	Anonymous	EP074: Benzene	71-43-2	25 µg/L	91.0	70	130
		EP074: Toluene	108-88-3	25 µg/L	97.7	70	130
EP074E: Halogenated Aliphatic Compounds (QCLot: 274938)							
ES1535912-001	Anonymous	EP074: 1.1-Dichloroethene	75-35-4	25 µg/L	84.5	70	130
		EP074: Trichloroethene	79-01-6	25 µg/L	89.0	70	130
EP074F: Halogenated Aromatic Compounds (QCLot: 274938)							
ES1535912-001	Anonymous	EP074: Chlorobenzene	108-90-7	25 µg/L	100	70	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 274940)							
ES1535912-001	Anonymous						

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EP080/071: Total Petroleum Hydrocarbons (QCLot: 274940) - continued							
ES1535912-001	Anonymous	EP080: C6 - C9 Fraction	----	325 µg/L	98.4	70	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 274940)							
ES1535912-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	375 µg/L	95.8	70	130
EP080: BTEXN (QCLot: 274940)							
ES1535912-001	Anonymous	EP080: Benzene	71-43-2	25 µg/L	83.5	70	130
		EP080: Ethylbenzene	100-41-4	25 µg/L	86.7	70	130
		EP080: meta- & para-Xylene	108-38-3 106-42-3	25 µg/L	87.5	70	130
		EP080: Naphthalene	91-20-3	25 µg/L	88.7	70	130
		EP080: ortho-Xylene	95-47-6	25 µg/L	89.5	70	130
		EP080: Toluene	108-88-3	25 µg/L	85.1	70	130
EP118: Nitrogenated Compounds (QCLot: 275422)							
ES1535966-002	MW202	EP118-1: Acrylonitrile	107-13-1	10 µg/L	82.5	80	120
EP121: Aldehydes (QCLot: 275068)							
ES1535966-002	MW202	EP121: Acetaldehyde	75-07-0	20 µg/L	117	70	130
		EP121: Acrolein (Propenal)	107-02-8	20 µg/L	# 43.4	70	130
		EP121: Butyraldehyde	123-72-8	20 µg/L	89.2	70	130
		EP121: Formaldehyde	50-00-0	20 µg/L	# Not Determined	70	130
		EP121: Propionaldehyde	123-38-6	20 µg/L	117	70	130
EP202A: Phenoxyacetic Acid Herbicides by LCMS (QCLot: 277738)							
EB1534277-001	Anonymous	EP202-SL: 2.4.5-T	93-76-5	100 µg/L	98.2	78	140
		EP202-SL: 2.4-D	94-75-7	100 µg/L	117	77	139
		EP202-SL: Clopyralid	1702-17-6	100 µg/L	# 36.1	70	145
		EP202-SL: MCPA	94-74-6	100 µg/L	106	76	140
		EP202-SL: Mecoprop	93-65-2	100 µg/L	106	75	143
		EP202-SL: Picloram	1918-02-1	100 µg/L	81.0	70	144
		EP202-SL: Triclopyr	55335-06-3	100 µg/L	119	77	141
EP203A: Explosives (QCLot: 274448)							
ES1535966-002	MW202	EP203-SL: 2.4.6-TNT	118-96-7	200 µg/L	101	66	138
		EP203-SL: 2.4-Dinitrotoluene	121-14-2	200 µg/L	108	69	133
		EP203-SL: 4-Amino.2.6-DNT	19406-51-0	200 µg/L	116	63	131
		EP203-SL: HMX	2691-41-0	200 µg/L	103	57	143
		EP203-SL: Nitrobenzene	98-95-3	200 µg/L	108	57	127
		EP203-SL: PETN	78-11-5	200 µg/L	102	51	145
EP231: Perfluorinated Compounds (QCLot: 274411)							
EB1534037-003	Anonymous	EP231: 6:2 Fluorotelomer sulfonate (6:2 FtS)	27619-97-2	2.5 µg/L	106	60	145

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	High
EP231: Perfluorinated Compounds (QCLot: 274411) - continued							
EB1534037-003	Anonymous	EP231: 8:2 Fluorotelomer sulfonate	39108-34-4	2.5 µg/L	76.4	70	130
		EP231: PFOA	335-67-1	0.5 µg/L	118	60	134
		EP231: PFOS	1763-23-1	0.5 µg/L	89.8	60	136
EP231: Perfluorinated Compounds (QCLot: 274412)							
EB1534037-003	Anonymous	EP231PFC: N-Et-FOSA	4151-50-2	2.5 µg/L	93.9	50	130
		EP231PFC: N-Et-FOSE	1691-99-2	2.5 µg/L	108	30	130
		EP231PFC: N-Me-FOSA	31506-32-8	2.5 µg/L	115	50	130
		EP231PFC: N-Me-FOSE	2448-09-7	2.5 µg/L	75.7	30	130
		EP231PFC: PFBS	375-73-5	0.5 µg/L	122	50	130
		EP231PFC: PFDcA	335-76-2	0.5 µg/L	79.6	50	130
		EP231PFC: PFDcS	67906-42-7	0.5 µg/L	80.8	30	130
		EP231PFC: PFDoA	307-55-1	0.5 µg/L	79.0	50	130
		EP231PFC: PFHpA	375-85-9	0.5 µg/L	120	50	130
		EP231PFC: PFHxA	307-24-4	0.5 µg/L	106	50	130
		EP231PFC: PFHxS	355-46-4	0.5 µg/L	91.0	50	130
		EP231PFC: PFNA	375-95-1	0.5 µg/L	118	50	130
		EP231PFC: PFOSA	754-91-6	0.5 µg/L	120	50	130
		EP231PFC: PFTeA	376-06-7	2.5 µg/L	37.0	30	130
		EP231PFC: PFTriA	72629-94-8	0.5 µg/L	40.8	30	130
		EP231PFC: PFUnA	2058-94-8	0.5 µg/L	66.4	30	130
EP234A: OP Pesticides (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Azinphos-ethyl	2642-71-9	0.2 µg/L	91.5	70	130
		EP234-1: Azinphos-methyl	86-50-0	0.2 µg/L	96.5	70	130
		EP234-1: Bromophos-ethyl	4824-78-6	1 µg/L	91.2	70	130
		EP234-1: Carbofenothion	786-19-6	0.2 µg/L	82.5	70	130
		EP234-1: Chlorfenvinphos	470-90-6	0.4 µg/L	86.5	70	130
		EP234-1: Chlorpyrifos	2921-88-2	0.2 µg/L	90.5	70	130
		EP234-1: Chlorpyrifos-methyl	5598-13-0	2 µg/L	85.0	58	136
		EP234-1: Coumaphos	56-72-4	0.1 µg/L	91.0	70	130
		EP234-1: Demeton-O & Demeton-S	298-03-3/126-75-0	0.2 µg/L	96.5	69	129
		EP234-1: Demeton-S-methyl	919-86-8	0.2 µg/L	90.0	70	130
		EP234-1: Diazinon	333-41-5	0.1 µg/L	89.0	70	130
		EP234-1: Dichlorvos	62-73-7	2 µg/L	82.6	70	130
		EP234-1: Dimethoate	60-51-5	0.2 µg/L	110	69	131
		EP234-1: Disulfoton	298-04-4	0.5 µg/L	91.4	70	130
		EP234-1: EPN	2104-64-5	0.5 µg/L	92.2	70	130
		EP234-1: Ethion	563-12-2	0.2 µg/L	89.5	70	130
		EP234-1: Ethoprophos	13194-48-4	0.1 µg/L	93.0	70	132

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	Recovery Limits (%) High
EP234A: OP Pesticides (QCLot: 276928) - continued							
ES1535894-016	Anonymous	EP234-1: Fenamiphos	22224-92-6	0.1 µg/L	93.0	70	130
		EP234-1: Fenchlorphos (Ronnel)	299-84-3	100 µg/L	95.4	71	133
		EP234-1: Fenitrothion	122-14-5	20 µg/L	84.4	64	136
		EP234-1: Fensulfothion	115-90-2	0.1 µg/L	89.0	83	123
		EP234-1: Fenthion	55-38-9	0.5 µg/L	82.0	70	130
		EP234-1: Malathion	121-75-5	0.2 µg/L	107	70	130
		EP234-1: Mevinphos	7786-34-7	0.4 µg/L	104	69	125
		EP234-1: Monocrotophos	6923-22-4	0.2 µg/L	102	70	128
		EP234-1: Omethoate	1113-02-6	0.1 µg/L	91.0	70	130
		EP234-1: Parathion	56-38-2	2 µg/L	86.2	70	130
		EP234-1: Parathion-methyl	298-00-0	20 µg/L	96.7	70	140
		EP234-1: Phorate	298-02-2	1 µg/L	100	70	130
		EP234-1: Pirimiphos-ethyl	23505-41-1	0.1 µg/L	90.0	70	130
		EP234-1: Pirimiphos-methyl	29232-93-7	0.1 µg/L	104	70	130
		EP234-1: Profenofos	41198-08-7	0.1 µg/L	93.0	70	130
		EP234-1: Prothiofos	34643-46-4	1 µg/L	96.0	70	130
		EP234-1: Sulfotep	3689-24-5	0.05 µg/L	100	63	135
		EP234-1: Sulprofos	35400-43-2	0.5 µg/L	92.2	70	130
		EP234-1: Temephos	3383-96-8	0.2 µg/L	84.0	70	130
		EP234-1: Terbufos	13071-79-9	0.1 µg/L	93.0	70	130
		EP234-1: Tetrachlorvinphos	22248-79-9	0.1 µg/L	87.0	77	125
		EP234-1: Triazophos	24017-47-8	0.05 µg/L	92.0	74	132
		EP234-1: Trichlorfon	52-68-6	0.2 µg/L	95.0	70	130
		EP234-1: Trichloronate	327-98-0	5 µg/L	98.2	63	139
EP234B: Thiocarbamates and Carbamates (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: 3-Hydroxy Carbofuran	16655-82-6	0.2 µg/L	99.0	70	130
		EP234-1: Aldicarb	116-06-3	0.5 µg/L	91.2	70	130
		EP234-1: Bendiocarb	22781-23-3	1 µg/L	99.3	70	130
		EP234-1: Benomyl	17804-35-2	0.1 µg/L	93.0	62	136
		EP234-1: Carbaryl	63-25-2	0.1 µg/L	103	70	130
		EP234-1: Carbofuran	1563-66-2	0.1 µg/L	97.0	70	130
		EP234-1: Methiocarb	2032-65-7	0.1 µg/L	94.0	70	130
		EP234-1: Methomyl	16752-77-5	0.1 µg/L	97.0	70	130
		EP234-1: Molinate	2212-67-1	1 µg/L	91.8	66	128
		EP234-1: Oxamyl	23135-22-0	0.1 µg/L	100	70	130
		EP234-1: Thiobencarb	28249-77-6	0.1 µg/L	85.0	70	130
		EP234-1: Thiodicarb	59669-26-0	0.1 µg/L	100	70	130
EP234C: Dinitroanilines (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Pendimethalin	40487-42-1	0.5 µg/L	110	70	130

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	High
EP234C: Dinitroanilines (QCLot: 276928) - continued							
ES1535894-016	Anonymous	EP234-1: Trifluralin	1582-09-8	100 µg/L	102	70	130
EP234D: Triazinone Herbicides (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Hexazinone	51235-04-2	0.2 µg/L	88.0	75	125
		EP234-1: Metribuzin	21087-64-9	0.2 µg/L	86.5	70	130
EP234E: Conazole and Aminopyrimidine Fungicides (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Cyproconazole	94361-06-5	0.4 µg/L	102	73	127
		EP234-1: Cyprodinil	121552-61-2	0.1 µg/L	90.0	74	130
		EP234-1: Difenoconazole	119446-68-3	0.2 µg/L	89.5	74	146
		EP234-1: Flusilazole	85509-19-9	0.2 µg/L	91.0	74	138
		EP234-1: Hexaconazole	79983-71-4	0.2 µg/L	93.0	69	135
		EP234-1: Paclobutrazole	76738-62-0	0.5 µg/L	88.0	73	137
		EP234-1: Penconazole	66246-88-6	0.1 µg/L	89.0	78	132
		EP234-1: Propiconazole	60207-90-1	0.5 µg/L	82.4	70	142
		EP234-1: Pyrimethanil	53112-28-0	0.2 µg/L	92.5	73	127
		EP234-1: Tebuconazole	107534-96-3	0.1 µg/L	99.0	69	135
EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Bromacil	314-40-9	0.2 µg/L	84.5	67	129
		EP234-1: Chlorsulfuron	64902-72-3	2 µg/L	92.1	66	134
		EP234-1: Diuron	330-54-1	0.2 µg/L	100	70	130
		EP234-1: Fluometuron	2164-17-2	0.2 µg/L	104	69	125
		EP234-1: Tebuthiuron	34014-18-1	0.2 µg/L	95.0	71	129
EP234G: Chloracetanilides (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Metolachlor	51218-45-2	0.1 µg/L	93.0	76	130
EP234H: Triazine Herbicides (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Ametryn	834-12-8	0.1 µg/L	97.0	74	126
		EP234-1: Atrazine	1912-24-9	0.1 µg/L	80.0	68	130
		EP234-1: Cyanazine	21725-46-2	0.2 µg/L	89.5	72	126
		EP234-1: Cyromazine	66215-27-8	0.5 µg/L	105	69	137
		EP234-1: Prometryn	7287-19-6	0.1 µg/L	89.0	72	130
		EP234-1: Propazine	139-40-2	0.1 µg/L	82.0	67	133
		EP234-1: Simazine	122-34-9	0.2 µg/L	96.0	70	132
		EP234-1: Terbuthylazine	5915-41-3	0.1 µg/L	97.0	70	126
		EP234-1: Terbutryn	886-50-0	0.1 µg/L	92.0	71	129
EP234I: Miscellaneous (ESI Positive Mode) Pesticides (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Diclofop-methyl	51338-27-3	0.5 µg/L	112	70	130
		EP234-1: Fenarimol	60168-88-9	0.2 µg/L	90.5	60	136
		EP234-1: Irgarol	28159-98-0	0.02 µg/L	100	69	127

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
				Concentration	MS	Low	High
EP234I: Miscellaneous (ESI Positive Mode) Pesticides (QCLot: 276928) - continued							
ES1535894-016	Anonymous	EP234-1: Oxyfluorfen	42874-03-3	10 µg/L	85.2	66	144
		EP234-1: Thiamethoxam	153719-23-4	0.2 µg/L	104	67	133

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1535966**	Page	: 1 of 20
Amendment	: **1**		
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR DAVE BARRETT	Telephone	: +61-2-8784 8555
Project	: LEACHATE ASSESSMENT	Date Samples Received	: 11-Nov-2015
Site	: ----	Issue Date	: 04-Dec-2015
Sampler	: JESSE SIMKUS	No. of samples received	: 2
Order number	: 2218015	No. of samples analysed	: 2

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **Laboratory Control outliers exist - please see following pages for full details.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **Surrogate recovery outliers exist for all regular sample matrices - please see following pages for full details.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Laboratory Control Spike (LCS) Recoveries							
EP075E: Nitroaromatics and Ketones	QC-276812-002	----	**Acetophenone**	98-86-2	67.2 %	68-112%	**Recovery less than lower control limit**
EP075E: Nitroaromatics and Ketones	QC-276812-002	----	**Nitrobenzene**	98-95-3	66.3 %	68-112%	**Recovery less than lower control limit**
EP075F: Haloethers	QC-276812-002	----	**Bis(2-chloroethyl) ether**	111-44-4	68.4 %	69-112%	**Recovery less than lower control limit**
EP075G: Chlorinated Hydrocarbons	QC-276812-002	----	**Hexachlorocyclopentadiene**	77-47-4	19.3 %	24-107%	**Recovery less than lower control limit**
Matrix Spike (MS) Recoveries							
EG020T: Total Metals by ICP-MS	EP1515746--001	Anonymous	**Zinc**	7440-66-6	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK026SF: Total CN by Segmented Flow Analyser	ES1535924--001	Anonymous	**Total Cyanide**	57-12-5	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK028SF: Weak Acid Dissociable CN by Segmented F	ES1535924--001	Anonymous	**Weak Acid Dissociable Cyanide**	----	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK085M: Sulfide as S2-	ES1535966--001	MW206	**Sulfide as S2-**	18496-25-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EP121: Aldehydes	ES1535966--002	MW202	**Acrolein (Propenal)**	107-02-8	43.4 %	70-130%	**Recovery less than lower data quality objective**
EP121: Aldehydes	ES1535966--002	MW202	**Formaldehyde**	50-00-0	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EP202A: Phenoxyacetic Acid Herbicides by LCMS	EB1534277--001	Anonymous	**Clopyralid**	1702-17-6	36.1 %	70-145%	**Recovery less than lower data quality objective**

Regular Sample Surrogates

Sub-Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Samples Submitted							
EP075S: Acid Extractable Surrogates	ES1535966-001	MW206	**2-Chlorophenol-D4**	93951-73-6	18.0 %	21-130 %	**Recovery less than lower data quality objective**
EP132S: Acid Extractable Surrogates	ES1535966-001	MW206	**Phenol-d6**	13127-88-3	76.8 %	10-65 %	**Recovery greater than upper data quality objective**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***

Matrix: **WATER**

Method	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EK010/011: Chlorine						
Clear Plastic Bottle - Natural						
MW206	----	----	----	13-Nov-2015	11-Nov-2015	2

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
Gross Alpha and Beta Activity	1	11	9.09	10.00	NEPM 2013 B3 & ALS QC Standard
Organotin Compounds (Soluble)	0	9	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	0	4	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	0	3	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	0	3	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Semivolatile Organic Compounds	0	2	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	0	3	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)					
Major Anions - Dissolved	0	4	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	0	2	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
Organotin Compounds (Soluble)	0	9	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	0	4	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	0	3	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	0	3	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Semivolatile Organic Compounds	0	2	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	0	3	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	0	2	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	Sample Date	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005: pH								
Clear Plastic Bottle - Natural (EA005)								
MW206		**11-Nov-2015**	----	----	----	**11-Nov-2015**	11-Nov-2015	✓
EA010P: Conductivity by PC Titrator								
Clear Plastic Bottle - Natural (EA010-P)								
MW206		**11-Nov-2015**	----	----	----	**12-Nov-2015**	09-Dec-2015	✓
EA025: Total Suspended Solids dried at 104 ± 2°C								
Clear Plastic Bottle - Natural (EA025H)								
MW206		**11-Nov-2015**	----	----	----	**16-Nov-2015**	18-Nov-2015	✓
EA030: Total Solids dried at 104 ± 2°C								
Clear Plastic Bottle - Natural (EA030H)								
MW206		**11-Nov-2015**	----	----	----	**16-Nov-2015**	18-Nov-2015	✓
EA036: Fixed/Volatile Suspended Solids								
Clear Plastic Bottle - Natural (EA036H)								
MW206		**11-Nov-2015**	----	----	----	**16-Nov-2015**	18-Nov-2015	✓
EA040: Colour (Apparent)								
Clear Plastic Bottle - Natural (EA040)								
MW206		**11-Nov-2015**	----	----	----	**13-Nov-2015**	13-Nov-2015	✓
EA041: Colour (True)								
Clear Plastic Bottle - Natural (EA041)								
MW206		**11-Nov-2015**	----	----	----	**13-Nov-2015**	13-Nov-2015	✓
EA250: Gross Alpha and Beta Activity								
Clear Plastic Bottle - Unspecified; Lab-acidified (EA250-LSC)								
MW206,	MW202	**11-Nov-2015**	**16-Nov-2015**	09-May-2016	✓	**16-Nov-2015**	14-May-2016	✓
ED037P: Alkalinity by PC Titrator								
Clear Plastic Bottle - Natural (ED037-P)								
MW206		**11-Nov-2015**	----	----	----	**12-Nov-2015**	25-Nov-2015	✓
ED040F: Dissolved Major Anions								
Clear Plastic Bottle - Natural (ED040F)								
MW206		**11-Nov-2015**	----	----	----	**13-Nov-2015**	09-Dec-2015	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Clear Plastic Bottle - Natural (ED041G)								
MW206		**11-Nov-2015**	----	----	----	**12-Nov-2015**	09-Dec-2015	✓
ED045G: Chloride by Discrete Analyser								
Clear Plastic Bottle - Natural (ED045G)								
MW206		**11-Nov-2015**	----	----	----	**12-Nov-2015**	09-Dec-2015	✓
ED093F: Dissolved Major Cations								
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)								
MW206		**11-Nov-2015**	----	----	----	**14-Nov-2015**	09-Dec-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / *Container / Client Sample ID(s)*	*Sample Date*	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
MW206	**11-Nov-2015**	**----**	----	----	**14-Nov-2015**	09-May-2016	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T)							
MW206	**11-Nov-2015**	**16-Nov-2015**	09-May-2016	✓	**16-Nov-2015**	09-May-2016	✓
EG020U: Unfiltered Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-U)							
MW206	**11-Nov-2015**	**----**	----	----	**18-Nov-2015**	09-May-2016	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020B-F)							
MW206	**11-Nov-2015**	**----**	----	----	**14-Nov-2015**	09-May-2016	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020B-T)							
MW206	**11-Nov-2015**	**16-Nov-2015**	09-May-2016	✓	**16-Nov-2015**	09-May-2016	✓
EG032: Arsenic Speciation by LC-ICPMS							
Opaque Plastic Bottle - HCl Preserved (Speciation) (EG032)							
MW206, MW202	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	09-Dec-2015	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
MW206	**11-Nov-2015**	**----**	----	----	**17-Nov-2015**	09-Dec-2015	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035T)							
MW206	**11-Nov-2015**	**----**	----	----	**18-Nov-2015**	09-Dec-2015	✓
EG050F: Dissolved Hexavalent Chromium							
Clear Plastic Bottle - NaOH Filtered (EG050G-F)							
MW206, MW202	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	09-Dec-2015	✓
EK010/011: Chlorine							
Clear Plastic Bottle - Natural (EK010)							
MW206	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	11-Nov-2015	×
EK026SF: Total CN by Segmented Flow Analyser							
White Plastic Bottle-NaOH (EK026SF)							
MW206	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	25-Nov-2015	✓
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser							
White Plastic Bottle-NaOH (EK028SF)							
MW206	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	25-Nov-2015	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P)							
MW206	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	09-Dec-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) MW206	**11-Nov-2015**	----	----	----	**13-Nov-2015**	09-Dec-2015	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) MW206	**11-Nov-2015**	----	----	----	**12-Nov-2015**	13-Nov-2015	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) MW206	**11-Nov-2015**	----	----	----	**13-Nov-2015**	09-Dec-2015	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) MW206	**11-Nov-2015**	**13-Nov-2015**	09-Dec-2015	✓	**13-Nov-2015**	09-Dec-2015	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) MW206	**11-Nov-2015**	**13-Nov-2015**	09-Dec-2015	✓	**13-Nov-2015**	09-Dec-2015	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G) MW206	**11-Nov-2015**	----	----	----	**12-Nov-2015**	13-Nov-2015	✓
EK085M: Sulfide as S2-							
Clear Plastic Bottle - Zinc Acetate/NaOH (EK085) MW206, MW202	**11-Nov-2015**	----	----	----	**16-Nov-2015**	18-Nov-2015	✓
EK086: Sulfite as SO3 2-							
Clear Plastic Bottle - EDTA/Zinc Acetate (EK086) MW206, MW202	**11-Nov-2015**	----	----	----	**13-Nov-2015**	13-Nov-2015	✓
EK087: Thiosulfate as S2O3 2-							
Clear Plastic Bottle - EDTA/Zinc Acetate (EK087) MW206, MW202	**11-Nov-2015**	----	----	----	**13-Nov-2015**	13-Nov-2015	✓
EP005: Total Organic Carbon (TOC)							
Amber TOC Vial - Sulfuric Acid (EP005) MW206	**11-Nov-2015**	----	----	----	**12-Nov-2015**	09-Dec-2015	✓
Amber VOC Vial - Sulfuric Acid (EP005) MW202	**11-Nov-2015**	----	----	----	**12-Nov-2015**	09-Dec-2015	✓
EP010: Formaldehyde							
Clear Plastic Bottle - Natural (EP010) MW206	**11-Nov-2015**	----	----	----	**13-Nov-2015**	13-Nov-2015	✓
EP020: Oil and Grease (O&G)							
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020) MW206, MW202	**11-Nov-2015**	----	----	----	**17-Nov-2015**	09-Dec-2015	✓
EP026SP: Chemical Oxygen Demand (Spectrophotometric)							
Clear Plastic Bottle - Sulfuric Acid (EP026SP) MW206	**11-Nov-2015**	----	----	----	**17-Nov-2015**	09-Dec-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / *Container / Client Sample ID(s)*	*Sample Date*	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EP041A: Nonionic Surfactants							
Pres. with Formaldehyde on receipt (EP041A) MW206	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	09-Dec-2015	✓
EP050: Anionic Surfactants as MBAS							
Pres. with Formaldehyde on receipt (EP050) MW206	**11-Nov-2015**	**----**	----	----	**14-Nov-2015**	15-Nov-2015	✓
EP066: Polychlorinated Biphenyls (PCB)							
Amber Glass Bottle - Unpreserved (EP066) MW202	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
Clear Plastic Bottle - Natural (EP066) MW206	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
EP068A: Organochlorine Pesticides (OC)							
Amber Glass Bottle - Unpreserved (EP068) MW202	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
Clear Plastic Bottle - Natural (EP068) MW206	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071) MW202	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
Clear Plastic Bottle - Natural (EP071) MW206	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
EP074A: Monocyclic Aromatic Hydrocarbons							
Amber TOC Vial - Sulfuric Acid (EP074) MW206	**11-Nov-2015**	**12-Nov-2015**	25-Nov-2015	✓	**12-Nov-2015**	25-Nov-2015	✓
Amber VOC Vial - Sulfuric Acid (EP074) MW202	**11-Nov-2015**	**12-Nov-2015**	25-Nov-2015	✓	**12-Nov-2015**	25-Nov-2015	✓
EP075B: Polynuclear Aromatic Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP075) MW202	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
Clear Plastic Bottle - Natural (EP075) MW206	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
EP080S: TPH(V)/BTEX Surrogates							
Amber TOC Vial - Sulfuric Acid (EP080) MW206	**11-Nov-2015**	**12-Nov-2015**	25-Nov-2015	✓	**12-Nov-2015**	25-Nov-2015	✓
Amber VOC Vial - Sulfuric Acid (EP080) MW202	**11-Nov-2015**	**12-Nov-2015**	25-Nov-2015	✓	**12-Nov-2015**	25-Nov-2015	✓
EP090: Organotin Compounds (Soluble)							
Amber Glass Bottle - Unpreserved (EP090S) MW206, MW202	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**17-Nov-2015**	26-Dec-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EP118: Nitrogenated Compounds							
Amber VOC Vial - Sulfuric Acid (EP118-1) MW202	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	25-Nov-2015	✓
VOC Vial - unpreserved (EP118-1) MW206	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	18-Nov-2015	✓
EP121: Aldehydes							
VOC Vial - unpreserved (EP121) MW206, MW202	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	16-Nov-2015	✓
EP132A: Phenolic Compounds							
Amber Glass Bottle - Unpreserved (EP132) MW202	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**18-Nov-2015**	26-Dec-2015	✓
Clear Plastic Bottle - Natural (EP132) MW206	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**18-Nov-2015**	26-Dec-2015	✓
EP202A: Phenoxyacetic Acid Herbicides by LCMS							
Amber Glass Bottle - Unpreserved (EP202-SL) MW206, MW202	**11-Nov-2015**	**----**	----	----	**16-Nov-2015**	18-Nov-2015	✓
EP203A: Explosives							
Amber Glass Bottle - Unpreserved (EP203-SL) MW202	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	18-Nov-2015	✓
Clear Plastic Bottle - Natural (EP203-SL) MW206	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	18-Nov-2015	✓
EP231: Perfluorinated Compounds							
HDPE (no PTFE) (EP231) MW206, MW202	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	09-May-2016	✓
EP231: Perfluorinated Compounds							
HDPE (no PTFE) (EP231PFC) MW206, MW202	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	09-May-2016	✓
EP234I: Miscellaneous (ESI Positive Mode) Pesticides							
Amber Glass Bottle - Unpreserved (EP234-1) MW206, MW202	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	18-Nov-2015	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Acrylonitrile by HS-GC-MS	EP118-1	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Aldehydes by Derivitization Headspace GCMS	EP121	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Anionic Surfactants as MBAS	EP050	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Arsenic Speciation by LC-ICPMS	EG032	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chemical Oxygen Demand (COD) (Spectrophotometric)	EP026SP	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorine	EK010	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Colour (Apparent)	EA040	1	1	**100.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Colour (True)	EA041	1	5	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Explosives (Standard Level)	EP203-SL	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fixed and/or Volatile Suspended Solids (High Level)	EA036H	1	1	**100.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Formaldehyde	EP010	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Gross Alpha and Beta Activity	EA250-LSC	1	11	**9.09**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium by Discrete Analyser - Dissolved	EG050G-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Dissolved	ED040F	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	9	**22.22**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	1	**100.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Compounds (Soluble)	EP090S	0	9	**0.00**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
Perfluorinated Compounds by LCMSMS	EP231PFC	1	9	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	0	4	**0.00**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
PFOS and PFOA	EP231	1	9	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH	EA005	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	10	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	EP066	0	3	**0.00**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	0	3	**0.00**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type / *Analytical Methods*	*Method*	*Count QC*	*Count Regular*	*Rate (%) Actual*	*Rate (%) Expected*	*Evaluation*	*Quality Control Specification*
Laboratory Duplicates (DUP) - Continued							
Semivolatile Organic Compounds	EP075	0	2	**0.00**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfide as S2-	EK085	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfite as SO3 2-	EK086	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	20	**10.00**	**9.52**	✓	NEPM 2013 B3 & ALS QC Standard
Thiosulfate as S2O3 2-	EK087	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	3	**0.00**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Volatile Organic Compounds	EP074	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Weak Acid Dissociable Cyanide by Segmented Flow Analyser	EK028SF	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Acrylonitrile by HS-GC-MS	EP118-1	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Aldehydes by Derivitization Headspace GCMS	EP121	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Alkalinity by PC Titrator	ED037-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Anionic Surfactants as MBAS	EP050	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Arsenic Speciation by LC-ICPMS	EG032	2	3	**66.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chemical Oxygen Demand (COD) (Spectrophotometric)	EP026SP	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Colour (Apparent)	EA040	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Colour (True)	EA041	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Explosives (Standard Level)	EP203-SL	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Formaldehyde	EP010	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Gross Alpha and Beta Activity	EA250-LSC	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium by Discrete Analyser - Dissolved	EG050G-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Dissolved	ED040F	0	4	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type / Analytical Methods	Method	Count QC	Count Regular	Rate (%) Actual	Rate (%) Expected	Evaluation	Quality Control Specification
Laboratory Control Samples (LCS) - Continued							
Major Cations - Dissolved	ED093F	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Compounds (Soluble)	EP090S	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Perfluorinated Compounds by LCMSMS	EP231PFC	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PFOS and PFOA	EP231	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	EP066	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Semivolatile Organic Compounds	EP075	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfide as S2-	EK085	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfite as SO3 2-	EK086	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	20	**10.00**	**9.52**	✓	NEPM 2013 B3 & ALS QC Standard
Thiosulfate as S2O3 2-	EK087	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	7	**28.57**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	20	**15.00**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	3	20	**15.00**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	0	2	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
Volatile Organic Compounds	EP074	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Weak Acid Dissociable Cyanide by Segmented Flow Analyser	EK028SF	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Acrylonitrile by HS-GC-MS	EP118-1	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Aldehydes by Derivitization Headspace GCMS	EP121	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Anionic Surfactants as MBAS	EP050	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Arsenic Speciation by LC-ICPMS	EG032	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chemical Oxygen Demand (COD) (Spectrophotometric)	EP026SP	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorine	EK010	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Colour (Apparent)	EA040	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Colour (True)	EA041	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Explosives (Standard Level)	EP203-SL	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fixed and/or Volatile Suspended Solids (High Level)	EA036H	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Formaldehyde	EP010	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Gross Alpha and Beta Activity	EA250-LSC	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium by Discrete Analyser - Dissolved	EG050G-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Dissolved	ED040F	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Compounds (Soluble)	EP090S	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Perfluorinated Compounds by LCMSMS	EP231PFC	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PFOS and PFOA	EP231	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	EP066	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Semivolatile Organic Compounds	EP075	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfide as S2-	EK085	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfite as SO3 2-	EK086	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	1	20	**5.00**	**4.76**	✓	NEPM 2013 B3 & ALS QC Standard
Thiosulfate as S2O3 2-	EK087	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: ✘ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Total Organic Carbon	EP005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Volatile Organic Compounds	EP074	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Weak Acid Dissociable Cyanide by Segmented Flow Analyser	EK028SF	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Acrylonitrile by HS-GC-MS	EP118-1	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Aldehydes by Derivitization Headspace GCMS	EP121	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Anionic Surfactants as MBAS	EP050	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Arsenic Speciation by LC-ICPMS	EG032	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chemical Oxygen Demand (COD) (Spectrophotometric)	EP026SP	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Explosives (Standard Level)	EP203-SL	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Formaldehyde	EP010	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium by Discrete Analyser - Dissolved	EG050G-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Compounds (Soluble)	EP090S	0	9	**0.00**	**5.00**	✘	NEPM 2013 B3 & ALS QC Standard
Perfluorinated Compounds by LCMSMS	EP231PFC	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	0	4	**0.00**	**5.00**	✘	NEPM 2013 B3 & ALS QC Standard
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PFOS and PFOA	EP231	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	EP066	0	3	**0.00**	**5.00**	✘	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	0	3	**0.00**	**5.00**	✘	NEPM 2013 B3 & ALS QC Standard
Semivolatile Organic Compounds	EP075	0	2	**0.00**	**5.00**	✘	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfide as S2-	EK085	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: ✘ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Matrix Spikes (MS) - Continued							
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	3	**0.00**	**5.00**	✘	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	0	2	**0.00**	**5.00**	✘	NEPM 2013 B3 & ALS QC Standard
Volatile Organic Compounds	EP074	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Weak Acid Dissociable Cyanide by Segmented Flow Analyser	EK028SF	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH	EA005	WATER	In house: Referenced to APHA 4500 H+ B. pH of water samples is determined by ISE either manually or by automated pH meter. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (Calculated)	EA017PGG	WATER	In house: Referenced to APHA 1030 E. Calculated as the sum of quantified major anions and cations This method is compliant with NEPM (2013) Schedule B(3)
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of `non-filterable` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Total Solids	EA030H	WATER	In house: Referenced to APHA 2540 B. A gravimetric procedure employed to determine the amount of residue in a aqueous sample. The sample is evaporated to dryness and dried to constant weight at 104+/-2C. This method is compliant with NEPM (2013) Schedule B(3)
Fixed and/or Volatile Suspended Solids (High Level)	EA036H	WATER	In house: Referenced to APHA 2540 E.This method is compliant with NEPM (2013) Schedule B(3)
Colour (Apparent)	EA040	WATER	In house: Referenced to APHA 2120 B. Apparent colour is determined on the original sample without filtration. This method is compliant with NEPM (2013) Schedule B(3)
Colour (True)	EA041	WATER	In house: Referenced to APHA 2120 B. This method is compliant with NEPM (2013) Schedule B(3)
Gross Alpha and Beta Activity	EA250-LSC	WATER	In house: Referenced to ASTM D7283-06: Determination of gross alpha and gross beta radioactivity in water samples by Liquid Scintillation Counting (LSC).
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Major Anions - Dissolved	ED040F	WATER	In house: Referenced to APHA 3120. The 0.45um filtered samples are determined by ICP/AES for Sulfur and/or Silcon content and reported as Sulfate and/or Silica after conversion by gravimetric factor.
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocyanate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003

Analytical Methods	Method	Matrix	Method Descriptions
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Metals by ICP-MS - Suite B	EG020B-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite B	EG020B-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Arsenic Speciation by LC-ICPMS	EG032	WATER	In house. The arsenic species are separated by HPLC with an anion exchange column and each species is quantified by ICPMS using a single ion at m/z 75
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45 um filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Hexavalent Chromium by Discrete Analyser - Dissolved	EG050G-F	WATER	In house: Referenced to APHA 3500 Cr-A & B. Samples are 0.45 um filtered prior to analysis. Hexavalent chromium is determined directly on water sample by Descrete Analyser as received by pH adjustment and colour development using dephenylcarbazide. Each run of samples is measured against a five-point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Chlorine	EK010	WATER	In-house (DPD colourimetry)
Total Cyanide by Segmented Flow Analyser	EK026SF	WATER	In house: Referenced to APHA 4500-CN O. Sodium hydroxide preserved samples are introduced into an automated segmented flow analyser. Complex bound cyanide is decomposed in a continuously flowing stream, at a pH of 3.8, by the effect of UV light. A UV-B lamp (312 nm) and a decomposition spiral of borosilicate glass are used to filter out UV light with a wavelength of less than 290 nm thus preventing the conversion of thiocyanate into cyanide. The hydrogen cyanide present at a pH of 3.8 is separated by gas dialysis. The hydrogen cyanide is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. This then reacts with 4-pyridine carboxylic acid and 1,3-dimethylbarbituric acid to give a red colour which is measured at 600 nm. This method is compliant with NEPM (2013) Schedule B(3)
Weak Acid Dissociable Cyanide by Segmented Flow Analyser	EK028SF	WATER	In house: Referenced to APHA 4500-CN-O. Samples preserved with sodium hydroxide are introduced into an automated segmented flow analyser. Hydrogen cyanide is liberated from a slightly acidified (pH 4.5) and is dialysed. Tight cyanide complexes that would not be amenable to oxidation by chlorine are not converted. Iron cyanide complexes are precipitated with zinc acetate. Liberated HCN diffuses through a membrane into a stream of sodium hydroxide where it is carried as CN- The cyanide in caustic solution is buffered to pH 5.2 and further converted to cyanogen chloride by reaction with chloramine-T. Cyanogen chloride subsequently reacts with 4 ¿pyridine carboxylic and 1,3 - dimethylbarbituric acids to give a red colour complex. This colour is measured at 600 nm. This method is compliant with NEPM (2013) Schedule B(3)
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500 F--C CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Sulfide as S2-	EK085	WATER	In house: Referenced to APHA 4500-S2- D. Sulfide species present in water samples are immediately precipitated when collected in pretreated caustic/zinc acetate preserved sample containers. After the supernatant is discarded, the resultant precipitate is then coloured using methylene blue indicator and measured using UV-VIS detection at 664nm. This method is compliant with NEPM (2013) Schedule B(3)
Sulfite as SO3 2-	EK086	WATER	In house: Referenced to APHA 4500-SO32- B. Sulfite is determined by standardised Iodate / Iodide titration.
Thiosulfate as S2O3 2-	EK087	WATER	In-house. Thiosulfate is determined by standardised Iodate / Iodide titration following formaledyde pretreatment.
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM (2013) Schedule B(3)
Formaldehyde	EP010	WATER	In house: Referenced to ASTM D 6303-98. Determined by colourimetry using NASH reagent. The Hantszch reaction method is based on the reaction of acetylacetone with formaldehyde in the presence of excess ammonium acetate to form a coloured compound.
Oil and Grease	EP020	WATER	In house: Referenced to APHA 5520 B. Oil & grease is a gravimetric procedure to determine the amount of oil & grease residue in an aqueous sample. The sample is serially extracted three times n-hexane. The resultant extracts are combined, dehydrated and concentrated prior to gravimetric determination. This method is compliant with NEPM (2013) Schedule B(3)
Chemical Oxygen Demand (COD) (Spectrophotometric)	EP026SP	WATER	In house: Referenced to APHA 5220 D. Samples are digested with a known excess of an acidic potassium dichromate solution using silver sulfate as a catalyst. The chromium is reduced from the Cr (VI) oxidation state to the Cr (III) state by the oxygen present in the organic material. Both of these chromium species are coloued and absorb in the visible region of (400nm & 600nm) the spectrum. The oxidisable organic matter can be calculated in terms of oxygen equivalents.
Nonionic Surfactants as CTAS	EP041A	WATER	In house: Referenced to APHA 5540 B&D. This method estimates the non-ionic surfactant content of waters. Sublation transfers all surfactants into a solvent matrix. Cationic and Anionic surfactants are removed by an ion exchange resin column. The remaining surfactant is coloured up with Cobalt Thiocyanate solution and quantified by UV-vis against LAS standards. This method is compliant with NEPM (2013) Schedule B(3)
Anionic Surfactants as MBAS	EP050	WATER	In house: Referenced to APHA 5540 B&C. This method comprises three successive extractions from acid aqueous medium containing excess methylene blue, into chloroform, followed by an aqueous backwash and measurement of the colour by spectrophotometry at 652nm. This method is compliant with NEPM (2013) Schedule B(3)
Polychlorinated Biphenyls (PCB)	EP066	WATER	USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Arochlors by GCMS	EP066-AR	WATER	Calculation based on ALS method EP066 for total PCB by GCMS. Identification of the Aroclor product based on the chromatography of Aroclors under EP066 method conditions.
Pesticides by GCMS	EP068	WATER	USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
Volatile Organic Compounds	EP074	WATER	USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Semivolatile Organic Compounds	EP075	WATER	USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
Organotin Compounds (Soluble)	EP090S	WATER	USEPA SW 846 - 8270D Sample extracts are analysed by GC/MS coupled with high volume injection and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Acrylonitrile by HS-GC-MS	EP118-1	WATER	In House. A 10 mL aliquot of sample is mixed with 4 g of sodium chloride, equilibrated at 80 degrees C for 10 minutes and the headspace analysed by GCMS in the selected ion monitoring mode.
Aldehydes by Derivitization Headspace GCMS	EP121	WATER	In-house. Aqueous aldehydes are derivatised with o-(2,3,4,5,6-pentafluorobenzyl)-hydroxylamine (PFBOA) in a sealed vial at 70°C. After a programmed heating time with gentle shaking, a reproducible headspace gas is extracted from the vial and injected into GC-MS.
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	WATER	USEPA 3640 (GPC Cleanup), 8270 GCMS Capiliary column, SIM mode. This method is compliant with NEPM (2013) Schedule B(3)
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	WATER	In-House, LCMS (Electrospray in negative mode). After adding surrogate and acetic acid, water samples are injected on a C18 column for LC/MS determination.
Explosives (Standard Level)	EP203-SL	WATER	USEPA 8330, Modified In-House, UV-DAD, LCMS (APCI in negative mode). Samples are diluted with acetonitrile and subjected to LC/MS for quantification.
PFOS and PFOA	EP231	WATER	In-house: Direct injection analysis of fresh and diluted saline waters. Analysis by LC-Electrospray-MS-MS, Negative Mode using MRM.
Perfluorinated Compounds by LCMSMS	EP231PFC	WATER	In-house: Direct injection analysis of fresh and diluted saline waters. In order to meet standard reporting limits, saline waters may be adsorped onto a solid phase extraction medium, the salt washed out and the sample eluted for analysis. Analysis by LC-Electrospray-MS-MS, Negative Mode using MRM.
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	WATER	In-House, LC-MSMS, direct injection. A sample is filtered and injected directly onto the LC-MSMS. Analysis is by LC/MSMS, ESI Positive Mode.

Preparation Methods	Method	Matrix	Method Descriptions
Preparation method for Radionuclides	EA250-PR	WATER	Preparation method for Radionuclides
TKN/TP Digestion	EK061/EK067	WATER	APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Digestion for Total Recoverable Metals	EN25	WATER	USEPA SW846-3005 Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1538298**	Page	: 1 of 4
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR PAUL MCFADYEN	Contact	:
Address	: PO BOX 5403 NEWCASTLE WEST NSW, AUSTRALIA 2302	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
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Facsimile	: +61 07 4772 6514	Facsimile	: +61-2-8784 8500
Project	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: ----	Date Samples Received	: 09-Dec-2015 13:34
C-O-C number	: ----	Date Analysis Commenced	: 10-Dec-2015
Sampler	: ----	Issue Date	: 21-Dec-2015 10:53
Site	: ----		
		No. of samples received	: 1
Quote number	: ----	No. of samples analysed	: 1

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Hoa Nguyen	Senior Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
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General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- EG020: Bromine & Iodine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.
- EG020: LOR's for some samples have been raised due to matrix interference
- Metals Analysis : Filtered concentration for some analytes may be greater than total concentration, but within experimental variation of the methods.
- EP050, LOR raised for MBAS due to sample matrix. (very dirty sample).
- EP041A, LOR has been raised for NIS due to sample matrix (dirty sample).
- MBAS is calculated as LAS, molecular weight 342

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	MW202	----	----	----	----
			Client sampling date / time	[09-Dec-2015]	----	----	----	----
				ES1538298-001	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.26**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.010	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.251**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.010	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.239**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0010	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	**0.144**	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.340**	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.023**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.010	----	----	----	----
Lithium	7439-93-2	0.001	mg/L	<0.010	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.540**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**1.26**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.288**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.10	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.010	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.199**	----	----	----	----
Thallium	7440-28-0	0.001	mg/L	<0.010	----	----	----	----
Tin	7440-31-5	0.001	mg/L	<0.010	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L	**1.76**	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.075**	----	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.10	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**14.6**	----	----	----	----
Bromine	7726-95-6	0.1	mg/L	**6.8**	----	----	----	----
Iodine	7553-56-2	0.1	mg/L	**9.1**	----	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**9.02**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.010	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.249**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.010	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.293**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0010	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	**0.150**	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.375**	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.032**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW202	----	----	----	----
			Client sampling date / time	[09-Dec-2015]	----	----	----	----
Compound	CAS Number	LOR	Unit	ES1538298-001	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued								
Lead	7439-92-1	0.001	mg/L	**0.016**	----	----	----	----
Lithium	7439-93-2	0.001	mg/L	**0.015**	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.581**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**1.41**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.314**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.10	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.010	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.227**	----	----	----	----
Thallium	7440-28-0	0.001	mg/L	<0.010	----	----	----	----
Tin	7440-31-5	0.001	mg/L	<0.010	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L	**1.92**	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.129**	----	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.10	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**19.4**	----	----	----	----
EG020U: Unfiltered Metals by ICP-MS								
Bromine	7726-95-6	0.05	mg/L	**6.08**	----	----	----	----
Iodine	7553-56-2	0.05	mg/L	**7.49**	----	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	**0.0122**	----	----	----	----
EP041A: Nonionic Surfactants								
Nonionic Surfactants as CTAS	----	5	mg/L	<10	----	----	----	----
EP050: Anionic Surfactants as MBAS								
Anionic Surfactants as MBAS	----	0.1	mg/L	<0.2	----	----	----	----

QUALITY CONTROL REPORT

Work Order	: **ES1538298**	Page	: 1 of 8
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR PAUL MCFADYEN	Contact	:
Address	: PO BOX 5403 NEWCASTLE WEST NSW, AUSTRALIA 2302	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: paul.mcfadyen@ghd.com	E-mail	:
Telephone	: +61 07 4771 5645	Telephone	: +61-2-8784 8555
Facsimile	: +61 07 4772 6514	Facsimile	: +61-2-8784 8500
Project	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: ----	Date Samples Received	: 09-Dec-2015
C-O-C number	: ----	Date Analysis Commenced	: 10-Dec-2015
Sampler	: ----	Issue Date	: 21-Dec-2015
Site	: ----	No. of samples received	: 1
Quote number	: ----	No. of samples analysed	: 1

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA Accredited
Laboratory 825

Accredited for
compliance with
ISO/IEC 17025.

WORLD RECOGNISED
ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Hoa Nguyen	Senior Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Shobhna Chandra	Metals Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot

CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

RPD = Relative Percentage Difference

= Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020F: Dissolved Metals by ICP-MS (QC Lot: 307176)									
ES1538428-003	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.154	0.154	0.00	0% - 20%
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lithium	7439-93-2	0.001	mg/L	0.066	0.066	0.00	0% - 20%
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.624	0.624	0.00	0% - 20%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	0.009	0.009	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-F: Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.008	0.008	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	0.50	0.50	0.00	0% - 50%
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Bromine	7726-95-6	0.1	mg/L	0.3	0.3	0.00	No Limit
		EG020A-F: Iodine	7553-56-2	0.1	mg/L	<0.1	<0.1	0.00	No Limit
ES1538266-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.002	0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.036	0.036	0.00	0% - 20%
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lithium	7439-93-2	0.001	mg/L	0.047	0.048	0.00	0% - 20%
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.212	0.221	4.52	0% - 20%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.006	0.006	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EG020F: Dissolved Metals by ICP-MS (QC Lot: 307176) - continued									
ES1538266-001	Anonymous	EG020A-F: Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.007	0.007	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	0.17	0.18	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Bromine	7726-95-6	0.1	mg/L	0.6	0.7	0.00	No Limit
		EG020A-F: Iodine	7553-56-2	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 307177)									
ES1538266-001	Anonymous	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-F: Strontium	7440-24-6	0.001	mg/L	0.788	0.784	0.635	0% - 20%
EG020T: Total Metals by ICP-MS (QC Lot: 306362)									
ES1538311-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.153	0.151	1.44	0% - 20%
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.024	0.022	6.83	0% - 20%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Lithium	7439-93-2	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.005	0.005	0.00	No Limit
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	0.001	0.002	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.016	0.017	0.00	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
ES1538320-008	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.008	0.009	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EG020T: Total Metals by ICP-MS (QC Lot: 306362) - continued									
ES1538320-008	Anonymous	EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.644	0.702	8.68	0% - 20%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lithium	7439-93-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.002	0.001	0.00	No Limit
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.062	0.067	9.12	0% - 50%
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.01	0.02	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 306363)									
ES1538311-001	Anonymous	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-T: Strontium	7440-24-6	0.001	mg/L	0.643	0.650	1.12	0% - 20%
ES1538320-008	Anonymous	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-T: Strontium	7440-24-6	0.001	mg/L	0.182	0.199	8.99	0% - 20%
EG020U: Unfiltered Metals by ICP-MS (QC Lot: 309312)									
ES1538298-001	MW202	EG020A-U: Bromine	7726-95-6	0.05	mg/L	6.08	6.43	5.56	0% - 50%
		EG020A-U: Iodine	7553-56-2	0.05	mg/L	7.49	7.86	4.84	0% - 50%
EG035F: Dissolved Mercury by FIMS (QC Lot: 307175)									
ES1538298-001	MW202	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
ES1538423-003	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 309604)									
ES1538259-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
ES1538320-002	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EP041A: Nonionic Surfactants (QC Lot: 307440)									
ES1538298-001	MW202	EP041A: Nonionic Surfactants as CTAS	----	5	mg/L	<10	<5	66.7	No Limit
EP050: Anionic Surfactants as MBAS (QC Lot: 305829)									
ES1538313-005	Anonymous	EP050: Anionic Surfactants as MBAS		0.1	mg/L	0.1	0.1	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 307176)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	103	80	116
EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	0.01 mg/L	90.7	85	115
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	101	85	114
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	98.2	82	110
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	107	85	115
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.1 mg/L	102	85	115
EG020A-F: Bromine	7726-95-6	0.1	mg/L	<0.1	----	----	----	----
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	103	84	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	102	85	111
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	99.4	82	112
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	101	81	111
EG020A-F: Iodine	7553-56-2	0.1	mg/L	<0.1	----	----	----	----
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	102	82	112
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	99.4	83	111
EG020A-F: Lithium	7439-93-2	0.001	mg/L	<0.001	0.1 mg/L	109	79	117
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	102	82	110
EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	94.3	79	113
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	98.3	82	112
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	101	85	115
EG020A-F: Thallium	7440-28-0	0.001	mg/L	<0.001	0.1 mg/L	101	85	111
EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	95.8	77	115
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	102	83	109
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	104	81	117
EG020F: Dissolved Metals by ICP-MS (QCLot: 307177)								
EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----
EG020B-F: Strontium	7440-24-6	0.001	mg/L	<0.001	0.1 mg/L	101	81	113
EG020T: Total Metals by ICP-MS (QCLot: 306362)								
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	103	82	120
EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	101	82	114
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	102	84	116
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	111	79	119
EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	0.1 mg/L	101	75	129
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	103	84	112

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 306362) - continued								
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	105	86	116
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	101	84	116
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	103	83	118
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	106	85	117
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	102	85	115
EG020A-T: Lithium	7439-93-2	0.001	mg/L	<0.001	0.1 mg/L	113	82	122
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	105	85	113
EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	116	83	121
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	102	84	116
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	120	68	126
EG020A-T: Thallium	7440-28-0	0.001	mg/L	<0.001	0.1 mg/L	117	87	117
EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	121	83	123
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	105	85	113
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	105	79	117
EG020T: Total Metals by ICP-MS (QCLot: 306363)								
EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----
EG020B-T: Strontium	7440-24-6	0.001	mg/L	<0.001	0.1 mg/L	102	84	118
EG020U: Unfiltered Metals by ICP-MS (QCLot: 309312)								
EG020A-U: Bromine	7726-95-6	0.05	mg/L	<0.05	----	----	----	----
EG020A-U: Iodine	7553-56-2	0.05	mg/L	<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS (QCLot: 307175)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	94.1	83	105
EG035T: Total Recoverable Mercury by FIMS (QCLot: 309604)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	94.0	77	111
EP041A: Nonionic Surfactants (QCLot: 307440)								
EP041A: Nonionic Surfactants as CTAS	----	5	mg/L	<5	5 mg/L	97.0	78	124
EP050: Anionic Surfactants as MBAS (QCLot: 305829)								
EP050: Anionic Surfactants as MBAS		0.1	mg/L	<0.1	2 mg/L	100	74	118

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
				Concentration	MS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 307176)							
ES1538296-001	Anonymous	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	118	70	130

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	Recovery Limits (%) High
EG020F: Dissolved Metals by ICP-MS (QCLot: 307176) - continued							
ES1538296-001	Anonymous	EG020A-F: Barium	7440-39-3	0.2 mg/L	126	70	130
		EG020A-F: Beryllium	7440-41-7	0.2 mg/L	87.9	70	130
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	88.0	70	130
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	92.3	70	130
		EG020A-F: Cobalt	7440-48-4	0.2 mg/L	126	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	# Not Determined	70	130
		EG020A-F: Lead	7439-92-1	0.2 mg/L	# Not Determined	70	130
		EG020A-F: Manganese	7439-96-5	0.2 mg/L	93.1	70	130
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	126	70	130
		EG020A-F: Vanadium	7440-62-2	0.2 mg/L	106	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	# Not Determined	70	130
EG020T: Total Metals by ICP-MS (QCLot: 306362)							
ES1538291-012	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	110	70	130
		EG020A-T: Barium	7440-39-3	1 mg/L	112	70	130
		EG020A-T: Beryllium	7440-41-7	1 mg/L	118	70	130
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	110	70	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	111	70	130
		EG020A-T: Cobalt	7440-48-4	1 mg/L	109	70	130
		EG020A-T: Copper	7440-50-8	1 mg/L	109	70	130
		EG020A-T: Lead	7439-92-1	1 mg/L	108	70	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	110	70	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	108	70	130
		EG020A-T: Vanadium	7440-62-2	1 mg/L	111	70	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	110	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 307175)							
ES1538266-001	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	97.2	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 309604)							
ES1538259-002	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	89.5	70	130
EP041A: Nonionic Surfactants (QCLot: 307440)							
EP1516895-001	Anonymous	EP041A: Nonionic Surfactants as CTAS	----	5 mg/L	82.0	70	130
EP050: Anionic Surfactants as MBAS (QCLot: 305829)							
ES1538313-005	Anonymous	EP050: Anionic Surfactants as MBAS		1 mg/L	90.0	70	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1538298**	Page	: 1 of 7
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR PAUL MCFADYEN	Telephone	: +61-2-8784 8555
Project	: ----	Date Samples Received	: 09-Dec-2015
Site	: ----	Issue Date	: 21-Dec-2015
Sampler	: ----	No. of samples received	: 1
Order number	: ----	No. of samples analysed	: 1

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EG020F: Dissolved Metals by ICP-MS	ES1538296--001	Anonymous	**Copper**	7440-50-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG020F: Dissolved Metals by ICP-MS	ES1538296--001	Anonymous	**Lead**	7439-92-1	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG020F: Dissolved Metals by ICP-MS	ES1538296--001	Anonymous	**Zinc**	7440-66-6	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Control Samples (LCS)					
Unfiltered Metals by ICP-MS - Suite A	0	1	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
Unfiltered Metals by ICP-MS - Suite A	0	1	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	*Sample Date*	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)		*Date extracted*	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) MW202	**09-Dec-2015**	**----**	----	----	**17-Dec-2015**	06-Jun-2016	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T) MW202	**09-Dec-2015**	**11-Dec-2015**	06-Jun-2016	✓	**11-Dec-2015**	06-Jun-2016	✓
EG020U: Unfiltered Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-U) MW202	**09-Dec-2015**	**----**	----	----	**17-Dec-2015**	06-Jun-2016	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020B-F)							
MW202	**09-Dec-2015**	**----**	----	----	**17-Dec-2015**	06-Jun-2016	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020B-T)							
MW202	**09-Dec-2015**	**11-Dec-2015**	06-Jun-2016	✓	**11-Dec-2015**	06-Jun-2016	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
MW202	**09-Dec-2015**	**----**	----	----	**16-Dec-2015**	06-Jan-2016	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035T)							
MW202	**09-Dec-2015**	**----**	----	----	**16-Dec-2015**	06-Jan-2016	✓
EP041A: Nonionic Surfactants							
Pres. with Formaldehyde on receipt (EP041A)							
MW202	**09-Dec-2015**	**----**	----	----	**11-Dec-2015**	06-Jan-2016	✓
EP050: Anionic Surfactants as MBAS							
Pres. with Formaldehyde on receipt (EP050)							
MW202	**09-Dec-2015**	**----**	----	----	**10-Dec-2015**	13-Dec-2015	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Anionic Surfactants as MBAS	EP050	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	1	1	**100.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Anionic Surfactants as MBAS	EP050	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	0	1	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Anionic Surfactants as MBAS	EP050	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Anionic Surfactants as MBAS	EP050	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Matrix Spikes (MS) - Continued							
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	0	1	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Metals by ICP-MS - Suite B	EG020B-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite B	EG020B-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45 um filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Nonionic Surfactants as CTAS	EP041A	WATER	In house: Referenced to APHA 5540 B&D. This method estimates the non-ionic surfactant content of waters. Sublation transfers all surfactants into a solvent matrix. Cationic and Anionic surfactants are removed by an ion exchange resin column. The remaining surfactant is coloured up with Cobalt Thiocyanate solution and quantified by UV-vis against LAS standards. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Anionic Surfactants as MBAS	EP050	WATER	In house: Referenced to APHA 5540 B&C. This method comprises three successive extractions from acid aqueous medium containing excess methylene blue, into chloroform, followed by an aqueous backwash and measurement of the colour by spectrophotometry at 652nm. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Digestion for Total Recoverable Metals	EN25	WATER	USEPA SW846-3005 Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)

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Certificate of Analysis

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

GHD Pty Ltd
3/24 Honeysuckle Dve
Newcastle
NSW 2300

Attention: **Paul McFadyen**

Report **483138-W**
Project name 22180150302
Received Date Dec 11, 2015

Client Sample ID			**MW202**	**MW206**
Sample Matrix			**Water**	**Water**
Eurofins | mgt Sample No.			**M15-De12338**	**M15-De12339**
Date Sampled			**Dec 09, 2015**	**Dec 09, 2015**
Test/Reference	LOR	Unit		
n-Decane	0.01	mg/L	< 0.05	< 0.05
n-Heptane	0.05	mg/L	< 0.05	< 0.05
n-Hexane	0.05	mg/L	< 0.05	< 0.05
n-Nonane	0.05	mg/L	< 0.05	< 0.05
n-Octane	0.05	mg/L	< 0.05	< 0.05
n-Pentane	0.05	mg/L	< 0.05	< 0.05
Chemical Oxygen Demand (COD)	20	mg/L	2900	-
Chloride	1	mg/L	870	-
Chlorine (free)	0.1	mg/L	< 0.1	-
Chlorine (total)	0.1	mg/L	< 0.1	-
Colour(Pt/Co) true	2	Pt/Co unit	13000	-
Conductivity (at 25°C)	1	uS/cm	35000	-
Cyanide (total)	0.005	mg/L	21	-
Cyanide (weak acid dissoc.)	0.005	mg/L	0.047	-
Fluoride	0.5	mg/L	250	-
Formaldehyde	0.2	mg/L	< 0.2	-
pH	0.1	pH Units	8.8	-
Phosphate ortho (as P)	0.05	mg/L	< 0.05	-
Phosphate total (as P)	0.05	mg/L	5.2	-
Reactive Silica (as SiO2)	5	mg/L	< 200	-
Suspended Solids	1	mg/L	240	-
Total Dissolved Solids	10	mg/L	32000	-
Total Organic Carbon[M10]	5	mg/L	310	-
Total Solids	10	mg/L	34000	-
Volatile Suspended Solids	1	mg/L	35	-
Sodium Adsorption Ratio*	0.1		360	-
Acetates				
Butyl acetate	0.5	mg/L	< 0.5	< 0.5
Ethyl acetate	1	mg/L	< 1	< 1
Propyl acetate	1	mg/L	< 1	< 1
Vinyl acetate	2.5	mg/L	< 2.5	< 2.5
Volatile Organics				
Comments			G01	
1.1-Dichloroethane	0.001	mg/L	< 0.02	-
1.1-Dichloroethene	0.001	mg/L	< 0.02	-
1.1.1-Trichloroethane	0.001	mg/L	< 0.02	-

Client Sample ID			MW202	MW206
Sample Matrix			Water	Water
Eurofins | mgt Sample No.			M15-De12338	M15-De12339
Date Sampled			Dec 09, 2015	Dec 09, 2015
Test/Reference	LOR	Unit		
Volatile Organics				
1.1.1.2-Tetrachloroethane	0.001	mg/L	< 0.02	-
1.1.2-Trichloroethane	0.001	mg/L	< 0.02	-
1.1.2.2-Tetrachloroethane	0.001	mg/L	< 0.02	-
1.2-Dibromoethane	0.001	mg/L	< 0.02	-
1.2-Dichlorobenzene	0.001	mg/L	< 0.02	-
1.2-Dichloroethane	0.001	mg/L	< 0.02	-
1.2-Dichloropropane	0.001	mg/L	< 0.02	-
1.2.3-Trichloropropane	0.001	mg/L	< 0.02	-
1.2.4-Trimethylbenzene	0.001	mg/L	< 0.02	-
1.3-Dichlorobenzene	0.001	mg/L	< 0.02	-
1.3-Dichloropropane	0.001	mg/L	< 0.02	-
1.3.5-Trimethylbenzene	0.001	mg/L	< 0.02	-
1.4-Dichlorobenzene	0.001	mg/L	< 0.02	-
2-Butanone (MEK)	0.001	mg/L	< 0.02	-
2-Propanone (Acetone)	0.001	mg/L	< 0.02	-
4-Chlorotoluene	0.001	mg/L	< 0.02	-
4-Methyl-2-pentanone (MIBK)	0.001	mg/L	< 0.02	-
Allyl chloride	0.001	mg/L	< 0.02	-
Benzene	0.001	mg/L	0.029	-
Bromobenzene	0.001	mg/L	< 0.02	-
Bromochloromethane	0.001	mg/L	< 0.02	-
Bromodichloromethane	0.001	mg/L	< 0.02	-
Bromoform	0.001	mg/L	< 0.02	-
Bromomethane	0.001	mg/L	< 0.02	-
Carbon disulfide	0.001	mg/L	< 0.02	-
Carbon Tetrachloride	0.001	mg/L	< 0.02	-
Chlorobenzene	0.001	mg/L	< 0.02	-
Chloroethane	0.001	mg/L	< 0.02	-
Chloroform	0.005	mg/L	< 0.02	-
Chloromethane	0.001	mg/L	< 0.02	-
cis-1.2-Dichloroethene	0.001	mg/L	< 0.02	-
cis-1.3-Dichloropropene	0.001	mg/L	< 0.02	-
Dibromochloromethane	0.001	mg/L	< 0.02	-
Dibromomethane	0.001	mg/L	< 0.02	-
Dichlorodifluoromethane	0.001	mg/L	< 0.02	-
Ethylbenzene	0.001	mg/L	< 0.02	-
Iodomethane	0.001	mg/L	< 0.02	-
Isopropyl benzene (Cumene)	0.001	mg/L	< 0.02	-
m&p-Xylenes	0.002	mg/L	< 0.04	-
Methylene Chloride	0.001	mg/L	< 0.02	-
o-Xylene	0.001	mg/L	< 0.02	-
Styrene	0.001	mg/L	< 0.02	-
Tetrachloroethene	0.001	mg/L	< 0.02	-
Toluene	0.001	mg/L	< 0.02	-
trans-1.2-Dichloroethene	0.001	mg/L	< 0.02	-
trans-1.3-Dichloropropene	0.001	mg/L	< 0.02	-
Trichloroethene	0.001	mg/L	< 0.02	-
Trichlorofluoromethane	0.001	mg/L	< 0.02	-
Vinyl chloride	0.001	mg/L	< 0.02	-

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Client Sample ID			MW202	MW206
Sample Matrix			Water	Water
Eurofins | mgt Sample No.			M15-De12338	M15-De12339
Date Sampled			Dec 09, 2015	Dec 09, 2015
Test/Reference	LOR	Unit		
Volatile Organics				
Xylenes - Total	0.003	mg/L	< 0.06	-
Fluorobenzene (surr.)	1	%	93	-
4-Bromofluorobenzene (surr.)	1	%	97	-
Semivolatile Organics				
Comments			G01	
2-Methyl-4.6-dinitrophenol	0.03	mg/L	< 0.03	-
1-Chloronaphthalene	0.005	mg/L	< 0.01	-
1-Naphthylamine	0.005	mg/L	< 0.01	-
1.2-Dichlorobenzene	0.005	mg/L	< 0.01	-
1.2.3-Trichlorobenzene	0.005	mg/L	< 0.01	-
1.2.3.4-Tetrachlorobenzene	0.005	mg/L	< 0.01	-
1.2.3.5-Tetrachlorobenzene	0.005	mg/L	< 0.01	-
1.2.4-Trichlorobenzene	0.005	mg/L	< 0.01	-
1.2.4.5-Tetrachlorobenzene	0.005	mg/L	< 0.01	-
1.3-Dichlorobenzene	0.005	mg/L	< 0.01	-
1.3.5-Trichlorobenzene	0.005	mg/L	< 0.01	-
1.4-Dichlorobenzene	0.005	mg/L	< 0.01	-
2-Chloronaphthalene	0.005	mg/L	< 0.01	-
2-Chlorophenol	0.003	mg/L	< 0.003	-
2-Methylnaphthalene	0.005	mg/L	< 0.01	-
2-Methylphenol (o-Cresol)	0.003	mg/L	< 0.003	-
2-Naphthylamine	0.005	mg/L	< 0.01	-
2-Nitroaniline	0.005	mg/L	< 0.01	-
2-Nitrophenol	0.01	mg/L	< 0.01	-
2-Picoline	0.005	mg/L	< 0.01	-
2.3.4.6-Tetrachlorophenol	0.01	mg/L	< 0.02	-
2.4-Dichlorophenol	0.003	mg/L	< 0.003	-
2.4-Dimethylphenol	0.003	mg/L	< 0.003	-
2.4-Dinitrophenol	0.03	mg/L	< 0.03	-
2.4-Dinitrotoluene	0.005	mg/L	< 0.01	-
2.4.5-Trichlorophenol	0.01	mg/L	< 0.01	-
2.4.6-Trichlorophenol	0.01	mg/L	< 0.01	-
2.6-Dichlorophenol	0.003	mg/L	< 0.003	-
2.6-Dinitrotoluene	0.005	mg/L	< 0.01	-
3&4-Methylphenol (m&p-Cresol)	0.006	mg/L	< 0.006	-
3-Methylcholanthrene	0.005	mg/L	< 0.01	-
3.3'-Dichlorobenzidine	0.005	mg/L	< 0.01	-
4-Aminobiphenyl	0.005	mg/L	< 0.01	-
4-Bromophenyl phenyl ether	0.005	mg/L	< 0.01	-
4-Chloro-3-methylphenol	0.01	mg/L	< 0.01	-
4-Chlorophenyl phenyl ether	0.005	mg/L	< 0.01	-
4-Nitrophenol	0.03	mg/L	< 0.03	-
4.4'-DDD	0.005	mg/L	< 0.01	-
4.4'-DDE	0.005	mg/L	< 0.01	-
4.4'-DDT	0.005	mg/L	< 0.01	-
7.12-Dimethylbenz(a)anthracene	0.005	mg/L	< 0.01	-
a-BHC	0.005	mg/L	< 0.01	-
Acenaphthene	0.001	mg/L	< 0.001	-
Acenaphthylene	0.001	mg/L	< 0.001	-

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Client Sample ID			MW202	MW206
Sample Matrix			Water	Water
Eurofins | mgt Sample No.			M15-De12338	M15-De12339
Date Sampled			Dec 09, 2015	Dec 09, 2015
Test/Reference	LOR	Unit		
Semivolatile Organics				
Acetophenone	0.005	mg/L	< 0.01	-
Aldrin	0.005	mg/L	< 0.01	-
Aniline	0.005	mg/L	< 0.01	-
Anthracene	0.001	mg/L	< 0.001	-
b-BHC	0.005	mg/L	< 0.01	-
Benz(a)anthracene	0.001	mg/L	< 0.001	-
Benzo(a)pyrene	0.001	mg/L	< 0.001	-
Benzo(b&j)fluoranthene[N07]	0.001	mg/L	< 0.001	-
Benzo(g.h.i)perylene	0.001	mg/L	< 0.001	-
Benzo(k)fluoranthene	0.001	mg/L	< 0.001	-
Benzyl chloride	0.005	mg/L	< 0.01	-
Bis(2-chloroethoxy)methane	0.005	mg/L	< 0.01	-
Bis(2-chloroisopropyl)ether	0.005	mg/L	< 0.01	-
Bis(2-ethylhexyl)phthalate	0.005	mg/L	< 0.01	-
Butyl benzyl phthalate	0.005	mg/L	< 0.01	-
Chrysene	0.001	mg/L	< 0.001	-
d-BHC	0.005	mg/L	< 0.01	-
Di-n-butyl phthalate	0.005	mg/L	< 0.01	-
Di-n-octyl phthalate	0.005	mg/L	< 0.01	-
Dibenz(a.h)anthracene	0.001	mg/L	< 0.001	-
Dibenz(a.j)acridine	0.005	mg/L	< 0.01	-
Dibenzofuran	0.005	mg/L	< 0.01	-
Dieldrin	0.005	mg/L	< 0.01	-
Diethyl phthalate	0.005	mg/L	< 0.01	-
Dimethyl phthalate	0.005	mg/L	< 0.01	-
Dimethylaminoazobenzene	0.005	mg/L	< 0.01	-
Diphenylamine	0.005	mg/L	< 0.01	-
Endosulfan I	0.005	mg/L	< 0.01	-
Endosulfan II	0.005	mg/L	< 0.01	-
Endosulfan sulphate	0.005	mg/L	< 0.01	-
Endrin	0.005	mg/L	< 0.01	-
Endrin aldehyde	0.005	mg/L	< 0.01	-
Endrin ketone	0.005	mg/L	< 0.01	-
Fluoranthene	0.001	mg/L	< 0.001	-
Fluorene	0.001	mg/L	< 0.001	-
g-BHC (Lindane)	0.005	mg/L	< 0.01	-
Heptachlor	0.005	mg/L	< 0.01	-
Heptachlor epoxide	0.005	mg/L	< 0.01	-
Hexachlorobenzene	0.005	mg/L	< 0.01	-
Hexachlorobutadiene	0.005	mg/L	< 0.01	-
Hexachlorocyclopentadiene	0.005	mg/L	< 0.01	-
Hexachloroethane	0.005	mg/L	< 0.01	-
Indeno(1.2.3-cd)pyrene	0.001	mg/L	< 0.001	-
Methoxychlor	0.005	mg/L	< 0.01	-
N-Nitrosodibutylamine	0.005	mg/L	< 0.01	-
N-Nitrosodipropylamine	0.005	mg/L	< 0.01	-
N-Nitrosopiperidine	0.005	mg/L	< 0.01	-
Naphthalene	0.001	mg/L	0.004	-
Nitrobenzene	0.05	mg/L	< 0.05	-

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Client Sample ID Sample Matrix Eurofins | mgt Sample No. Date Sampled Test/Reference	LOR	Unit	MW202 Water M15-De12338 Dec 09, 2015	MW206 Water M15-De12339 Dec 09, 2015
Semivolatile Organics				
Pentachlorobenzene	0.005	mg/L	< 0.01	-
Pentachloronitrobenzene	0.005	mg/L	< 0.01	-
Pentachlorophenol	0.01	mg/L	< 0.01	-
Phenanthrene	0.001	mg/L	< 0.001	-
Phenol	0.003	mg/L	< 0.003	-
Pronamide	0.005	mg/L	< 0.01	-
Pyrene	0.001	mg/L	< 0.001	-
Trifluralin	0.005	mg/L	< 0.01	-
Phenol-d6 (surr.)	1	%	27	-
Nitrobenzene-d5 (surr.)	1	%	56	-
2-Fluorobiphenyl (surr.)	1	%	53	-
2.4.6-Tribromophenol (surr.)	1	%	42	-
Alkalinity (speciated)				
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	20000	-
Carbonate Alkalinity (as CaCO3)	10	mg/L	6700	-
Hydroxide Alkalinity (as CaCO3)	10	mg/L	< 10	-
Total Alkalinity (as CaCO3)	20	mg/L	27000	-
Total Sulphur Set (as S)				
Sulphate (as S)	5	mg/L	680	-
Sulphide (as S)	0.05	mg/L	< 0.05	-
Sulphite (as S)	0.5	mg/L	< 5	-
Thiosulphate (as S)	1	mg/L	< 10	-
Total Sulphur (as S)	5	mg/L	680	-
Nitrogens (speciated)				
Ammonia (as N)	0.01	mg/L	48	-
Nitrate (as N)	0.02	mg/L	< 0.2	-
Nitrite (as N)	0.02	mg/L	< 0.2	-
Organic Nitrogen (as N)	0.2	mg/L	27	-
Total Kjeldahl Nitrogen (as N)	0.2	mg/L	75	-
Total Nitrogen (as N)	0.2	mg/L	75	-
Alkali Metals				
Calcium	0.5	mg/L	5.0	-
Magnesium	0.5	mg/L	41	-
Potassium	0.5	mg/L	46	-
Sodium	0.5	mg/L	12000	-

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Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
n-Decane	Melbourne	Dec 11, 2015	14 Day
n-Heptane	Melbourne	Dec 11, 2015	14 Day
- Method: ..			
n-Hexane	Melbourne	Dec 11, 2015	14 Day
- Method: USEPA 8000 - Hexane			
n-Nonane	Melbourne	Dec 11, 2015	14 Day
- Method: ..			
n-Octane	Melbourne	Dec 11, 2015	14 Day
- Method: ..			
n-Pentane	Melbourne	Dec 11, 2015	14 Day
- Method: USEPA 8260 - n-Pentane			
Chemical Oxygen Demand (COD)	Melbourne	Dec 11, 2015	28 Day
- Method: APHA 5220 COD Open Reflux Method			
Chloride	Melbourne	Dec 14, 2015	28 Day
- Method: MGT 1100A			
Chlorine (free)	Melbourne	Dec 11, 2015	1 Day
Chlorine (total)	Melbourne	Dec 11, 2015	5 Day
Colour(Pt/Co) true	Melbourne	Dec 11, 2015	2 Day
- Method: APHA 2120B Colour			
Conductivity (at 25°C)	Melbourne	Dec 14, 2015	28 Day
- Method: LTM-INO-4030			
Cyanide (total)	Melbourne	Dec 14, 2015	14 Day
- Method: LTM-INO-4020 Total Free WAD Cyanide by CFA			
Cyanide (weak acid dissoc.)	Melbourne	Dec 14, 2015	14 Day
- Method: LTM-INO-4020 Total Free WAD Cyanide by CFA			
Fluoride	Melbourne	Dec 11, 2015	28 Day
- Method: LM-LTM-INO-4300 (Fluoride by Ion Chromatography)			
Formaldehyde	Melbourne	Dec 11, 2015	7 Day
- Method: Fomaldehyde MW AWA			
pH	Melbourne	Dec 14, 2015	0 Hours
- Method: LTM-GEN-7090 pH in water by ISE			
Phosphate ortho (as P)	Melbourne	Dec 14, 2015	2 Day
- Method: APHA 4500-P E. Phosphate (ortho)			
Phosphate total (as P)	Melbourne	Dec 14, 2015	28 Day
- Method: APHA 4500-P E. Phosphorous			
Reactive Silica (as SiO2)	Melbourne	Dec 11, 2015	5 Day
- Method: #4500SiC			
Suspended Solids	Melbourne	Dec 11, 2015	7 Day
- Method: APHA 2540D Total Suspended Solids			
Total Dissolved Solids	Melbourne	Dec 11, 2015	7 Day
- Method: APHA 2540C Total Dissolved Solids			
Total Organic Carbon	Melbourne	Dec 14, 2015	28 Day
- Method: APHA 5310B Total Organic Carbon			
Total Solids	Melbourne	Dec 11, 2015	7 Day
- Method: APHA 2540B - Total Solids			
Volatile Suspended Solids	Melbourne	Dec 11, 2015	5 Day
Acetates	Melbourne	Dec 11, 2015	5 Day
- Method: USEPA SW846 Method 8260 Purge & Trap GC/MS & MGT Method 460A Headspace GC-FID			
Volatile Organics	Melbourne	Dec 11, 2015	7 Day
- Method: USEPA 8260 - MGT 350A Volatile Organics by GCMS			

Description	Testing Site	Extracted	Holding Time
Semivolatile Organics	Melbourne	Dec 17, 2015	7 Day
- Method: USEPA 8270 Semivolatile Organics			
Alkalinity (speciated)	Melbourne	Dec 14, 2015	14 Day
- Method: APHA 2320 Alkalinity by Titration			
Total Sulphur Set (as S)			
Sulphate (as S)	Melbourne	Dec 18, 2015	28 Day
- Method: In house MGT1110A (SO4 by Discrete Analyser)			
Sulphide (as S)	Melbourne	Dec 18, 2015	7 Day
- Method: APHA 4500-S C & D - Sulphide			
Sulphite (as S)	Melbourne	Dec 18, 2015	2 Day
- Method: APHA 4500 Sulphite			
Thiosulphate (as S)	Melbourne	Dec 18, 2015	2 Day
- Method: APHA 4500 Thiosulphate			
Total Sulphur (as S)	Melbourne	Dec 18, 2015	7 Day
- Method: Sum of Constituent Analytes			
Nitrogens (speciated)			
Ammonia (as N)	Melbourne	Dec 14, 2015	28 Day
- Method: APHA 4500-NH3 Ammonia Nitrogen by FIA			
Nitrate (as N)	Melbourne	Dec 14, 2015	7 Day
- Method: APHA 4500-NO3 Nitrate Nitrogen by FIA			
Nitrite (as N)	Melbourne	Dec 14, 2015	2 Day
- Method: APHA 4500-NO2 Nitrite Nitrogen by FIA			
Organic Nitrogen (as N)	Melbourne	Dec 14, 2015	7 Day
- Method: APHA 4500 Organic Nitrogen (N)			
Total Kjeldahl Nitrogen (as N)	Melbourne	Dec 14, 2015	7 Day
- Method: APHA 4500 TKN			
Alkali Metals	Melbourne	Dec 11, 2015	180 Day
- Method: USEPA 6010 Alkali Metals			

Company Name:	GHD Pty Ltd NEWCASTLE	**Order No.:**		**Received:**	Dec 11, 2015 12:06 PM
Address:	3/24 Honeysuckle Dve Newcastle NSW 2300	**Report #:**	483138	**Due:**	Dec 18, 2015
		Phone:	02 4979 9999	**Priority:**	5 Day
		Fax:	02 4979 9988	**Contact Name:**	Paul McFadyen
Project Name:	22180150302				

Eurofins | mgt Client Manager: Charl Du Preez

Sample Detail					Chemical Oxygen Demand (COD)	Chloride	Chlorine (free)	Chlorine (total)	Colour(Pt/Co) true	Conductivity (at 25°C)	Cyanide (total)	Cyanide (weak acid dissoc.)	Fluoride	Formaldehyde	n-Decane	n-Heptane	n-Hexane	n-Nonane	n-Octane	n-Pentane	pH	Phosphate ortho (as P)	Phosphate total (as P)	Reactive Silica (as SiO2)	Sodium Adsorption Ratio*	Suspended Solids	Total Dissolved Solids	Total Organic Carbon	Total Solids	Volatile Suspended Solids	Acetates	Alkalinity (speciated)	Alkali Metals	Total Sulphur Set (as S)	Subcontracted Tests	Nitrogens (speciated)	Volatile Organics	Semivolatile Organics
Laboratory where analysis is conducted																																						
Melbourne Laboratory - NATA Site # 1254 & 14271					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																																						
Brisbane Laboratory - NATA Site # 20794																																						
External Laboratory																																						
Sample ID	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																																		
MW202	Dec 09, 2015		Water	M15-De12338	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW206	Dec 09, 2015		Water	M15-De12339											X	X	X	X	X	X											X							

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Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
4. Results are uncorrected for matrix spikes or surrogate recoveries.
5. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
6. Samples were analysed on an 'as received' basis. 7. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Advice.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per Kilogram

ug/l: micrograms per litre

ppb: Parts per billion

org/100ml: Organisms per 100 millilitres

MPN/100mL: Most Probable Number of organisms per 100 millilitres

mg/l: milligrams per litre

ppm: Parts per million

%: Percentage

NTU: Nephelometric Turbidity Units

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery
CRM	Certified Reference Material - reported as percent recovery
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands. In the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
Batch Duplicate	A second piece of analysis from a sample outside of the clients batch of samples but run within the laboratory batch of analysis.
Batch SPIKE	Spike recovery reported on a sample from outside of the clients batch of samples but run within the laboratory batch of analysis.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
ASLP	Australian Standard Leaching Procedure (AS4439.3)
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries : Recoveries must lie between 50-150% - Phenols 20-130%.

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxophene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxophene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Arochlor 1260 in Matrix Spikes and LCS's.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPD's are calculated from raw analytical data thus it is possible to have two sets of data.

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Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
n-Heptane	mg/L	< 0.05			0.05	Pass	
n-Hexane	mg/L	< 0.05			0.05	Pass	
n-Nonane	mg/L	< 0.05			0.05	Pass	
n-Octane	mg/L	< 0.05			0.05	Pass	
n-Pentane	mg/L	< 0.05			0.05	Pass	
Chemical Oxygen Demand (COD)	mg/L	< 20			20	Pass	
Chloride	mg/L	< 1			1	Pass	
Chlorine (free)	mg/L	< 0.1			0.1	Pass	
Chlorine (total)	mg/L	< 0.1			0.1	Pass	
Colour(Pt/Co) true	Pt/Co unit	< 2			2	Pass	
Cyanide (total)	mg/L	< 0.005			0.005	Pass	
Cyanide (weak acid dissoc.)	mg/L	< 0.005			0.005	Pass	
Fluoride	mg/L	< 0.5			0.5	Pass	
Formaldehyde	mg/L	< 0.2			0.2	Pass	
Phosphate ortho (as P)	mg/L	< 0.05			0.05	Pass	
Phosphate total (as P)	mg/L	< 0.05			0.05	Pass	
Reactive Silica (as SiO2)	mg/L	< 5			5	Pass	
Suspended Solids	mg/L	< 1			1	Pass	
Total Dissolved Solids	mg/L	< 10			10	Pass	
Total Organic Carbon	mg/L	< 5			5	Pass	
Total Solids	mg/L	< 10			10	Pass	
Method Blank							
Acetates							
Butyl acetate	mg/L	< 0.5			0.5	Pass	
Ethyl acetate	mg/L	< 1			1	Pass	
Propyl acetate	mg/L	< 1			1	Pass	
Vinyl acetate	mg/L	< 2.5			2.5	Pass	
Method Blank							
Volatile Organics							
1.1-Dichloroethane	mg/L	< 0.001			0.001	Pass	
1.1-Dichloroethene	mg/L	< 0.001			0.001	Pass	
1.1.1-Trichloroethane	mg/L	< 0.001			0.001	Pass	
1.1.1.2-Tetrachloroethane	mg/L	< 0.001			0.001	Pass	
1.1.2-Trichloroethane	mg/L	< 0.001			0.001	Pass	
1.1.2.2-Tetrachloroethane	mg/L	< 0.001			0.001	Pass	
1.2-Dibromoethane	mg/L	< 0.001			0.001	Pass	
1.2-Dichlorobenzene	mg/L	< 0.001			0.001	Pass	
1.2-Dichloroethane	mg/L	< 0.001			0.001	Pass	
1.2-Dichloropropane	mg/L	< 0.001			0.001	Pass	
1.2.3-Trichloropropane	mg/L	< 0.001			0.001	Pass	
1.2.4-Trimethylbenzene	mg/L	< 0.001			0.001	Pass	
1.3-Dichlorobenzene	mg/L	< 0.001			0.001	Pass	
1.3-Dichloropropane	mg/L	< 0.001			0.001	Pass	
1.3.5-Trimethylbenzene	mg/L	< 0.001			0.001	Pass	
1.4-Dichlorobenzene	mg/L	< 0.001			0.001	Pass	
2-Butanone (MEK)	mg/L	< 0.001			0.001	Pass	
2-Propanone (Acetone)	mg/L	< 0.001			0.001	Pass	
4-Chlorotoluene	mg/L	< 0.001			0.001	Pass	
4-Methyl-2-pentanone (MIBK)	mg/L	< 0.001			0.001	Pass	
Allyl chloride	mg/L	< 0.001			0.001	Pass	
Benzene	mg/L	< 0.001			0.001	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Bromobenzene	mg/L	< 0.001			0.001	Pass	
Bromochloromethane	mg/L	< 0.001			0.001	Pass	
Bromodichloromethane	mg/L	< 0.001			0.001	Pass	
Bromoform	mg/L	< 0.001			0.001	Pass	
Bromomethane	mg/L	< 0.001			0.001	Pass	
Carbon disulfide	mg/L	< 0.001			0.001	Pass	
Carbon Tetrachloride	mg/L	< 0.001			0.001	Pass	
Chlorobenzene	mg/L	< 0.001			0.001	Pass	
Chloroethane	mg/L	< 0.001			0.001	Pass	
Chloroform	mg/L	< 0.005			0.005	Pass	
Chloromethane	mg/L	< 0.001			0.001	Pass	
cis-1.2-Dichloroethene	mg/L	< 0.001			0.001	Pass	
cis-1.3-Dichloropropene	mg/L	< 0.001			0.001	Pass	
Dibromochloromethane	mg/L	< 0.001			0.001	Pass	
Dibromomethane	mg/L	< 0.001			0.001	Pass	
Dichlorodifluoromethane	mg/L	< 0.001			0.001	Pass	
Ethylbenzene	mg/L	< 0.001			0.001	Pass	
Iodomethane	mg/L	< 0.001			0.001	Pass	
Isopropyl benzene (Cumene)	mg/L	< 0.001			0.001	Pass	
m&p-Xylenes	mg/L	< 0.002			0.002	Pass	
Methylene Chloride	mg/L	< 0.001			0.001	Pass	
o-Xylene	mg/L	< 0.001			0.001	Pass	
Styrene	mg/L	< 0.001			0.001	Pass	
Tetrachloroethene	mg/L	< 0.001			0.001	Pass	
Toluene	mg/L	< 0.001			0.001	Pass	
trans-1.2-Dichloroethene	mg/L	< 0.001			0.001	Pass	
trans-1.3-Dichloropropene	mg/L	< 0.001			0.001	Pass	
Trichloroethene	mg/L	< 0.001			0.001	Pass	
Trichlorofluoromethane	mg/L	< 0.001			0.001	Pass	
Vinyl chloride	mg/L	< 0.001			0.001	Pass	
Xylenes - Total	mg/L	< 0.003			0.003	Pass	
Method Blank							
Semivolatile Organics							
2-Methyl-4.6-dinitrophenol	mg/L	< 0.03			0.03	Pass	
1-Chloronaphthalene	mg/L	< 0.005			0.005	Pass	
1-Naphthylamine	mg/L	< 0.005			0.005	Pass	
1.2-Dichlorobenzene	mg/L	< 0.005			0.005	Pass	
1.2.3-Trichlorobenzene	mg/L	< 0.005			0.005	Pass	
1.2.3.4-Tetrachlorobenzene	mg/L	< 0.005			0.005	Pass	
1.2.3.5-Tetrachlorobenzene	mg/L	< 0.005			0.005	Pass	
1.2.4-Trichlorobenzene	mg/L	< 0.005			0.005	Pass	
1.2.4.5-Tetrachlorobenzene	mg/L	< 0.005			0.005	Pass	
1.3-Dichlorobenzene	mg/L	< 0.005			0.005	Pass	
1.3.5-Trichlorobenzene	mg/L	< 0.005			0.005	Pass	
1.4-Dichlorobenzene	mg/L	< 0.005			0.005	Pass	
2-Chloronaphthalene	mg/L	< 0.005			0.005	Pass	
2-Chlorophenol	mg/L	< 0.003			0.003	Pass	
2-Methylnaphthalene	mg/L	< 0.005			0.005	Pass	
2-Methylphenol (o-Cresol)	mg/L	< 0.003			0.003	Pass	
2-Naphthylamine	mg/L	< 0.005			0.005	Pass	
2-Nitroaniline	mg/L	< 0.005			0.005	Pass	
2-Nitrophenol	mg/L	< 0.01			0.01	Pass	
2-Picoline	mg/L	<0.005			0.005	Pass	
2.3.4.6-Tetrachlorophenol	mg/L	< 0.01			0.01	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
2.4-Dichlorophenol	mg/L	< 0.003			0.003	Pass	
2.4-Dimethylphenol	mg/L	< 0.003			0.003	Pass	
2.4-Dinitrophenol	mg/L	< 0.03			0.03	Pass	
2.4-Dinitrotoluene	mg/L	< 0.005			0.005	Pass	
2.4.5-Trichlorophenol	mg/L	< 0.01			0.01	Pass	
2.4.6-Trichlorophenol	mg/L	< 0.01			0.01	Pass	
2.6-Dichlorophenol	mg/L	< 0.003			0.003	Pass	
2.6-Dinitrotoluene	mg/L	< 0.005			0.005	Pass	
3&4-Methylphenol (m&p-Cresol)	mg/L	< 0.006			0.006	Pass	
3-Methylcholanthrene	mg/L	< 0.005			0.005	Pass	
3.3'-Dichlorobenzidine	mg/L	< 0.005			0.005	Pass	
4-Aminobiphenyl	mg/L	< 0.005			0.005	Pass	
4-Bromophenyl phenyl ether	mg/L	< 0.005			0.005	Pass	
4-Chloro-3-methylphenol	mg/L	< 0.01			0.01	Pass	
4-Chlorophenyl phenyl ether	mg/L	< 0.005			0.005	Pass	
4-Nitrophenol	mg/L	< 0.03			0.03	Pass	
4.4'-DDD	mg/L	< 0.005			0.005	Pass	
4.4'-DDE	mg/L	< 0.005			0.005	Pass	
4.4'-DDT	mg/L	< 0.005			0.005	Pass	
7.12-Dimethylbenz(a)anthracene	mg/L	< 0.005			0.005	Pass	
a-BHC	mg/L	< 0.005			0.005	Pass	
Acenaphthene	mg/L	< 0.001			0.001	Pass	
Acenaphthylene	mg/L	< 0.001			0.001	Pass	
Acetophenone	mg/L	< 0.005			0.005	Pass	
Aldrin	mg/L	< 0.005			0.005	Pass	
Aniline	mg/L	< 0.005			0.005	Pass	
Anthracene	mg/L	< 0.001			0.001	Pass	
b-BHC	mg/L	< 0.005			0.005	Pass	
Benz(a)anthracene	mg/L	< 0.001			0.001	Pass	
Benzo(a)pyrene	mg/L	< 0.0005			0.001	Pass	
Benzo(b&j)fluoranthene	mg/L	< 0.001			0.001	Pass	
Benzo(g.h.i)perylene	mg/L	< 0.001			0.001	Pass	
Benzo(k)fluoranthene	mg/L	< 0.001			0.001	Pass	
Benzyl chloride	mg/L	< 0.005			0.005	Pass	
Bis(2-chloroethoxy)methane	mg/L	< 0.005			0.005	Pass	
Bis(2-chloroisopropyl)ether	mg/L	< 0.005			0.005	Pass	
Bis(2-ethylhexyl)phthalate	mg/L	< 0.005			0.005	Pass	
Butyl benzyl phthalate	mg/L	< 0.005			0.005	Pass	
Chrysene	mg/L	< 0.001			0.001	Pass	
d-BHC	mg/L	< 0.005			0.005	Pass	
Di-n-butyl phthalate	mg/L	< 0.005			0.005	Pass	
Di-n-octyl phthalate	mg/L	< 0.005			0.005	Pass	
Dibenz(a.h)anthracene	mg/L	< 0.001			0.001	Pass	
Dibenz(a.j)acridine	mg/L	< 0.005			0.005	Pass	
Dibenzofuran	mg/L	< 0.005			0.005	Pass	
Dieldrin	mg/L	< 0.005			0.005	Pass	
Diethyl phthalate	mg/L	< 0.005			0.005	Pass	
Dimethyl phthalate	mg/L	<0.005			0.005	Pass	
Dimethylaminoazobenzene	mg/L	< 0.005			0.005	Pass	
Diphenylamine	mg/L	< 0.005			0.005	Pass	
Endosulfan I	mg/L	< 0.005			0.005	Pass	
Endosulfan II	mg/L	< 0.005			0.005	Pass	
Endosulfan sulphate	mg/L	< 0.005			0.005	Pass	
Endrin	mg/L	< 0.005			0.005	Pass	

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Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Endrin aldehyde	mg/L	< 0.005			0.005	Pass	
Endrin ketone	mg/L	< 0.005			0.005	Pass	
Fluoranthene	mg/L	<0.001			0.001	Pass	
Fluorene	mg/L	< 0.001			0.001	Pass	
g-BHC (Lindane)	mg/L	< 0.005			0.005	Pass	
Heptachlor	mg/L	< 0.005			0.005	Pass	
Heptachlor epoxide	mg/L	< 0.005			0.005	Pass	
Hexachlorobenzene	mg/L	< 0.005			0.005	Pass	
Hexachlorobutadiene	mg/L	< 0.005			0.005	Pass	
Hexachlorocyclopentadiene	mg/L	< 0.005			0.005	Pass	
Hexachloroethane	mg/L	< 0.005			0.005	Pass	
Indeno(1.2.3-cd)pyrene	mg/L	< 0.001			0.001	Pass	
Methoxychlor	mg/L	< 0.005			0.005	Pass	
N-Nitrosodibutylamine	mg/L	< 0.005			0.005	Pass	
N-Nitrosodipropylamine	mg/L	< 0.005			0.005	Pass	
N-Nitrosopiperidine	mg/L	< 0.005			0.005	Pass	
Naphthalene	mg/L	<0.001			0.001	Pass	
Nitrobenzene	mg/L	< 0.05			0.05	Pass	
Pentachlorobenzene	mg/L	< 0.005			0.005	Pass	
Pentachloronitrobenzene	mg/L	< 0.005			0.005	Pass	
Pentachlorophenol	mg/L	< 0.01			0.01	Pass	
Phenanthrene	mg/L	< 0.001			0.001	Pass	
Phenol	mg/L	< 0.003			0.003	Pass	
Pronamide	mg/L	< 0.005			0.005	Pass	
Pyrene	mg/L	<0.001			0.001	Pass	
Trifluralin	mg/L	< 0.005			0.005	Pass	
Method Blank							
Alkalinity (speciated)							
Bicarbonate Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Carbonate Alkalinity (as CaCO3)	mg/L	< 10			10	Pass	
Hydroxide Alkalinity (as CaCO3)	mg/L	< 10			10	Pass	
Total Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Method Blank							
Total Sulphur Set (as S)							
Sulphate (as S)	mg/L	< 5			5	Pass	
Sulphide (as S)	mg/L	< 0.05			0.05	Pass	
Sulphite (as S)	mg/L	< 0.5			0.5	Pass	
Thiosulphate (as S)	mg/L	< 1			1	Pass	
Method Blank							
Nitrogens (speciated)							
Ammonia (as N)	mg/L	< 0.01			0.01	Pass	
Nitrate (as N)	mg/L	< 0.02			0.02	Pass	
Nitrite (as N)	mg/L	< 0.02			0.02	Pass	
Total Kjeldahl Nitrogen (as N)	mg/L	< 0.2			0.2	Pass	
Total Nitrogen (as N)	mg/L	< 0.2			0.2	Pass	
Method Blank							
Alkali Metals							
Calcium	mg/L	< 0.5			0.5	Pass	
Magnesium	mg/L	< 0.5			0.5	Pass	
Potassium	mg/L	< 0.5			0.5	Pass	
Sodium	mg/L	< 0.5			0.5	Pass	
LCS - % Recovery							
Chemical Oxygen Demand (COD)	%	105			70-130	Pass	
Chloride	%	105			70-130	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Chlorine (total)	%	103			70-130	Pass	
Cyanide (total)	%	105			70-130	Pass	
Cyanide (weak acid dissoc.)	%	104			70-130	Pass	
Fluoride	%	104			70-130	Pass	
Formaldehyde	%	102			70-130	Pass	
Phosphate ortho (as P)	%	106			70-130	Pass	
Phosphate total (as P)	%	102			70-130	Pass	
Reactive Silica (as SiO2)	%	106			70-130	Pass	
Total Organic Carbon	%	90			70-130	Pass	
LCS - % Recovery							
Acetates							
Butyl acetate	%	95			70-130	Pass	
LCS - % Recovery							
Volatile Organics							
1.1-Dichloroethene	%	87			70-130	Pass	
1.1.1-Trichloroethane	%	111			70-130	Pass	
1.2-Dichlorobenzene	%	101			70-130	Pass	
1.2-Dichloroethane	%	94			70-130	Pass	
Benzene	%	91			70-130	Pass	
Ethylbenzene	%	83			70-130	Pass	
m&p-Xylenes	%	93			70-130	Pass	
Toluene	%	90			70-130	Pass	
Trichloroethene	%	82			70-130	Pass	
Xylenes - Total	%	94			70-130	Pass	
LCS - % Recovery							
Semivolatile Organics							
2-Methyl-4.6-dinitrophenol	%	74			30-130	Pass	
1.2.4-Trichlorobenzene	%	118			70-130	Pass	
1.4-Dichlorobenzene	%	111			70-130	Pass	
2-Chlorophenol	%	81			30-130	Pass	
2-Methylphenol (o-Cresol)	%	65			30-130	Pass	
2-Nitrophenol	%	124			30-130	Pass	
2.4-Dichlorophenol	%	95			30-130	Pass	
2.4-Dimethylphenol	%	77			30-130	Pass	
2.4-Dinitrophenol	%	48			30-130	Pass	
2.4-Dinitrotoluene	%	95			75-125	Pass	
2.4.5-Trichlorophenol	%	92			30-130	Pass	
2.4.6-Trichlorophenol	%	87			30-130	Pass	
2.6-Dichlorophenol	%	78			30-130	Pass	
3&4-Methylphenol (m&p-Cresol)	%	59			30-130	Pass	
4-Chloro-3-methylphenol	%	80			30-130	Pass	
4-Nitrophenol	%	64			30-130	Pass	
Acenaphthene	%	88			70-130	Pass	
Acenaphthylene	%	94			70-130	Pass	
Anthracene	%	75			70-130	Pass	
Benz(a)anthracene	%	99			70-130	Pass	
Benzo(a)pyrene	%	106			70-130	Pass	
Benzo(b&j)fluoranthene	%	94			70-130	Pass	
Benzo(g.h.i)perylene	%	90			70-130	Pass	
Benzo(k)fluoranthene	%	97			70-130	Pass	
Chrysene	%	99			70-130	Pass	
Dibenz(a.h)anthracene	%	121			70-130	Pass	
Fluoranthene	%	94			70-130	Pass	
Fluorene	%	96			70-130	Pass	

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Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Indeno(1.2.3-cd)pyrene			%	119			70-130	Pass	
N-Nitrosodipropylamine			%	77			75-125	Pass	
Naphthalene			%	75			70-130	Pass	
Pentachlorophenol			%	68			30-130	Pass	
Phenanthrene			%	97			70-130	Pass	
Phenol			%	32			30-130	Pass	
Pyrene			%	91			70-130	Pass	
LCS - % Recovery									
Alkalinity (speciated)									
Total Alkalinity (as CaCO3)			%	112			70-130	Pass	
LCS - % Recovery									
Total Sulphur Set (as S)									
Sulphate (as S)			%	101			70-130	Pass	
Sulphide (as S)			%	80			70-130	Pass	
LCS - % Recovery									
Nitrogens (speciated)									
Ammonia (as N)			%	99			70-130	Pass	
Nitrate (as N)			%	91			70-130	Pass	
Nitrite (as N)			%	110			70-130	Pass	
Total Kjeldahl Nitrogen (as N)			%	106			70-130	Pass	
Total Nitrogen (as N)			%	106			70-130	Pass	
LCS - % Recovery									
Alkali Metals									
Calcium			%	108			70-130	Pass	
Magnesium			%	116			70-130	Pass	
Potassium			%	102			70-130	Pass	
Sodium			%	96			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Spike - % Recovery									
				Result 1					
Chemical Oxygen Demand (COD)	M15-JI27328	NCP	%	99			70-130	Pass	
Chloride	M15-De16286	NCP	%	100			70-130	Pass	
Cyanide (total)	M15-De15969	NCP	%	87			70-130	Pass	
Cyanide (weak acid dissoc.)	M15-De07990	NCP	%	89			70-130	Pass	
Fluoride	M15-De11530	NCP	%	89			70-130	Pass	
Phosphate ortho (as P)	M15-De16309	NCP	%	100			70-130	Pass	
Phosphate total (as P)	B15-De13949	NCP	%	83			70-130	Pass	
Spike - % Recovery									
Semivolatile Organics				Result 1					
2-Chlorophenol	M15-De15572	NCP	%	105			30-130	Pass	
2-Methylphenol (o-Cresol)	M15-De15572	NCP	%	107			30-130	Pass	
2-Nitrophenol	M15-De15572	NCP	%	115			30-130	Pass	
2.4-Dichlorophenol	M15-De15572	NCP	%	111			30-130	Pass	
2.4-Dimethylphenol	M15-De15572	NCP	%	103			30-130	Pass	
2.4.5-Trichlorophenol	M15-De15572	NCP	%	88			30-130	Pass	
2.4.6-Trichlorophenol	M15-De15572	NCP	%	43			30-130	Pass	
2.6-Dichlorophenol	M15-De15572	NCP	%	72			30-130	Pass	
3&4-Methylphenol (m&p-Cresol)	M15-De15572	NCP	%	109			30-130	Pass	
4-Chloro-3-methylphenol	M15-De15572	NCP	%	98			30-130	Pass	
4-Nitrophenol	M15-De15572	NCP	%	129			30-130	Pass	
Acenaphthene	S15-De12086	NCP	%	73			70-130	Pass	
Acenaphthylene	S15-De12086	NCP	%	77			70-130	Pass	
Anthracene	S15-De12086	NCP	%	88			70-130	Pass	
Benz(a)anthracene	S15-De12086	NCP	%	79			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Benzo(a)pyrene	S15-De12086	NCP	%	86			70-130	Pass	
Benzo(b&j)fluoranthene	S15-De12086	NCP	%	75			70-130	Pass	
Benzo(g.h.i)perylene	S15-De12086	NCP	%	74			70-130	Pass	
Benzo(k)fluoranthene	S15-De12086	NCP	%	75			70-130	Pass	
Chrysene	S15-De12086	NCP	%	79			70-130	Pass	
Dibenz(a.h)anthracene	S15-De12086	NCP	%	98			70-130	Pass	
Fluoranthene	S15-De12086	NCP	%	74			70-130	Pass	
Fluorene	S15-De12086	NCP	%	76			70-130	Pass	
Indeno(1.2.3-cd)pyrene	S15-De12086	NCP	%	96			70-130	Pass	
Naphthalene	S15-De12086	NCP	%	74			70-130	Pass	
Phenanthrene	S15-De12086	NCP	%	75			70-130	Pass	
Phenol	M15-De15572	NCP	%	90			30-130	Pass	
Pyrene	S15-De12086	NCP	%	74			70-130	Pass	
Spike - % Recovery									
Alkalinity (speciated)				Result 1					
Bicarbonate Alkalinity (as CaCO3)	M15-De15171	NCP	%	96			70-130	Pass	
Total Alkalinity (as CaCO3)	M15-De13661	NCP	%	112			70-130	Pass	
Spike - % Recovery									
Total Sulphur Set (as S)				Result 1					
Sulphate (as S)	M15-De12492	NCP	%	94			70-130	Pass	
Spike - % Recovery									
Nitrogens (speciated)				Result 1					
Ammonia (as N)	M15-De11770	NCP	%	101			70-130	Pass	
Nitrate (as N)	M15-De11770	NCP	%	95			70-130	Pass	
Nitrite (as N)	M15-De11770	NCP	%	105			70-130	Pass	
Spike - % Recovery									
Alkali Metals				Result 1					
Calcium	S15-De10350	NCP	%	97			70-130	Pass	
Magnesium	S15-De10350	NCP	%	95			70-130	Pass	
Potassium	S15-De10350	NCP	%	88			70-130	Pass	
Sodium	M15-De14933	NCP	%	106			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
Chemical Oxygen Demand (COD)	M15-De12338	CP	mg/L	2900	3000	2.0	30%	Pass	
Chloride	M15-De16285	NCP	mg/L	110	100	1.5	30%	Pass	
Chlorine (free)	M15-De11503	NCP	mg/L	31	33	6.0	30%	Pass	
Colour(Pt/Co) true	B15-De11914	NCP	Pt/Co unit	15	15	<1	30%	Pass	
Conductivity (at 25°C)	M15-De12492	NCP	uS/cm	4000	4000	1.0	30%	Pass	
Cyanide (total)	M15-De15969	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Cyanide (weak acid dissoc.)	M15-De07990	NCP	mg/L	0.028	0.018	16	30%	Pass	
Fluoride	M15-De11530	NCP	mg/L	< 0.5	< 0.5	<1	30%	Pass	
Formaldehyde	M15-De12426	NCP	mg/L	2.1	1.9	9.9	30%	Pass	
pH	M15-De12492	NCP	pH Units	7.9	7.9	pass	30%	Pass	
Phosphate ortho (as P)	M15-De16285	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Phosphate total (as P)	B15-De13949	NCP	mg/L	0.26	0.28	9.0	30%	Pass	
Total Dissolved Solids	M15-De12338	CP	mg/L	32000	31000	3.0	30%	Pass	
Total Organic Carbon	M15-De13301	NCP	mg/L	< 5	< 5	<1	30%	Pass	
Duplicate									
Volatile Organics				Result 1	Result 2	RPD			
1.1-Dichloroethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.1-Dichloroethene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.1.1-Trichloroethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.1.1.2-Tetrachloroethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	

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Duplicate									
Volatile Organics				Result 1	Result 2	RPD			
1.1.2-Trichloroethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.1.2.2-Tetrachloroethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.2-Dibromoethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.2-Dichlorobenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.2-Dichloroethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.2-Dichloropropane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.2.3-Trichloropropane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.2.4-Trimethylbenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.3-Dichlorobenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.3-Dichloropropane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.3.5-Trimethylbenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.4-Dichlorobenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
2-Butanone (MEK)	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
2-Propanone (Acetone)	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
4-Chlorotoluene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
4-Methyl-2-pentanone (MIBK)	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Allyl chloride	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Bromobenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Bromochloromethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Bromodichloromethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Bromoform	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Bromomethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Carbon disulfide	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Carbon Tetrachloride	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Chlorobenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Chloroethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Chloroform	M15-De12429	NCP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Chloromethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
cis-1.2-Dichloroethene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
cis-1.3-Dichloropropene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Dibromochloromethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Dibromomethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Dichlorodifluoromethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Ethylbenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Iodomethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Isopropyl benzene (Cumene)	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
m&p-Xylenes	M15-De12429	NCP	mg/L	< 0.002	< 0.002	<1	30%	Pass	
Methylene Chloride	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
o-Xylene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Styrene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Tetrachloroethene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Toluene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
trans-1.2-Dichloroethene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
trans-1.3-Dichloropropene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Trichloroethene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Trichlorofluoromethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Vinyl chloride	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Xylenes - Total	M15-De12429	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	

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Duplicate									
Semivolatile Organics				Result 1	Result 2	RPD			
2-Methyl-4.6-dinitrophenol	S15-De12085	NCP	mg/L	< 0.03	< 0.03	<1	30%	Pass	
1-Chloronaphthalene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1-Naphthylamine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.2-Dichlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.2.3-Trichlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.2.3.4-Tetrachlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.2.3.5-Tetrachlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.2.4-Trichlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.2.4.5-Tetrachlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.3-Dichlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.3.5-Trichlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.4-Dichlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2-Chloronaphthalene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2-Chlorophenol	S15-De12085	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
2-Methylnaphthalene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2-Methylphenol (o-Cresol)	S15-De12085	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
2-Naphthylamine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2-Nitroaniline	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2-Nitrophenol	S15-De12085	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2-Picoline	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2.3.4.6-Tetrachlorophenol	M15-De18212	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
2.4-Dichlorophenol	S15-De12085	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
2.4-Dimethylphenol	S15-De12085	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
2.4-Dinitrophenol	S15-De12085	NCP	mg/L	< 0.03	< 0.03	<1	30%	Pass	
2.4-Dinitrotoluene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2.4.5-Trichlorophenol	S15-De12085	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2.4.6-Trichlorophenol	S15-De12085	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2.6-Dichlorophenol	S15-De12085	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
2.6-Dinitrotoluene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
3&4-Methylphenol (m&p-Cresol)	S15-De12085	NCP	mg/L	< 0.006	< 0.006	<1	30%	Pass	
3-Methylcholanthrene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
3.3'-Dichlorobenzidine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
4-Aminobiphenyl	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
4-Bromophenyl phenyl ether	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
4-Chloro-3-methylphenol	S15-De12085	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
4-Chlorophenyl phenyl ether	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
4-Nitrophenol	S15-De12085	NCP	mg/L	< 0.03	< 0.03	<1	30%	Pass	
4.4'-DDD	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
4.4'-DDE	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
4.4'-DDT	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
7.12-Dimethylbenz(a)anthracene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
a-BHC	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Acenaphthene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Acenaphthylene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Acetophenone	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Aldrin	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Aniline	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Anthracene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
b-BHC	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Benz(a)anthracene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(a)pyrene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(b&j)fluoranthene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(g.h.i)perylene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(k)fluoranthene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	

Duplicate									
Semivolatile Organics				Result 1	Result 2	RPD			
Benzyl chloride	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Bis(2-chloroethoxy)methane	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Bis(2-chloroisopropyl)ether	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Bis(2-ethylhexyl)phthalate	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Butyl benzyl phthalate	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Chrysene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
d-BHC	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Di-n-butyl phthalate	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Di-n-octyl phthalate	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Dibenz(a.h)anthracene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Dibenz(a.j)acridine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Dibenzofuran	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Dieldrin	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Diethyl phthalate	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Dimethyl phthalate	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Dimethylaminoazobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Diphenylamine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Endosulfan I	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Endosulfan II	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Endosulfan sulphate	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Endrin	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Endrin aldehyde	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Endrin ketone	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Fluoranthene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Fluorene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
g-BHC (Lindane)	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Heptachlor	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Heptachlor epoxide	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Hexachlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Hexachlorobutadiene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Hexachlorocyclopentadiene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Hexachloroethane	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Indeno(1.2.3-cd)pyrene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Methoxychlor	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
N-Nitrosodibutylamine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
N-Nitrosodipropylamine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
N-Nitrosopiperidine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Naphthalene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Nitrobenzene	M15-De18212	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Pentachlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Pentachloronitrobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Pentachlorophenol	S15-De12085	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Phenanthrene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Phenol	S15-De12085	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
Pronamide	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Pyrene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Trifluralin	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	B15-De11621	NCP	mg/L	< 20	< 20	<1	30%	Pass	
Carbonate Alkalinity (as CaCO3)	B15-De11621	NCP	mg/L	< 10	< 10	<1	30%	Pass	
Hydroxide Alkalinity (as CaCO3)	B15-De11621	NCP	mg/L	< 10	< 10	<1	30%	Pass	
Total Alkalinity (as CaCO3)	B15-De11621	NCP	mg/L	< 20	< 20	<1	30%	Pass	

Duplicate									
Total Sulphur Set (as S)				Result 1	Result 2	RPD			
Sulphate (as S)	M15-De16285	NCP	mg/L	60	60	<1	30%	Pass	
Sulphide (as S)	M15-De09731	NCP	mg/L	0.10	0.10	<1	30%	Pass	
Sulphite (as S)	M15-De12338	CP	mg/L	< 5	< 5	<1	30%	Pass	
Thiosulphate (as S)	M15-De12338	CP	mg/L	< 10	< 10	<1	30%	Pass	
Duplicate									
Nitrogens (speciated)				Result 1	Result 2	RPD			
Ammonia (as N)	M15-De11770	NCP	mg/L	0.02	0.02	7.0	30%	Pass	
Nitrate (as N)	M15-De11770	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Nitrite (as N)	M15-De11770	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Duplicate									
Alkali Metals				Result 1	Result 2	RPD			
Calcium	S15-De10350	NCP	mg/L	41	40	2.0	30%	Pass	
Magnesium	S15-De10350	NCP	mg/L	49	48	1.0	30%	Pass	
Potassium	S15-De10350	NCP	mg/L	< 5	< 5	<1	30%	Pass	
Sodium	M15-De14933	NCP	mg/L	560	540	4.0	30%	Pass	

Comments

1,2-Diphenylhydrazine: Conducted by SGS Leeder Consulting, Report number M152819

Mercaptans: Conducted by ACS Laboratories, Report number ACS1612541

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	Yes

Qualifier Codes/Comments

Code	Description
G01	The LORs have been raised due to matrix interference
M10	NATA accreditation does not cover the performance of this service in soil matrices
N07	Please note:- These two PAH isomers closely co-elute using the most contemporary analytical methods and both the reported concentration (and the TEQ) apply specifically to the total of the two co-eluting PAHs

Authorised By

Charl Du Preez	Analytical Services Manager
Emily Rosenberg	Senior Analyst-Metal (VIC)
Harry Bacalis	Senior Analyst-Volatile (VIC)
Huong Le	Senior Analyst-Inorganic (VIC)
Mele Singh	Senior Analyst-Organic (VIC)

Glenn Jackson

National Operations Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Uncertainty data is available on request

ACS Laboratories (Australia)
ABN: 85 708 233 006

37 Stubbs Street
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W www.acslab.com.au

12 January 2016 **Report No: ACS1612541**

Charl Du Preez
Eurofins MGT
2-5 Kingston Town Close
Oakleigh, Vic 3164

Dear Charl

Date of Sample Receipt: 14th December 2015
No. of Samples Received: 1
MGT-LabMark Ref: 483138

Results (mg/L)

Analyte	**ID: DE12338**
	Lab No: 12541-1
Methyl Mercaptan	<0.05
Ethyl Mercaptan	<0.05
Isobutyl Mercaptan	<0.05
Propyl Mercaptan	<0.05
Butyl Mercaptan	<0.05

Method: ACS-TM-AM 125.

Comment
Benzene Detected

Yours faithfully,
ACS Laboratories (Australia)

Vince Murone
Principal Chemist

SGS LEEDER CONSULTING

A.B.N. 44 000 964 278
3 - 5, 18 Redland Drive
Mitcham, Vic, 3132
Telephone: (03) 9874 1988
Fax: (03) 9874 1933

Chartered Chemists

REPORT NUMBER: M152819

21-Dec-2015

Site/Client Ref: 483138

Order No: 483138 15/1409

Eurofins /MGT

3 Kingston Town Close
Oakleigh
VIC 3166
Attention: Charl Du Preez

CERTIFICATE OF ANALYSIS

SAMPLES:	Two samples were received for analysis
DATE RECEIVED:	**14-Dec-2015**
DATE COMMENCED:	**14-Dec-2015**
METHODS:	See Attached Results
RESULTS:	Please refer to attached pages for results.

Note: Results are based on samples as received at SGS Leeder Consulting's laboratories

REPORTED BY:

Adam Atkinson
Business Manager

ANALYTICAL RESULTS

Matrix: Water
Method: USEPA 8270C.WW.ADD.00 Additional SVOCs in water
Sample units are expressed in mg/L — Test Started: 17-Dec-15

	Leeder ID	2015034389	2015034390	2015034392
	Client ID	MW202 DE12338	MW206 DE12339	Method
Analyte Name	**Sampled Date**			
	PQL			Blank
1,2-Diphenylhydrazine	0.001	nd	nd	nd

Matrix: Water
Method: Surrogate Recovery
Sample units are expressed in % — Test Started: 17-Dec-15

	Leeder ID	2015034389	2015034390	2015034392
	Client ID	MW202 DE12338	MW206 DE12339	Method
Analyte Name	**Sampled Date**			
	PQL			Blank
Fluorobiphenyl		90	83	65

SGS LEEDER CONSULTING

Report N°: M152819

QA/QC RESULTS

Matrix: Water
Method: USEPA 8270C.WW.ADD.00 Additional SVOCs in water
Quality Control Results are expressed in Percent Recovery of expected result — Test Started: 17-Dec-15

Analyte Name			
	Leeder ID	2015034393	2015034394
	Client ID	MW202	MW202
	Sampled Date		
	PQL	Spike	Spike Dup
1,2-Diphenylhydrazine		71	76

Matrix: Water
Method: Surrogate Recovery
Quality Control Results are expressed in Percent Recovery of expected result — Test Started: 17-Dec-15

Analyte Name			
	Leeder ID	2015034393	2015034394
	Client ID	MW202	MW202
	Sampled Date		
	PQL	Spike	Spike Dup
Fluorobiphenyl		84	82

QUALIFIERS / NOTES FOR REPORTED RESULTS

PQL	Practical Quantitation Limit
nd	Not Detected – The analyte was not detected above the reported PQL.
is	Insufficient Sample to perform this analysis.
T	Tentative identification based on computer library search of mass spectra.
NC	Not calculated and/or Results below PQL
NV	No Vacuum, Canister received above standard atmospheric pressure
nr	Not Requested for analysis.
R	Rejected Result – results for this analysis failed QC checks.
SQ	Semi-Quantitative result – quantitation based on a generic response factor for this class of analyte.
IM	Inappropriate method of analysis for this compound
U	Unable to provide Quality Control data – high levels of compounds in sample interfered with analysis of QC results.
UF	Unable to provide Quality Control data- Surrogates failed QC checks due to sample matrix effects
L	Analyte detected at a level above the linear response of calibration curve.
E	Estimated result. NATA accreditation does not cover estimated results.
C1	These compounds co-elute.
--	Parameter Not Determined
CT	Elevated concentration. Results reported from carbon tube analysis
**	Sample shows non-petroleum hydrocarbon profile

SGS LEEDER CONSULTING

APPENDIX ONE.

CHAIN OF CUSTODY DOCUMENT

eurofins mgt

☒ **MELBOURNE**
Ph: +61 3 8564 5000
2-5 Kingston Town Close, Oakleigh, Vic 3164
Email: EnviroSampleVic@eurofins.com.au

☐ **BRISBANE**
Ph: +61 7 3902 4600
1/21 Smallwood Place Murarrie, Qld 4172
Email: EnviroSampleQLD@eurofins.com.au

☐ **SYDNEY**
Ph: +61 2 9900 8400
Unit F3, 16 Mars Road, Lane Cove West, NSW 2066
Email: EnviroSampleNSW@eurofins.com.au

Purchase Order for External Analysis

Eurofins | mgt Ref: 483138 **Eurofins | mgt Purchase Order:** 483138 15/1409 **Results Required:** 5 DAY **Page:** 1 of 1

Receiving Laboratory: SGS/Leeder Consulting **Eurofins | mgt Contact:** ~~Bob Symons~~ Charl Du Preez

Address: 3-5 Redland Drive
Mitcham, Vic 3132

Telephone: **Fax:**

Report results to: EnviroReports@eurofins.com.au ☒
Eurofins | mgt, P.O. Box 276, Oakleigh, Vic 3166, Australia ☐
Send invoices to: EnviroAP@eurofins.com.au ☒

Client ID	Eurofins | mgt ID	Matrix	Tests Required	
MW202	DE12338	w	1.2-Diphenylhydrazine	
MW206	DE12339	w	1.2-Diphenylhydrazine	

Total No. Samples: 2

Comments: Please identify samples using Eurofins | mgt ID and Client ID

Chain of Custody

Relinquished by:	Liam Prescott	Date/Time:	11/12/2015
Received by:	Benedict Robinson [signature]	Date/Time:	14/12/15 11:15am
Relinquished by:		Date/Time:	
Received by:		Date/Time:	

Sample Receipt Advice *(Receiving Lab Use Only)*

All Samples Received in Good Condition ☑
All Documentation in Proper Order ☐
Samples Received with an Attempt to Chill ☑
Samples Received Within Holding Times ☑

Average sample temp on receipt: (°C) 7.8

For all enquires please quote Ref. No.

Please complete this section and email a scan copy to EnviroReports@eurofins.com.au

Appendix B Estimated Leachate Generation

Leachate Flow Design Basis Summary Tables

Leachate generation – 50% AEP rainfall year			Stage/ Transition Duration (Months)	Leachate Generation												
Stage	Stage Description	Leachate Source		January (kL/mth)	February (kL/mth)	March (kL/mth)	April (kL/mth)	May (kL/mth)	June (kL/mth)	July (kL/mth)	August (kL/mth)	September (kL/mth)	October (kL/mth)	November (kL/mth)	December (kL/mth)	Annual (kL/yr)
1	Filling occurring in sub-cell 1 below ground, all	Sub-Cells - Stage 1	5	296	530	273	225	200	179	97	122	160	216	314	371	3744
	other sub-cells separated from sub-cell 1	Capped Waste Stockpile - Stage 1	5	178	318	164	135	120	107	58	73	96	130	188	222	2246
2	Filling occurring in sub-cell 2 below ground, sub-	Sub-Cells - Stage 1 to 2	2	474	848	437	360	319	286	155	195	256	346	502	593	5990
	cell 1 intermediate covered, sub-cell 3 separated	Sub-Cells - Stage 2 (after 1 to 2 transition)	3	355	636	328	270	239	214	116	146	192	259	377	445	4492
	from sub-cells 1 and 2	Capped Waste Stockpile - Stage 2	5	181	324	167	138	122	109	59	75	98	132	192	227	2291
3	Filling occurring in sub-cell 3 below ground, sub-	Sub-Cells - Stage 2 to 3	2	533	954	491	405	359	321	175	220	288	389	565	667	6738
	cell 2 intermediate covered, sub-cell 1 interim	Sub-Cells - Stage 3 (after 2 to 3 transition)	3	414	742	382	315	279	250	136	171	224	302	440	519	5241
	capped	Capped Waste Stockpile - Stage 3	5	185	331	170	140	124	111	61	76	100	135	196	231	2336
4	All cells interim capped	Sub-Cells - Stage 3 to 4	2	592	1060	546	450	399	357	194	244	320	432	628	741	7487
		Sub-Cells - Stage 4 (after 3 to 4 transition)	3	474	848	437	360	319	286	155	195	256	346	502	593	5990
		Capped Waste Stockpile - Stage 4	5	188	337	174	143	127	114	62	78	102	137	200	236	2381
Final	All cells final capped	Sub-Cells - Final capped	12	237	424	218	180	160	143	78	98	128	173	251	296	2995
		Sub-Cells - Final capped 1-2 yr	12	36	64	33	27	24	21	12	15	19	26	38	44	449
		Sub-Cells - Final capped 2-3 yr	12	5.3	9.5	4.9	4.1	3.6	3.2	1.7	2.2	2.9	3.9	5.7	6.7	67.4
		Sub-Cells - Final capped 3-4 yr	12	0.8	1.4	0.7	0.6	0.5	0.5	0.3	0.3	0.4	0.6	0.8	1.0	10.1
		Sub-Cells - Final capped 4-5 yr	12	0.12	0.21	0.11	0.09	0.08	0.07	0.04	0.05	0.06	0.09	0.13	0.15	1.52
		Sub-Cells - Final capped + 5 yr	12	0.024	0.042	0.022	0.018	0.016	0.014	0.008	0.010	0.013	0.017	0.025	0.030	0.299

Leachate generation – 90% AEP rainfall year			Stage/ Transition Duration (Months)	Leachate Generation												
Stage	Stage Description	Leachate Source		January (kL/mth)	February (kL/mth)	March (kL/mth)	April (kL/mth)	May (kL/mth)	June (kL/mth)	July (kL/mth)	August (kL/mth)	September (kL/mth)	October (kL/mth)	November (kL/mth)	December (kL/mth)	Annual (kL/yr)
1	Filling occurring in sub-cell 1 below ground, all	Sub-Cells - Stage 1	5	**760**	**974**	**637**	**598**	**396**	**549**	**265**	**388**	**485**	**496**	**718**	**702**	**4855**
	other sub-cells separated from sub-cell 1	Capped Waste Stockpile - Stage 1	5	456	584	382	359	238	329	159	233	291	297	431	421	2913
2	Filling occurring in sub-cell 2 below ground, sub-	Sub-Cells - Stage 1 to 2	2	1216	1558	1019	956	634	878	424	620	776	793	1148	1123	7767
	cell 1 intermediate covered, sub-cell 3 separated	Sub-Cells - Stage 2 (after 1 to 2 transition)	3	912	1169	764	717	475	659	318	465	582	595	861	842	5825
	from sub-cells 1 and 2	Capped Waste Stockpile - Stage 2	5	465	596	390	366	242	336	162	237	297	303	439	430	2971
3	Filling occurring in sub-cell 3 below ground, sub-	Sub-Cells - Stage 2 to 3	2	1368	1753	1147	1076	713	988	477	698	873	892	1292	1264	8738
	cell 2 intermediate covered, sub-cell 1 interim	Sub-Cells - Stage 3 (after 2 to 3 transition)	3	1064	1364	892	837	554	769	371	543	679	694	1005	983	6796
	capped	Capped Waste Stockpile - Stage 3	5	474	608	397	373	247	343	165	242	303	309	448	438	3029
4	All cells interim capped	Sub-Cells - Stage 3 to 4	2	1520	1948	1274	1195	792	1098	530	775	970	991	1435	1404	9709
		Sub-Cells - Stage 4 (after 3 to 4 transition)	3	1216	1558	1019	956	634	878	424	620	776	793	1148	1123	7767
		Capped Waste Stockpile - Stage 4	5	483	619	405	380	252	349	169	246	308	315	456	446	3087
Final	All cells final capped	Sub-Cells - Final capped	12	608	779	510	478	317	439	212	310	388	396	574	562	3884
		Sub-Cells - Final capped 1-2 yr	12	91	117	76	72	48	66	32	47	58	59	86	84	583
		Sub-Cells - Final capped 2-3 yr	12	13.7	17.5	11.5	10.8	7.1	9.9	4.8	7.0	8.7	8.9	12.9	12.6	87.4
		Sub-Cells - Final capped 3-4 yr	12	2.1	2.6	1.7	1.6	1.1	1.5	0.7	1.0	1.3	1.3	1.9	1.9	13.1
		Sub-Cells - Final capped 4-5 yr	12	0.31	0.39	0.26	0.24	0.16	0.22	0.11	0.16	0.20	0.20	0.29	0.28	1.97
		Sub-Cells - Final capped + 5 yr	12	0.061	0.078	0.051	0.048	0.032	0.044	0.021	0.031	0.039	0.040	0.057	0.056	0.388

Appendix C Australian Sewage Quality Management Guidelines

3. Determine the local trade waste guideline concentration based on Best Economically Available Reasonable Pre treatment Technology (BEARPIT)

Local trade waste guideline concentration = 1.0 mg/L

4. Determine the local trade waste guideline concentration

Comparing guideline concentrations determined in Steps 2 and 3, the trade waste mass load based guideline concentration is the limiting aspect for nickel in this sewage system with the trade waste guideline concentration for nickel = 0.47 mg/L.

5. Determine the nickel upper daily mass load for a trade waste customer

The trade waste mass load allocation is 341 gram/day.

Upper daily mass load = trade waste mass load allocation / maximum number of nickel dischargers
= 341 gram/day / 6 customers
= 57 gram/day per customer

Implementation

The upper daily mass load may be used in conjunction with the trade waste guideline concentration to establish a comprehensive local trade waste acceptance criterion for nickel as follows:

- For mass discharges up to 57 gram/day, the local trade waste guideline concentration of 0.47 mg/L applies.
- The mass discharge must not exceed 57 gram/day, irrespective of concentration. Additional preventative measures will be needed to reduce the mass load if the discharge exceeds 57 gram/day.

Table C3: Guideline concentrations for discharge to sewerage systems

Fact sheet no.*	Parameter	Primary basis for guideline concentration	Guideline concentration (mg/L)	Typical sewage concentration influent value (mg/L)	Analytical method reference APHA Method
NA	Acetaldehyde	worker safety	5	<0.001	
NA	Acetone	worker safety	400	<0.001	
2	Ammonia	worker safety	100[1]	50	4500-NH3-B
NA	Benzene	worker safety	<0.001	<0.001	6200
NA	Chloroform	worker safety	0.1	<0.001	
NA	Dimethyl sulphide	odour	1		
NA	Ethylbenzene	worker safety	1	<0.001	6200
22	Sulphide - dissolved	asset protection	1	1	4500S2-C&D or E
10	Flammable / explosive substances	flammability	5% LEL		
11	Formaldehyde	worker safety	30	<DL	
NA	Gross solids – non-faecal	asset protection	13 mm QSV<3m/hr	N/A	

NA	Halogenated volatile organic compounds – total	worker safety	1[2]	<0.001	6200B
NA	Methyl mercaptan	odour	1	<0.1	NA
NA	Methyl Ethyl Ketone (MEK)	worker safety	100	<0.001	
NA	Perchloroethylene				
NA	Petroleum hydrocarbons C6-C9	flammability	5		USEPA 8015B USEPA 8260B
NA	Propionaldehyde	worker safety	5	<0.001	
17	pH	asset protection	6 to 10	7.5	
NA	Radioactive isotopes	worker safety	site specific		
NA	Sulphite	asset protection	15		4500BSO3B
22	Temperature	worker safety and asset protection	< 38ºC	22ºC	
NA	Toluene	worker safety	0.5		6200
NA	Trichloroethylene	worker safety	0.1	<0.001	
NA	Xylene (o)	worker safety	1		6200

[1] Henry's Law assessment based on a maximum sewer pH of 8.8
[1] Henry's Law assessment based on the common volatile organic compound, Methylene Chloride

Table C4: BEARPIT threshold values

Fact sheet no.	Parameter	BEARPIT	Guideline concentration (mg/L)	Typical sewage concentration influent value (mg/L)	Analytical method reference APHA Method
1	Aluminium	chemical precipitation (hydroxide)	100	1.5	3120B
NA	Arsenic	chemical precipitation (iron and hydroxide)	0.5	0.002	3114B
NA	Barium	chemical precipitation	5	0.05	3120B
3	Biochemical oxygen demand	N/A (Designed to be removed via sewage treatment)	To be determined - site specific	325	5210B
4	Boron	chemical precipitation	5	0.3	3120B
NA	Bromine - free	air-stripping	5		DPD-colorimetric test kit
5	Cadmium	chemical precipitation (iron - hydroxide)	1	0.0005	3120B
3	Chemical oxygen demand (COD)	N/A (designed to be removed via sewage treatment)	To be determined - site specific	800	
NA	Chlorine - Free	air-stripping	10	<DL	DPD-colorimetric test kit
6	Chromium (total)	Reduction (SMBS) and chemical precipitation (hydroxide)	3	0.03	3120B
NA	Cobalt	chemical precipitation	5	0.002	3120B
7	Colour	chemical oxidation (ozone)	100 (Pt–Co)	90	
8	Copper	chemical precipitation (hydroxide)	5	0.13	3120B
9	Cyanide - weak and dissociable	alkaline chlorination	1		4500-CN-G and E
NA	Fluoride	chemical precipitation (calcium)	30	0.3	4500-F-C
NA	Genetically engineered/ modified organisms	cleaner production	To be determined - site specific		
NA	Iron	chemical precipitation (hydroxide)	10	1.6	3120B
	Lead	chemical precipitation(carbonate or hydroxide)	1	0.01	3120B
12	Lithium	chemical precipitation	10		3120B
NA	Manganese	chemical oxidation, precipitation, clarification	10	0.15	3120B

Fact sheet no.	Parameter	BEARPIT	Guideline concentration (mg/L)	Typical sewage concentration influent value (mg/L)	Analytical method reference APHA Method
NA	Methylene blue active substances	cleaner production	100	2	
NA	Mercury	chemical precipitation (iron) ion exchange carbon adsorption	.01	0.0001	3112B
NA		mercury amalgam trap[3]	??		
NA	Molybdenum	chemical precipitation	5	0.01	3120B
NA	Non-ionic surfactants	cleaner production	100	2	
NA	Nickel	chemical precipitation (hydroxide)	1	0.03	3120B
13	Oil and grease - non hydrocarbon (TOG - TPH)	grease trap	200	60	USEPA1664
16	Organic nitrogen (TKN-Ammonia)	cleaner production	150	20	4500-Norg B or C
14	Organoarsenic compounds	cleaner production	0.1		NA
NA	Organochlorine pesticides	N/A (Hazardous Waste)	prohibited discharge		6410B
NA	Organophosphate pesticides	adsorption (activated carbon) and chemical oxidation (H2O2)	prohibited discharge		6410B
NA	Petroleum hydrocarbons - total	CPI or VGS	30		USEPA 8015B USEPA 8260B
NA	Phenolic compounds - non-halogenated	chemical oxidation	1		6410B
18	Phosphorous - total	N/A (designed to be removed via sewage treatment)	To be determined - site specific	13	4500P-I & 4500P-F
19	Polybrominated biphenyls (PBB's)	N/A (hazardous waste)	prohibited discharge		6200B
NA	Polychlorinated biphenyls (PCB's)	N/A (hazardous waste)	prohibited discharge		6200B
	Polynuclear aromatic hydrocarbons	adsorption (activated carbon) and chemical oxidation (H2O2)	5		6410B & 6440
NA	Selenium	chemical precipitation (sulphide)	1	0.001	3120B

[33] Dental Industry only

Fact sheet no.	Parameter	BEARPIT	Guideline concentration (mg/L)	Typical sewage concentration influent value (mg/L)	Analytical method reference APHA Method
NA	Silver	silver recovery unit	50		3120B
20	Sulphate	chemical precipitation (calcium)	2000 [4]	100	3120B
21	Suspended solids	N/A (Designed to be removed via sewage treatment)	To be determined - site specific	350	2540D
22	Temperature	equalisation heat exchange	< 38ºC	22ºC	
15	Tin	chemical precipitation	10	0.004	3120B
23	Total dissolved solids (TDS)	cleaner production	5000	850	2510B
24	Zinc	chemical precipitation (hydroxide)	1	0.2	3120B
25					
26					

Table C5: Typical threshold concentrations (mg/L) for common substances in sewage that are known to inhibit activated sludge, nitrification and anaerobic digestion processes.

Pollutant	Activated Sludge	Anaerobic Digestion	Nitrification
Acenaphthene	NI# at 10	Not Available	Not Available
Acrolein	NI at 62	Not Available	Not Available
Acrylonitrile	NI at 152	5	Not Available
Ammonia	480	1500-3000	Not Available
Arsenic	0.04-0.4	0.1-1	Not Available
Benzene	125	Not Available	Not Available
Benzidine	5	S	Not Available
Boron	0.05-10	2	Not Available
Cadmium	0.5-10	0.02-1	5-9
Calcium	2500	Not Available	Not Available
Carbon tetrachloride	NI at 10	2.9	Not Available
Chlorobenzene	NI at 1	0.96	Not Available
1,2,4-tridilorobenzene	NI at 6	Not Available	Not Available
Hezachlorobenzene	5	Not Available	Not Available
1,2-dichloroethane	NI at 258	1	Not Available
1,1,1-trichloroethane	NI at 10	Not Available	Not Available
Hexachloroethane	NI at 10	Not Available	Not Available
1,1-dichloroethane	NI at 10	Not Available	Not Available

[4] Measured as SO4-S

Pollutant	Activated Sludge	Anaerobic Digestion	Nitrification
1,1,2-trichloroethane	NI at 5	Not Available	Not Available
1,1,2,2-tetrachloroethane	NI at 201	20	Not Available
Bis-(2-chloroethyl)ether	NI at 10	Not Available	Not Available
2-chloroethyl vinyl ether	NI at 10	Not Available	Not Available
2-chloranaphthalene	NI at 10	Not Available	Not Available
2,4,6-trichlorophenol	50	Not Available	Not Available
Pata-chloro-meta-cresol	NI at 10	Not Available	Not Available
Chloroform	NI at 10	1	10
2-chlorophenol	NI at 10	Not Available	Not Available
1,2-dichlorobenzene	5	0.23	Not Available
1,3-dichlorobenzene	5	Not Available	Not Available
1,4-dichlorobenzene	5	1.4	Not Available
1,1 -dichloroethylene	NI at 10	Not Available	Not Available
1,2-trans-dichloroethylene	NI at 10	Not Available	Not Available
2,4-dichlorophenol	NI at 75	Not Available	Not Available
1,2-dichloropropane	NI at 182	Not Available	Not Available
1,3-dichloropropylene	NI at 10	Not Available	Not Available
2,4-dimethylphenol	NI at 10	Not Available	Not Available
2,4-dinitrotoluene	5	Not Available	Not Available
2,6-dinitrotoluene	5	Not Available	Not Available
1,2-diphenylhydrazine	5	Not Available	Not Available
Ethylbenzene	NI at 10	Not Available	Not Available
Fluoroanthene	NI at 5	Not Available	Not Available
bis-(2-chloroisopropyl)ether	NI at 10	Not Available	Not Available
Chloride	Not Available	20000	180
Chloromethane	NI at 180	3..3	Not Available
Methylene chloride	Not Available	100	Not Available
Chloroform	NI at 10	Not Available	Not Available
Dichlorobromomethane	NI at 10	Not Available	Not Available
Trichlorofluoromethane	NI at 10	0.7	Not Available
Chlorodibramomethane	NI at 10	Not Available	Not Available
Hexachlorobutadiene	NI at 10	Not Available	Not Available
Hexachlorocyclopentadiene	NI at 10	Not Available	Not Available
Chromium (Tot.)	0.1-20	1.5-50	0.25-1
Chromium (Hex.)	1	50	Not Available
Copper	0.1-1	0.5-100	0.05-0.5
Iodine	10	Not Available	Not Available
Iron	5-500	5	Not Available
Isophorone	NI at 15.4	Not Available	Not Available

Pollutant	Activated Sludge	Anaerobic Digestion	Nitrification
Lead	0.1-10	50-250	0.5-1.7
Manganese	10	Not Available	Not Available
Magnesium	Not Available	1000	50
Mercury	0.1-5	1400	2-12.5
Napthalene	500	Not Available	Not Available
Nickel	1-5	2-200	0.25-5
Nitrobenzene	500	Not Available	Not Available
2-nitrophenol	NI at 10	Not Available	Not Available
4-nitrophenol	NI at 10	Not Available	Not Available
2,4-dinitrophenol	1	Not Available	Not Available
N-nitrosodiphenylamine	NI at 10	Not Available	Not Available
N-nitraso-di-N-propylamine	NI at 10	Not Available	Not Available
Pentachlorophenol	0.95	0.2	Not Available
Phenol	200	Not Available	4
Bis-(2-ethyl hexyl)phthalate	NI at 10	Not Available	Not Available
Butyl benzyl phthalate	NI at 10	Not Available	Not Available
Di-n-butyl phthalate	NI at 10	Not Available	Not Available
Di-N-octyl phthalate	NI at 16..3	Not Available	Not Available
Diethyl phthalate	NI at 10	Not Available	Not Available
Dimethyl phthalate	NI at 10	Not Available	Not Available
Chrysene	NI at 5	Not Available	Not Available
Acenaphthylene	NI at 10	Not Available	Not Available
Anthracene	500	Not Available	Not Available
Fluotene	NI at 10	Not Available	Not Available
Phenanthrene	500	Not Available	Not Available
Pyrene	NI at 5	Not Available	Not Available
Tetrachloroethylene	NI at 10	20	Not Available
Toluene	NI at 35	Not Available	Not Available
Trichloroethylene	NI at 10	20	Not Available
Aroclor-1242	NI at 1	Not Available	Not Available
Aroclor-1254	NI at 1	Not Available	Not Available
Aroclor-1221	NI at 1	Not Available	Not Available
Aroclor-1232	NI at 10	Not Available	Not Available
Aroclor-1016	NI at 1	Not Available	Not Available
Silver	0.03-5	Not Available	0.25
Sodium	Not Available	3500	Not Available
Sulphide	50	50-100	Not Available
Tin	Not Available	9	Not Available
Vanadium	20	Not Available	Not Available
Zinc	0.3-20	1-10	0.01-1

Key: NI – No Inhibition at the nominated concentrations

Table C6: Typical substance removal rates through an extended aeration activated sludge treatment plant.

Substances	Removal Efficiency	Type
Alkalinity	52%	Inorganic
Aluminium	99%	Inorganic
Ammonia	100%	Inorganic
Arsenic	77%	Inorganic
Barium	91%	Inorganic
Biochemical Oxygen Demand	99.9%	
Cadmium	84%	Inorganic
Calcium	18%	Inorganic
Chromium	65%	Inorganic
Copper	93%	Inorganic
Iron	96%	Inorganic
Lead	85%	Inorganic
Magnesium	18%	Inorganic
Manganese	68%	Inorganic
Mercury	87%	Inorganic
Methylene Blue Anionic Surfactants	87%	
Nickel	52%	Inorganic
Ortho-Phosphorus	54%	Inorganic
pH	No Reduction	
Potassium	9%	Inorganic
Sodium	No Reduction	Inorganic
Suspended Solids	99%	
Total Nitrogen	95%	Inorganic
Total Phosphorus	65%	Inorganic
Zinc	69%	Inorganic
Acrylonitrile	99%	Volatile Organic Carbon
Benzene	100%	Volatile Organic Carbon
Bromomethane	100%	Volatile Organic Carbon
Bromodichloromethane	100%	Volatile Organic Carbon

Substances	Removal Efficiency	Type
Carbon Tetrachloride	100%	Volatile Organic Carbon
Chlorobenzene	56%	Volatile Organic Carbon
Chloroethane	91%	Volatile Organic Carbon
Chloroform	99%	Volatile Organic Carbon
Dibromochloromethane	100%	Volatile Organic Carbon
1,1 Dichloroethane	79%	Volatile Organic Carbon
1,2 Dichloroethane	99%	Volatile Organic Carbon
1,1 Dichloroethene	100%	Volatile Organic Carbon
1,2 Dichloroethene	98%	Volatile Organic Carbon
1,2 Dichloropropane	97%	Volatile Organic Carbon
1,3 Dichloropropane	98%	Volatile Organic Carbon
Ethyl acetate	98%	Volatile Organic Carbon
Ethylbenzene	99%	Volatile Organic Carbon
Methylene Chloride	75%	Volatile Organic Carbon
1,1,2,2 Tetrachloroethane	93%	Volatile Organic Carbon
1,1,2,2 Tetrachloroethene	27%	Volatile Organic Carbon
1,1,1 Trichloroethane	38%	Volatile Organic Carbon
1,1,2 Trichloroethane	72%	Volatile Organic Carbon
Trichloroethene	40%	Volatile Organic Carbon
Toluene	100%	Volatile Organic Carbon
Vinyl Chloride	100%	Volatile Organic Carbon
Acenaphthene	95%	Base / Neutral Compounds
Acenaphthylene	93%	Base / Neutral Compounds
Anthracene	97%	Base / Neutral Compounds
Benzo (a) anthracene	56%	Base / Neutral Compounds
Bis (2-ethylhexyl) phthalates	64%	Base / Neutral Compounds
Di-n-butylphthalate	99%	Base / Neutral Compounds
1,3 Dichlorobenzene	100%	Base / Neutral Compounds
1,2 Dichlorobenzene	94%	Base / Neutral Compounds
Diethylphthalate	99%	Base / Neutral Compounds
Dimethylphthalate	99%	Base / Neutral Compounds

Substances	Removal Efficiency	Type
Dioctylphthalate	90%	Base / Neutral Compounds
Fluoranthene	83%	Base / Neutral Compounds
Isophorone	100%	Base / Neutral Compounds
Naphthalene	100%	Base / Neutral Compounds
Nitrobenzene	98%	Base / Neutral Compounds
Phananthrene	98%	Base / Neutral Compounds
Pyrene	84%	Base / Neutral Compounds
1,2,4 Trichlorobenzene	82%	Acid Compounds
2 Chlorophenol	41%	Acid Compounds
2,4 Dichlorophenol	91%	Acid Compounds
2,4 Dimethylphenol	100%	Acid Compounds
2,4 Dinitrophenol	84%	Acid Compounds
2 Nitrophenol	77%	Acid Compounds
Pentachlorophenol	36%	Acid Compounds
Phenol	98%	Acid Compounds
2,4,6 Trichlorophenol	45%	Acid Compounds

Sewage quality within a typical domestic catchment in City West Water's service area is provided in Table C7. The sewer services predominantly domestic and commercial catchments within a growth area in Melbourne's Western suburbs. Water restrictions were in place during the sampling. Samples were obtained over 2 x 14 day periods in 2006 and 2007. The data is representative of the daily composite samples taken over 2 x 14 day periods.

Table C7: Typical concentrations for common substances in 'domestic' sewage (Source: City West Water's data).

Parameter	Average Concentration (mg/L)
Antimony	ND
Barium	0.027
Beryllium	ND
Boron	0.134
Chromium	0.006*
Cobalt	ND
Copper	0.118
Manganese	0.038
Molybdenum	ND
Nickel	0.006*
Selenium	0.008*
Silver	ND
Strontium	0.041
Thallium	ND
Tin	0.007
Titanium	0.023
Vanadium	ND
Zinc	0.120
Arsenic	0.002*
Cadmium	ND
Lead	0.003*
Mercury	ND
Calcium	11.493
Iron	0.486
Magnesium	3.890
Potassium	17.907
Sodium	78.018
Biological Oxygen Demand	287.286
chemical Oxygen Demand	657.024
Cyanide	0.010*
Electrical Conductivity	842.393
pH	7.275
Bicarbonate Alkalinity	300.500
Ammonia Nitrogen	45.324
Grease & Oil	60.357
Chloride	44.348
fluoride	0.62*
Phosphate	25.229
Sulphate	31.919
Total Kjeldahl Nitrogen	53.500
Total Nitrogen	59.802
Organic Total Dissolved Solids	121.536
Total Suspended solids	326.010
Sulphide	0.147
Total organic carbon	176.495
Total Phenols	0.107
Total Solids	646.167
Silica	11.786

ND – Not detected

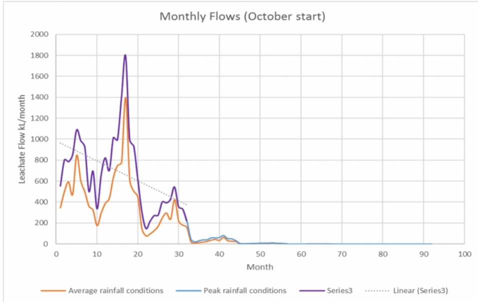
* – Represents the maximum result obtained from a measured concentration during one of the composite sampling programs and a non detect during the other program, rather than an average.

Leachate Flow Design Basis Summary Tables

Leachate generation – 50% AEP rainfall year			Stage/	Leachate Generation												
Stage	Stage Description	Leachate Source	Transition Duration (Months)	January (kL/mth)	February (kL/mth)	March (kL/mth)	April (kL/mth)	May (kL/mth)	June (kL/mth)	July (kL/mth)	August (kL/mth)	September (kL/mth)	October (kL/mth)	November (kL/mth)	December (kL/mth)	Annual (kL/yr)
1	Filling occurring in sub-cell 1 below ground, all	Sub-Cells - Stage 1	5	296	530	273	225	200	179	97	122	160	216	314	371	3744
	other sub-cells separated from sub-cell 1	Capped Waste Stockpile - Stage 1	5	178	318	164	135	120	107	58	73	96	130	188	222	2246
2	Filling occurring in sub-cell 2 below ground, sub-	Sub-Cells - Stage 1 to 2	2	474	848	437	360	319	286	155	195	256	346	502	593	5990
	cell 1 intermediate covered, sub-cell 3 separated	Sub-Cells - Stage 2 (after 1 to 2 transition)	3	355	636	328	270	239	214	116	146	192	259	377	445	4492
	from sub-cells 1 and 2	Capped Waste Stockpile - Stage 2	5	181	324	167	138	122	109	59	75	98	132	192	227	2291
3	Filling occurring in sub-cell 3 below ground, sub-	Sub-Cells - Stage 2 to 3	2	533	954	491	405	359	321	175	220	288	389	565	667	6738
	cell 2 intermediate covered, sub-cell 1 interim	Sub-Cells - Stage 3 (after 2 to 3 transition)	3	414	742	382	315	279	250	136	171	224	302	440	519	5241
	capped	Capped Waste Stockpile - Stage 3	5	185	331	170	140	124	111	61	76	100	135	196	231	2336
4	All cells interim capped	Sub-Cells - Stage 3 to 4	2	592	1060	546	450	399	357	194	244	320	432	628	741	7487
		Sub-Cells - Stage 4 (after 3 to 4 transition)	3	474	848	437	360	319	286	155	195	256	346	502	593	5990
		Capped Waste Stockpile - Stage 4	5	188	337	174	143	127	114	62	78	102	137	200	236	2381
Final	All cells final capped	Sub-Cells - Final capped	12	237	424	218	180	160	143	78	98	128	173	251	296	2995
		Sub-Cells - Final capped 1-2 yr	12	36	64	33	27	24	21	12	15	19	26	38	44	449
		Sub-Cells - Final capped 2-3 yr	12	5.3	9.5	4.9	4.1	3.6	3.2	1.7	2.2	2.9	3.9	5.7	6.7	67.4
		Sub-Cells - Final capped 3-4 yr	12	0.8	1.4	0.7	0.6	0.5	0.5	0.3	0.3	0.4	0.6	0.8	1.0	10.1
		Sub-Cells - Final capped 4-5 yr	12	0.12	0.21	0.11	0.09	0.08	0.07	0.04	0.05	0.06	0.09	0.13	0.15	1.52
		Sub-Cells - Final capped + 5 yr	12	0.024	0.042	0.022	0.018	0.016	0.014	0.008	0.010	0.013	0.017	0.025	0.030	0.299

Leachate generation – 90% AEP rainfall year			Stage/	Leachate Generation												
Stage	Stage Description	Leachate Source	Transition Duration (Months)	January (kL/mth)	February (kL/mth)	March (kL/mth)	April (kL/mth)	May (kL/mth)	June (kL/mth)	July (kL/mth)	August (kL/mth)	September (kL/mth)	October (kL/mth)	November (kL/mth)	December (kL/mth)	Annual (kL/yr)
1	Filling occurring in sub-cell 1 below ground, all	Sub-Cells - Stage 1	5	**760**	**974**	**637**	**598**	**396**	**549**	**265**	**388**	**485**	**496**	**718**	**702**	**4855**
	other sub-cells separated from sub-cell 1	Capped Waste Stockpile - Stage 1	5	456	584	382	359	238	329	159	233	291	297	431	421	2913
2	Filling occurring in sub-cell 2 below ground, sub-	Sub-Cells - Stage 1 to 2	2	1216	1558	1019	956	634	878	424	620	776	793	1148	1123	7767
	cell 1 intermediate covered, sub-cell 3 separated	Sub-Cells - Stage 2 (after 1 to 2 transition)	3	912	1169	764	717	475	659	318	465	582	595	861	842	5825
	from sub-cells 1 and 2	Capped Waste Stockpile - Stage 2	5	465	596	390	366	242	336	162	237	297	303	439	430	2971
3	Filling occurring in sub-cell 3 below ground, sub-	Sub-Cells - Stage 2 to 3	2	1368	1753	1147	1076	713	988	477	698	873	892	1292	1264	8738
	cell 2 intermediate covered, sub-cell 1 interim	Sub-Cells - Stage 3 (after 2 to 3 transition)	3	1064	1364	892	837	554	769	371	543	679	694	1005	983	6796
	capped	Capped Waste Stockpile - Stage 3	5	474	608	397	373	247	343	165	242	303	309	448	438	3029
4	All cells interim capped	Sub-Cells - Stage 3 to 4	2	1520	1948	1274	1195	792	1098	530	775	970	991	1435	1404	9709
		Sub-Cells - Stage 4 (after 3 to 4 transition)	3	1216	1558	1019	956	634	878	424	620	776	793	1148	1123	7767
		Capped Waste Stockpile - Stage 4	5	483	619	405	380	252	349	169	246	308	315	456	446	3087
Final	All cells final capped	Sub-Cells - Final capped	12	608	779	510	478	317	439	212	310	388	396	574	562	3884
		Sub-Cells - Final capped 1-2 yr	12	91	117	76	72	48	66	32	47	58	59	86	84	583
		Sub-Cells - Final capped 2-3 yr	12	13.7	17.5	11.5	10.8	7.1	9.9	4.8	7.0	8.7	8.9	12.9	12.6	87.4
		Sub-Cells - Final capped 3-4 yr	12	2.1	2.6	1.7	1.6	1.1	1.5	0.7	1.0	1.3	1.3	1.9	1.9	13.1
		Sub-Cells - Final capped 4-5 yr	12	0.31	0.39	0.26	0.24	0.16	0.22	0.11	0.16	0.20	0.20	0.29	0.28	1.97
		Sub-Cells - Final capped + 5 yr	12	0.061	0.078	0.051	0.048	0.032	0.044	0.021	0.031	0.039	0.040	0.057	0.056	0.388

Appendix D Option Cost Estimates



Option 1 - Treat on-site and use for irrigation/dust suppression

Basis:

5 yrs 50% AEP Volumes used for operating costs
Peak storage requirements consider peak flows
Treatment on site for first 20 mths, contractor removal of leachate after then
20 mths' leachate volume = 11.0ML, remaining 40 mths volume = 2.8ML
Assumes cold wells / water head tanks condition is adequate and materials appropriate for leachate storage and they are available for 20mths

Cost Element	Quantity	Rate	Cost	Comment	
Additional tank and pump infrastructure					
Plant feed pump from cold wells	3	15000 allow	45000	1 l/s pump installed	
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from cold wells to plant			13000	Mostly above ground PE100-40-12.5, ~200m and valves/fittings	
Power pump to plant (11.0ML)	5700 kWh	9 c/kWh	$600	Pump to plant at 1L/s	
Water head tanks pump from 1 cold well	3	15000 allow	45000	1 l/s pump installed	Water head tanks ~1ML storage. Additional 1.3ML (3m high internal bunds, 1 cell only, 40% porosity) emergency storage in cell for massive rain events. 90% AEP peak month ~2ML
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from cold wells to water head tanks			5000	Mostly above ground PE100-40-12.5, ~100m and valves/fittings	
Power pump to water head tanks (25% of 11.0ML)	1500 kWh	9 c/kWh	$200	Pump from cold well at 1L/s, only need to use water head tanks for 25% of water	
Permeate pump to south surge pond	1	15000 allow	15000	1 l/s pump installed	
Pump electrics / controls	1	15000 allow	15000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from plant to pond			16250	Mostly above ground PE100-40-12.5, ~250m and valves/fittings	
Power pump to south pond (7.7ML)	4300 kWh	9 c/kWh	$400	Pump from plant at 1L/s, permeat 70% of 20mth leachate volume	
Power pump south pond to east pond (7.7ML)	2800 kWh	9 c/kWh	$300	Pump from plant at 10/s, permeat 70% of 20mth leachate volume	
Power pump east pond to north pond (7.7ML)	2800 kWh	9 c/kWh	$300	Pump from plant at 10/s, permeat 70% of 20mth leachate volume	
Truck leachate to plant					
Sump pumps in cell	2	15000 allow	30000	1 l/s stainless pump installed	
Pump electrics / controls	2	15000 allow	30000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from cell to surface			10000	Above ground PE100-40-12.5, ~50m and valves/fittings	
Truck from Cell to CT cold wells (7.6ML)	7630	20 $/t	152600	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm	
Truck from CWS to CT Cold Wells (3.3ML)	3338	20 $/t	66760	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm	
Pretreatment + membrane container plant					
Pretreatment + membrane container plant, delivered to site			$1,000,000	Osmoflo	Very Approximate Power
Balance tanks at treatment plant			$20,000	Allowance	Membrane System
Interconnecting pipework			$10,000	Allowance	0.8 L/s
Installation			$50,000	Allowance	2.8 kL/h
Operator Full time	1.7 yrs	80000 $/yr	$133,333	Assume after 20 mths revert to contractor disposal	28 kW
Chemicals and cartridge filters			$60,000	Previous project $40k for 7.5ML, membranes should last more than 3 yrs so no replacement allowed	
Amenities/office hire			$50,000	Possibly able to use existing HAKK offices	
Power to treat 11.0ML	109680 kWh	9 c/kWh	$9,900	MMF, UF, NF up front assume 10kWh/kL as the HPRO is the main power draw	
Salvage value - sell plant after 2 yrs			-150000	Assume salvage value 15% of new capex, boutique customised plant so not significant demand	
Evapoconcentrator - brine treatment					Very Approximate Power
Mobilisation			$30,000	Previous project	Brine Concentrator / Crystalliser System
Demobilisation			$5,000	Previous project	0.23 L/s
Insurance			$5,000	Previous project	0.83 kL/h
Freight to and from site			$20,000	Previous project	55 kW
Plant Hire Charges	20 month	30000 $/month	$600,000	Previous pr Likely to be able to get lower rate for longer term hire, this is also for larger unit. However, need to be able to find smaller rental unit or just operate periodically	
Generator diesel			$357,333	Previous project - EVC has generator included in price [factored up based on total leachate treated, similar recovery]	
Salt/Sludge Stabilisation					
Salt Stabilisation - quicklime supply	75 dry t	350 $/t	26265	Previous project estimate - must be testwork conducted to confirm	10.968 ML leachate
Salt Stabilisation - zeolite supply	75 dry t	300 $/t	22513	Previous project estimate - must be testwork conducted to confirm	39 g/L TDS current
Excavator handling/mixing	113 days	300 $/day	33894	1 day per 7t skip load	total salt mass t 428
Salt/Sludge Transport					preciptation suldge mass 55 allow another 5g/L for ppt
Salt/sludge transport to cell (per load - 7 t net load)		300 $/7t load		Previous project - 6.0 cubic meter skip, net 7 t	stabilisation additives mass t 150
Bin Liners no liquid dripping over site (per liner - 7 t net load)		132 $/7t load		Previous project	wet salt mass at 20% moisture t 791
Total transport solids to cell	113 7t load	432 $/7t load	49000	Note the landfill transport contractor likely do this transport; on-site, asbestos certified etc	
	Subtotal brine treatment		1,149,006	assume less if using power from TL6, and assume 100k less if no salt stabilisation required, still not more attracttive than contractor disposal	
OR					
Brine Contractor Disposal					
Brine Storage tanks tanks for contractor removal	4 unit	10000 $/tank	40000	Poly 30kL tanks	
Truck and dispose all brine from HAKK storage to Homebush	3587 t	300 $/t	1,075,961	Cleanaway indicative escalated price for ~3 x TDS - simialr price to evapoconcentrating and disposing of salt in cells	
	Subtotal brine disposal		1,115,961	Also the risk of remobilising dissolved contaminants in the cell is avoided.	
Contractor Waste Disposal after 20 mths treating					
Install cell leachate access standpipes for contractor leachate collection			10000	Allowance; leachate drawn from cells directly by contractor for disposal	
Additional cost to decommission contaminated cold wells and water head tanks		allow	30000	Allowance; additional cleaning/disposal costs to decommission reused infrastructure contaminated by storing leachate	
Truck and dispose remaining leachate from HAKK storage to Homebush	2798 t	130 $/t	363760	Cleanaway indicative price	
Testing on leachate to confirm treatment requirements			25000	Leachate suitability for treatment	
Subtotal Option Cost			**$3,263,364**		
Project Management, Design/Spec, Reporting		15 %	$489,505		
Contingency		30 %	$979,009		
Total Option Cost			**$4,800,000**		
Ongoing annual leachate management fee after 60 months	7 t	260 $/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc	

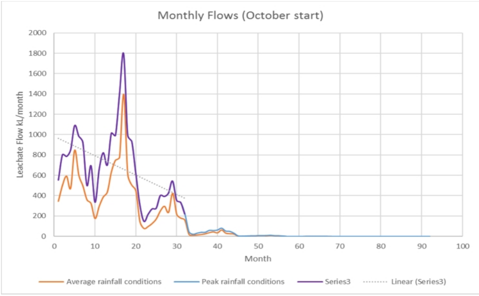
Option 1 - Treat on-site and use for irrigation/dust suppression

Basis:

Check cost impact of 50% more volume

Used to score evaluation criteria: "Cost sentitivity to total leachate volume"

- 5 yrs 50% AEP Volumes used for operating costs
- Peak storage requirements consider peak flows
- Treatment on site for first 20 mths, contractor removal of leachate after then
- 20 mths' leachate volume = 11.0ML, remaining 40 mths volume = 2.8ML
- Assumes cold wells / water head tanks condition is adequate and materials appropriate for leachate storage and they are available for 20mths
- Assume additional 50% of leachate volume over same timeframe



Cost Element	Quantity	Rate	Cost	Comment
Additional tank and pump infrastructure				
Plant feed pump from cold wells	3	15000 allow	45000	1 l/s pump installed
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables
Pipework/valves from cold wells to plant			13000	Mostly above ground PE100-40-12.5, ~200m and valves/fittings
Power pump to plant (11.0ML)	8550 kWh	9 c/kWh	$800	Pump to plant at 1L/s
Water head tanks pump from 1 cold well	3	15000 allow	45000	1 l/s pump installed
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables
Pipework/valves from cold wells to water head tanks			5000	Mostly above ground PE100-40-12.5, ~100m and valves/fittings
Power pump to water head tanks (25% of 11.0ML)	2250 kWh	9 c/kWh	$300	Pump from cold well at 1L/s, only need to use water head tanks for 25% of water
Permeate pump to south surge pond	1	15000 allow	15000	1 l/s pump installed
Pump electrics / controls	1	15000 allow	15000	Installed basic switchboard, level switch to protect pump, cables
Pipework/valves from plant to pond			16250	Mostly above ground PE100-40-12.5, ~250m and valves/fittings
Power pump to south pond (7.7ML)	6450 kWh	9 c/kWh	$600	Pump from plant at 1L/s, permeat 70% of 20mth leachate volume
Power pump south pond to east pond (7.7ML)	4200 kWh	9 c/kWh	$400	Pump from plant at 10/s, permeat 70% of 20mth leachate volume
Power pump east pond to north pond (7.7ML)	4200 kWh	9 c/kWh	$400	Pump from plant at 10/s, permeat 70% of 20mth leachate volume
Truck leachate to plant				
Sump pumps in cell	2	15000 allow	30000	1 l/s stainless pump installed
Pump electrics / controls	2	15000 allow	30000	Installed basic switchboard, level switch to protect pump, cables
Pipework/valves from cell to surface			10000	Above ground PE100-40-12.5, ~50m and valves/fittings
Truck from Cell to CT cold wells (7.6ML)	11445	20 $/t	228900	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm
Truck from CWS to CT Cold Wells (3.3ML)	5007	20 $/t	100140	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm
Pretreatment + membrane container plant			probably not a full 1.5 multiplier here - say 1.2	
Pretreatment + membrane container plant, delivered to site			$1,200,000	Osmoflo
Balance tanks at treatment plant			$20,000	Allowance
Interconnecting pipework			$10,000	Allowance
Installation			$50,000	Allowance
Operator Full time	1.7 yrs	80000 $/yr	$133,333	Assume after 20 mths revert to contractor disposal
Chemicals and cartridge filters			$90,000	Previous project $40k for 7.5ML, membranes should last more than 3 yrs so no replacement allowed
Amenities/office hire			$50,000	Possibly able to use existing HAKK offices
Power to treat 11.0ML	164520 kWh	9 c/kWh	$14,900	MMF, UF, NF up front assume 10kWh/kL as the HPRO is the main power draw
Salvage value - sell plant after 2 yrs			-180000	Assume salvage value 15% of new capex, boutique customised plant so not significant demand
Evapoconcentrator - brine treatment				
Mobilisation			$30,000	Previous project
Demobilisation			$5,000	Previous project
Insurance			$5,000	Previous project
Freight to and from site	probably not a full 1.5 multiplier here - say 1.2		$20,000	Previous project
Plant Hire Charges	20 month	36000 $/month	$720,000	Previous proj Likely to be able to get lower rate for longer term hire, this is also for larger unit. However, need to be able to find smaller rental unit or just operate periodically
Generator diesel			$357,333	Previous project - EVC has generator included in price [factored up based on total leachate treated, similar recovery]
Salt/Sludge Stabilisation				
Salt Stabilisation - quicklime supply	113 dry t	350 $/t	39398	Previous project estimate - must be testwork conducted to confirm; 16.452 ML leachate
Salt Stabilisation - zeolite supply	113 dry t	300 $/t	33770	Previous project estimate - must be testwork conducted to confirm; 39 g/L TDS current
Excavator handling/mixing	169 days	300 $/day	50840	1 day per 7t skip load; total salt mass t 642
Salt/Sludge Transport				preciptation suldge mass 82; allow another 5g/L for ppt
Salt/sludge transport to cell (per load - 7 t net load)		300 $/7t load		Previous project - 6.0 cubic meter skip, net 7 t; stabilisation additives mass t 225
Bin Liners no liquid dripping over site (per liner - 7 t net load)		132 $/7t load		Previous project; wet salt mass at 20% moisture t 1186
Total transport solids to cell	169 7t load	432 $/7t load	74000	Note the landfill transport contractor likely do this transport; on-site, asbestos certified etc
	Subtotal brine treatment	1,335,342		assume less if using power from TL6, and assume 100k less if no salt stabilisation required, still not more attracttive than contractor disposal
OR				
Brine Contractor Disposal				
Brine Storage tanks tanks for contractor removal	4 unit	10000 $/tank	40000	Poly 30kL tanks
Truck and dispose all brine from HAKK storage to Homebush	5380 t	300 $/t	1,613,941	Cleanaway indicative escalated price for ~3 x TDS - simialr price to evapoconcentrating and disposing of salt in cells
	Subtotal brine disposal	1,653,941		Also the risk of remobilising dissolved contaminants in the cell is avoided.
Contractor Waste Disposal after 20 mths treating				
Install cell leachate access standpipes for contractor leachate collection			10000	Allowance; leachate drawn from cells directly by contractor for disposal
Additional cost to decommission contaminated cold wells and water head tanks		allow	30000	Allowance; additional cleaning/disposal costs to decommission reused infrastructure contaminated by storing leachate
Truck and dispose remaining leachate from HAKK storage to Homebush	4197 t	130 $/t	545640	Cleanaway indicative price
Testing on leachate to confirm treatment requirements			25000	Leachate suitability for treatment
Subtotal Option Cost			**$3,980,005**	
Project Management, Design/Spec, Reporting		15 %	$597,001	Cost increase for increased flow option: 1.5 x average flow
Contingency		30 %	$1,194,001	
Total Option Cost			**$5,800,000**	$1,000,000
Ongoing annual leachate management fee after 60 months	7 t	260 $/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc

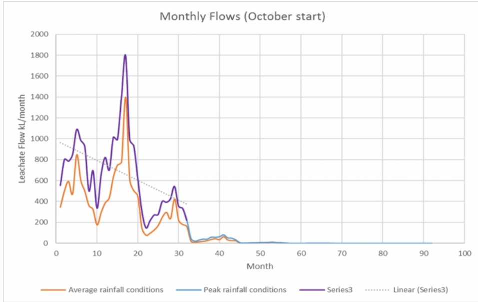
Option 1 - Treat on-site and use for irrigation/dust suppression

Basis:

Check cost impact of increased contractor disposal rates

Used to score Sensitivity Analysis Scenario E

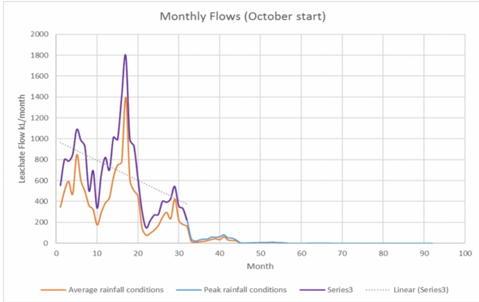
- 5 yrs 50% AEP Volumes used for operating costs
- Peak storage requirements consider peak flows
- Treatment on site for first 20 mths, contractor removal of leachate after then
- 20 mths' leachate volume = 11.0ML, remaining 40 mths volume = 2.8ML
- Assumes cold wells / water head tanks condition is adequate and materials appropriate for leachate storage and they are available for 20mths



Cost Element	Quantity	Rate	Cost	Comment	
Additional tank and pump infrastructure					
Plant feed pump from cold wells	3	15000 allow	45000	1 l/s pump installed	
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from cold wells to plant			13000	Mostly above ground PE100-40-12.5, ~200m and valves/fittings	
Power pump to plant (11.0ML)	5700 kWh	9 c/kWh	$600	Pump to plant at 1L/s	
Water head tanks pump from 1 cold well	3	15000 allow	45000	1 l/s pump installed	Water head tanks ~1ML storage. Additional 1.3ML (3m high internal bunds, 1 cell only, 40% porosity) emergency storage in cell for massive rain events. 90% AEP peak month ~2ML
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from cold wells to water head tanks			5000	Mostly above ground PE100-40-12.5, ~100m and valves/fittings	
Power pump to water head tanks (25% of 11.0ML)	1500 kWh	9 c/kWh	$200	Pump from cold well at 1L/s, only need to use water head tanks for 25% of water	
Permeate pump to south surge pond	1	15000 allow	15000	1 l/s pump installed	
Pump electrics / controls	1	15000 allow	15000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from plant to pond			16250	Mostly above ground PE100-40-12.5, ~250m and valves/fittings	
Power pump to south pond (7.7ML)	4300 kWh	9 c/kWh	$400	Pump from plant at 1L/s, permeat 70% of 20mth leachate volume	
Power pump south pond to east pond (7.7ML)	2800 kWh	9 c/kWh	$300	Pump from plant at 10/s, permeat 70% of 20mth leachate volume	
Power pump east pond to north pond (7.7ML)	2800 kWh	9 c/kWh	$300	Pump from plant at 10/s, permeat 70% of 20mth leachate volume	
Truck leachate to plant					
Sump pumps in cell	2	15000 allow	30000	1 l/s stainless pump installed	
Pump electrics / controls	2	15000 allow	30000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from cell to surface			10000	Above ground PE100-40-12.5, ~50m and valves/fittings	
Truck from Cell to CT cold wells (7.6ML)	7630	20 $/t	152600	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm	
Truck from CWS to CT Cold Wells (3.3ML)	3338	20 $/t	66760	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm	
Pretreatment + membrane container plant					
Pretreatment + membrane container plant, delivered to site			$1,000,000	Osmoflo	Very Approximate Power
Balance tanks at treatment plant			$20,000	Allowance	Membrane System
Interconnecting pipework			$10,000	Allowance	0.8 L/s
Installation			$50,000	Allowance	2.8 kL/h
Operator Full time	1.7 yrs	80000 $/yr	$133,333	Assume after 20 mths revert to contractor disposal	28 kW
Chemicals and cartridge filters			$60,000	Previous project $40k for 7.5ML, membranes should last more than 3 yrs so no replacement allowed	
Amenities/office hire			$50,000	Possibly able to use existing HAKK offices	
Power to treat 11.0ML	109680 kWh	9 c/kWh	$9,900	MMF, UF, NF up front assume 10kWh/kL as the HPRO is the main power draw	
Salvage value - sell plant after 2 yrs			-150000	Assume salvage value 15% of new capex, boutique customised plant so not significant demand	
Evapoconcentrator - brine treatment					Very Approximate Power
Mobilisation			$30,000	Previous project	Brine Concentrator / Crystalliser System
Demobilisation			$5,000	Previous project	0.23 L/s
Insurance			$5,000	Previous project	0.83 kL/h
Freight to and from site			$20,000	Previous project	55 kW
Plant Hire Charges	20 month	30000 $/month	$600,000	Previous pr Likely to be able to get lower rate for longer term hire, this is also for larger unit. However, need to be able to find smaller rental unit or just operate periodically	
Generator diesel			$357,333	Previous project - EVC has generator included in price [factored up based on total leachate treated, similar recovery]	
Salt/Sludge Stabilisation					
Salt Stabilisation - quicklime supply	75 dry t	350 $/t	26265	Previous project estimate - must be testwork conducted to confirm	10.968 ML leachate
Salt Stabilisation - zeolite supply	75 dry t	300 $/t	22513	Previous project estimate - must be testwork conducted to confirm	39 g/L TDS current
Excavator handling/mixing	113 days	300 $/day	33894	1 day per 7t skip load	total salt mass t 428
Salt/Sludge Transport					preciptation suldge mass 55 allow another 5g/L for ppt
Salt/sludge transport to cell (per load - 7 t net load)		300 $/7t load		Previous project - 6.0 cubic meter skip, net 7 t	stabilisation additives mass t 150
Bin Liners no liquid dripping over site (per liner - 7 t net load)		132 $/7t load		Previous project	wet salt mass at 20% moisture t 791
Total transport solids to cell	113 7t load	432 $/7t load	49000	Note the landfill transport contractor likely do this transport; on-site, asbestos certified etc	
	Subtotal brine treatment	1,149,006		assume less if using power from TL6, and assume 100k less if no salt stabilisation required, still not more attracttive than contractor disposal	
OR					
Brine Contractor Disposal					
Brine Storage tanks tanks for contractor removal	4 unit	10000 $/tank	40000	Poly 30kL tanks	
Truck and dispose all brine from HAKK storage to Homebush	3587 t	416 $/t	1,493,613	Cleanaway indicative escalated price for ~3 x TDS - simialr price to evapoconcentrating and disposing of salt in cells	
	Subtotal brine disposal	1,533,613		Also the risk of remobilising dissolved contaminants in the cell is avoided.	
Contractor Waste Disposal after 20 mths treating					
Install cell leachate access standpipes for contractor leachate collection			10000	Allowance; leachate drawn from cells directly by contractor for disposal	
Additional cost to decommission contaminated cold wells and water head tanks		allow	30000	Allowance; additional cleaning/disposal costs to decommission reused infrastructure contaminated by storing leachate	
Truck and dispose remaining leachate from HAKK storage to Homebush	2798 t	229 $/t	639937	Cleanaway indicative price	
Testing on leachate to confirm treatment requirements			25000	Leachate suitability for treatment	
Subtotal Option Cost			**$3,957,194**		
Project Management, Design/Spec, Reporting		15 %	$593,579		
Contingency		30 %	$1,187,158		
Total Option Cost			**$5,800,000**		
Ongoing annual leachate management fee after 60 months	7 t	260 $/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc	

Option 1 - Treat on-site and use for irrigation/dust suppression
Basis:

Check cost impact of increased contractor disposal rates
Used to score Sensitivity Analysis Scenario G



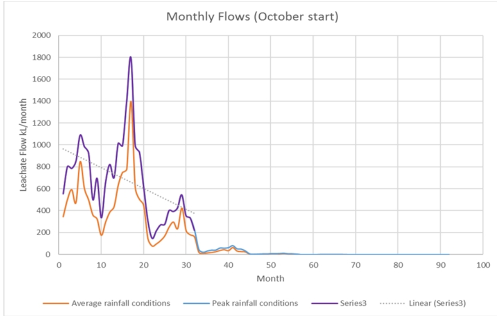
5 yrs 50% AEP Volumes used for operating costs
Peak storage requirements consider peak flows
Treatment on site for first 20 mths, contractor removal of leachate after then
20 mths' leachate volume = 11.0ML, remaining 40 mths volume = 2.8ML
Assumes cold wells / water head tanks condition is adequate and materials appropriate for leachate storage and they are available for 20mths

Cost Element	Quantity	Rate	Cost	Comment	
Additional tank and pump infrastructure					
Plant feed pump from cold wells	3	15000 allow	45000	1 l/s pump installed	
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from cold wells to plant			13000	Mostly above ground PE100-40-12.5, ~200m and valves/fittings	
Power pump to plant (11.0ML)	5700 kWh	9 c/kWh	$600	Pump to plant at 1L/s	
Water head tanks pump from 1 cold well	3	15000 allow	45000	1 l/s pump installed	Water head tanks ~1ML storage. Additional 1.3ML (3m high internal bunds, 1 cell only, 40% porosity) emergency storage in cell for massive rain events. 90% AEP peak month ~2ML
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from cold wells to water head tanks			5000	Mostly above ground PE100-40-12.5, ~100m and valves/fittings	
Power pump to water head tanks (25% of 11.0ML)	1500 kWh	9 c/kWh	$200	Pump from cold well at 1L/s, only need to use water head tanks for 25% of water	
Permeate pump to south surge pond	1	15000 allow	15000	1 l/s pump installed	
Pump electrics / controls	1	15000 allow	15000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from plant to pond			16250	Mostly above ground PE100-40-12.5, ~250m and valves/fittings	
Power pump to south pond (7.7ML)	4300 kWh	9 c/kWh	$400	Pump from plant at 1L/s, permeat 70% of 20mth leachate volume	
Power pump south pond to east pond (7.7ML)	2800 kWh	9 c/kWh	$300	Pump from plant at 10/s, permeat 70% of 20mth leachate volume	
Power pump east pond to north pond (7.7ML)	2800 kWh	9 c/kWh	$300	Pump from plant at 10/s, permeat 70% of 20mth leachate volume	
Truck leachate to plant					
Sump pumps in cell	2	15000 allow	30000	1 l/s stainless pump installed	
Pump electrics / controls	2	15000 allow	30000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from cell to surface			10000	Above ground PE100-40-12.5, ~50m and valves/fittings	
Truck from Cell to CT cold wells (7.6ML)	7630	20 $/t	152600	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm	
Truck from CWS to CT Cold Wells (3.3ML)	3338	20 $/t	66760	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm	
Pretreatment + membrane container plant					
Pretreatment + membrane container plant, delivered to site			$1,000,000	Osmoflo	Very Approximate Power
Balance tanks at treatment plant			$20,000	Allowance	Membrane System
Interconnecting pipework			$10,000	Allowance	0.8 L/s
Installation			$50,000	Allowance	2.8 kL/h
Operator Full time	1.7 yrs	80000 $/yr	$133,333	Assume after 20 mths revert to contractor disposal	28 kW
Chemicals and cartridge filters			$60,000	Previous project $40k for 7.5ML, membranes should last more than 3 yrs so no replacement allowed	
Amenities/office hire			$50,000	Possibly able to use existing HAKK offices	
Power to treat 11.0ML	109680 kWh	9 c/kWh	$9,900	MMF, UF, NF up front assume 10kWh/kL as the HPRO is the main power draw	
Salvage value - sell plant after 2 yrs			-150000	Assume salvage value 15% of new capex, boutique customised plant so not significant demand	
Evapoconcentrator - brine treatment					Very Approximate Power
Mobilisation			$30,000	Previous project	Brine Concentrator / Crystalliser System
Demobilisation			$5,000	Previous project	0.23 L/s
Insurance			$5,000	Previous project	0.83 kL/h
Freight to and from site			$20,000	Previous project	55 kW
Plant Hire Charges	20 month	30000 $/month	$600,000	Previous pr Likely to be able to get lower rate for longer term hire, this is also for larger unit. However, need to be able to find smaller rental unit or just operate periodically	
Generator diesel			$357,333	Previous project - EVC has generator included in price [factored up based on total leachate treated, similar recovery]	
Salt/Sludge Stabilisation					
Salt Stabilisation - quicklime supply	75 dry t	350 $/t	26265	Previous project estimate - must be testwork conducted to confirm	10.968 ML leachate
Salt Stabilisation - zeolite supply	75 dry t	300 $/t	22513	Previous project estimate - must be testwork conducted to confirm	39 g/L TDS current
Excavator handling/mixing	113 days	300 $/day	33894	1 day per 7t skip load	total salt mass t 428
Salt/Sludge Transport					preciptation suldge mass 55 allow another 5g/L for ppt
Salt/sludge transport to cell (per load - 7 t net load)		300 $/7t load		Previous project - 6.0 cubic meter skip, net 7 t	stabilisation additives mass t 150
Bin Liners no liquid dripping over site (per liner - 7 t net load)		132 $/7t load		Previous project	wet salt mass at 20% moisture t 791
Total transport solids to cell	113 7t load	432 $/7t load	49000	Note the landfill transport contractor likely do this transport; on-site, asbestos certified etc	
	Subtotal brine treatment	1,149,006		assume less if using power from TL6, and assume 100k less if no salt stabilisation required, still not more attracttive than contractor disposal	
OR					
Brine Contractor Disposal					
Brine Storage tanks tanks for contractor removal	4 unit	10000 $/tank	40000	Poly 30kL tanks	
Truck and dispose all brine from HAKK storage to Homebush	3587 t	406 $/t	1,456,026	Cleanaway indicative escalated price for ~3 x TDS - simialr price to evapoconcentrating and disposing of salt in cells	
	Subtotal brine disposal	1,496,026		Also the risk of remobilising dissolved contaminants in the cell is avoided.	
Contractor Waste Disposal after 20 mths treating					
Install cell leachate access standpipes for contractor leachate collection			10000	Allowance; leachate drawn from cells directly by contractor for disposal	
Additional cost to decommission contaminated cold wells and water head tanks		allow	30000	Allowance; additional cleaning/disposal costs to decommission reused infrastructure contaminated by storing leachate	
Truck and dispose remaining leachate from HAKK storage to Homebush	2798 t	369 $/t	1032696	Cleanaway indicative price	
Testing on leachate to confirm treatment requirements			25000	Leachate suitability for treatment	
Subtotal Option Cost			**$4,312,366**		
Project Management, Design/Spec, Reporting		15 %	$646,855		
Contingency		30 %	$1,293,710		
Total Option Cost			**$6,300,000**		
Ongoing annual leachate management fee after 60 months	7 t	260 $/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc	

Option 2 - Treat on-site for discharge to trade waste

Basis:

5 yrs 50% AEP Volumes used for operating costs
Peak storage requirements consider peak flows
Treatment on site for first 20 mths, contractor removal of leachate after then
20 mths' leachate volume = 11.0ML, remaining 40 mths volume = 2.8ML
Assumes cold wells / water head tanks condition is adequate and materials appropriate for leachate storage and they are available for 20mths



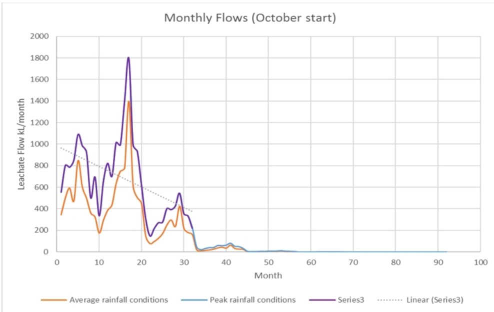
Cost Element	Quantity	Rate	Cost	Comment
Additional tank and pump infrastructure				
Plant feed pump from cold wells	3	15000 allow	45000	1 l/s pump installed
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables
Pipework/valves from cold wells to plant			13000	Mostly above ground PE100-40-12.5, ~200m and valves/fittings
Power pump to plant (11.0ML)	5700 kWh	9 c/kWh	$600	Pump to plant at 1L/s
Water head tanks pump from 1 cold well	3	15000 allow	45000	1 l/s pump installed Water head tanks ~1ML storage. Additional 1.3ML (3m high internal bunds, 1 cell only, 40% porosity) emergency storage in cell for massive rain events. 90% AEP peak month ~2ML
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables
Pipework/valves from cold wells to water head tanks			5000	Mostly above ground PE100-40-12.5, ~100m and valves/fittings
Power pump to water head tanks (25% of 11.0ML)	1500 kWh	9 c/kWh	$200	Pump from cold well at 1L/s, only need to use water head tanks for 25% of water
Pipework/valves from plant to sewage pump station			3250	Mostly above ground PE100-40-12.5, ~50m and valves/fittings
Power sewage pump station (5.1ML)	3100 kWh	9 c/kWh	$300	Pump from sewage pump station at 20L/s (150mm dia pipe), permeate 70% of first 15mth leachate volume
Truck permeate to Kurri Kurri WWTP	2616 t	20 $/t	52318	After sewage pump station demolished in stage 2, say 70% of 3.7ML (mths 16 to 20) assuming pump station demoslished 15mths into demo
Trade waste charges			28200	Assumed equivalent to $3/kL
Truck leachate to plant				
Sump pumps in cell	2	15000 allow	30000	1 l/s stainless pump installed
Pump electrics / controls	2	15000 allow	30000	Installed basic switchboard, level switch to protect pump, cables
Pipework/valves from cell to surface			10000	Above ground PE100-40-12.5, ~50m and valves/fittings
Truck from Cell to CT cold wells (7.6ML)	7630	20 $/t	152600	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm
Truck from CWS to CT Cold Wells (3.3ML)	3338	20 $/t	66760	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm
Pretreatment + membrane container plant				
Pretreatment + membrane container plant, delivered to site			$1,000,000	Osmoflo
Balance tanks at treatment plant			$20,000	Allowance
Interconnecting pipework			$10,000	Allowance
Installation			$50,000	Allowance
Operator Full time	1.7 yrs	80000 $/yr	$133,333	Assume after 20 mths revert to contractor disposal
Chemicals and cartridge filters			$60,000	Previous project $40k for 7.5ML, membranes should last more than 3 yrs so no replacement allowed
Amenities/office hire			$50,000	Possibly able to use existing HAKK offices
Power to treat 11.0ML	109680 kWh	9 c/kWh	$9,900	MMF, UF, NF up front assume 10kWh/kL as the HPRO is the main power draw
Salvage value - sell plant after 2 yrs			-150000	Assume salvage value 15% of new capex, boutique customised plant so not significant demand
Evapoconcentrator - brine treatment				
Mobilisation			$30,000	Previous project
Demobilisation			$5,000	Previous project
Insurance			$5,000	Previous project
Freight to and from site			$20,000	Previous project
Plant Hire Charges	20 month	30000 $/month	$600,000	Previous pı Likely to be able to get lower rate for longer term hire, this is also for larger unit. However, need to be able to find smaller rental unit or just operate periodically
Generator diesel			$357,333	Previous project- EVC has generator included in price [factored up based on total leachate treated, similar recovery]
Salt/Sludge Stabilisation				
Salt Stabilisation - quicklime supply	75 dry t	350 $/t	26265	Previous project estimate - must be testwork conducted to confirm 10.968 ML leachate
Salt Stabilisation - zeolite supply	75 dry t	300 $/t	22513	Previous project estimate - must be testwork conducted to confirm 39 g/L TDS current
Excavator handling/mixing	113 days	300 $/day	33894	1 day per 7t skip load total salt mass t 428
Salt/Sludge Transport				preciptation suldge mass 55 allow another 5g/L for ppt
Salt/sludge transport to cell (per load - 7 t net load)		300 $/7t load		Previous project - 6.0 cubic meter skip, net 7 t stabilisation additives mass t 150
Bin Liners no liquid dripping over site (per liner - 7 t net load)		132 $/7t load		Previous project wet salt mass at 20% moisture t 791
Total transport solids to cell	113 7t load	432 $/7t load	49000	Note the landfill transport contractor likely do this transport; on-site, asbestos certified etc
	Subtotal brine treatment	1,149,006		assume less if using power from TL6, and assume 100k less if no salt stabilisation required, still not more attracttive than contractor disposal
OR				
Brine Contractor Disposal				
Brine Storage tanks tanks for contractor removal	4 unit	10000 $/tank	40000	Poly 30kL tanks
Truck and dispose all brine from HAKK storage to Homebush	3587 t	300 $/t	1,075,961	Cleanaway indicative escalated price for ~3 x TDS - simialr price to evapoconcentrating and disposing of salt in cells
	Subtotal brine disposal	1,115,961		Also the risk of remobilising dissolved contaminants in the cell is avoided.
Contractor Waste Disposal after 20 mths treating				
Install cell leachate access standpipes for contractor leachate collection			10000	Allowance; leachate drawn from cells directly by contractor for disposal
Additional cost to decommission contaminated cold wells and water head tanks		allow	30000	Allowance; additional cleaning/disposal costs to decommission reused infrastructure contaminated by storing leachate
Truck and dispose remaining leachate from HAKK storage to Homebush	2798 t	130 $/t	363760	Cleanaway indicative price
Testing on leachate to confirm treatment requirements			25000	Leachate suitability for treatment
Subtotal Option Cost			**$3,300,182**	
Project Management, Design/Spec, Reporting		15 %	$495,027	
Contingency		30 %	$990,055	
Total Option Cost			**$4,800,000**	
Ongoing annual leachate management fee after 60 months	7 t	260 $/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc

Option 2 - Treat on-site for discharge to trade waste

Basis:

5 yrs 50% AEP Volumes used for operating costs
Peak storage requirements consider peak flows
Treatment on site for first 20 mths, contractor removal of leachate after then
20 mths' leachate volume = 11.0ML, remaining 40 mths volume = 2.8ML
Assumes cold wells / water head tanks condition is adequate and materials appropriate for leachate storage and they are available for 20mths
Assume additional 50% of leachate volume over same timeframe

Check cost impact of 50% more volume
Used to score evaluation criteria: "Cost sentitivity to total leachate volume"



Cost Element	Quantity	Rate	Cost	Comment	
Additional tank and pump infrastructure					
Plant feed pump from cold wells	3	15000 allow	45000	1 l/s pump installed	
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from cold wells to plant			13000	Mostly above ground PE100-40-12.5, ~200m and valves/fittings	
Power pump to plant (11.0ML)	8550 kWh	9 c/kWh	$800	Pump to plant at 1L/s	
Water head tanks pump from 1 cold well	3	15000 allow	45000	1 l/s pump installed	
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from cold wells to water head tanks			5000	Mostly above ground PE100-40-12.5, ~100m and valves/fittings	
Power pump to water head tanks (25% of 11.0ML)	2250 kWh	9 c/kWh	$300	Pump from cold well at 1L/s, only need to use water head tanks for 25% of water	
Pipework/valves from plant to sewage pump station			3250	Mostly above ground PE100-40-12.5, ~50m and valves/fittings	
Power sewage pump station (5.1ML)	4650 kWh	9 c/kWh	$500	Pump from sewage pump station at 20L/s (150mm dia pipe), permeate 70% of first 15mth leachate volume	
Truck permeate to Kurri Kurri WWTP	3924 t	20 $/t	78477	After sewage pump station demolished in stage 2, say 70% of 3.7ML (mths 16 to 20) assuming pump station demoslished 15mths into demo	
Trade waste charges			28200	Assumed equivalent to $3/kL	
Truck leachate to plant					
Sump pumps in cell	2	15000 allow	30000	1 l/s stainless pump installed	
Pump electrics / controls	2	15000 allow	30000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from cell to surface			10000	Above ground PE100-40-12.5, ~50m and valves/fittings	
Truck from Cell to CT cold wells (7.6ML)	11445	20 $/t	228900	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm	
Truck from CWS to CT Cold Wells (3.3ML)	5007	20 $/t	100140	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm	
Pretreatment + membrane container plant			probably not a full 1.5 multiplier here - say 1.2		
Pretreatment + membrane container plant, delivered to site			$1,200,000	Osmoflo	
Balance tanks at treatment plant			$20,000	Allowance	
Interconnecting pipework			$10,000	Allowance	
Installation			$50,000	Allowance	
Operator Full time	1.7 yrs	80000 $/yr	$133,333	Assume after 20 mths revert to contractor disposal	
Chemicals and cartridge filters			$90,000	Previous project $40k for 7.5ML, membranes should last more than 3 yrs so no replacement allowed	
Amenities/office hire			$50,000	Possibly able to use existing HAKK offices	
Power to treat 11.0ML	164520 kWh	9 c/kWh	$14,900	MMF, UF, NF up front assume 10kWh/kL as the HPRO is the main power draw	
Salvage value - sell plant after 2 yrs			-180000	Assume salvage value 15% of new capex, boutique customised plant so not significant demand	
Evapoconcentrator - brine treatment					
Mobilisation			$30,000	Previous project	
Demobilisation			$5,000	Previous project	
Insurance			$5,000	Previous project	
Freight to and from site	probably not a full 1.5 multiplier here - say 1.2		$20,000	Previous project	
Plant Hire Charges	20 month	36000 $/month	$720,000	Previous pro Likely to be able to get lower rate for longer term hire, this is also for larger unit. However, need to be able to find smaller rental unit or just operate periodically	
Generator diesel			$357,333	Previous project- EVC has generator included in price [factored up based on total leachate treated, similar recovery]	
Salt/Sludge Stabilisation					
Salt Stabilisation - quicklime supply	113 dry t	350 $/t	39398	Previous project estimate - must be testwork conducted to confirm	16.452 ML leachate
Salt Stabilisation - zeolite supply	113 dry t	300 $/t	33770	Previous project estimate - must be testwork conducted to confirm	39 g/L TDS current
Excavator handling/mixing	169 days	300 $/day	50840	1 day per 7t skip load	total salt mass t 642
Salt/Sludge Transport					preciptation suldge mass 82 allow another 5g/L for ppt
Salt/sludge transport to cell (per load - 7 t net load)		300 $/7t load		Previous project - 6.0 cubic meter skip, net 7 t	stabilisation additives mass t 225
Bin Liners no liquid dripping over site (per liner - 7 t net load)		132 $/7t load		Previous project	wet salt mass at 20% moisture t 1186
Total transport solids to cell	169 7t load	432 $/7t load	74000	Note the landfill transport contractor likely do this transport; on-site, asbestos certified etc	
		Subtotal brine treatment 1,335,342		assume less if using power from TL6, and assume 100k less if no salt stabilisation required, still not more attracttive than contractor disposal	
OR					
Brine Contractor Disposal					
Brine Storage tanks tanks for contractor removal	4 unit	10000 $/tank	40000	Poly 30kL tanks	
Truck and dispose all brine from HAKK storage to Homebush	5380 t	300 $/t	1,613,941	Cleanaway indicative escalated price for ~3 x TDS - simialr price to evapoconcentrating and disposing of salt in cells	
		Subtotal brine disposal 1,653,941		Also the risk of remobilising dissolved contaminants in the cell is avoided.	
Contractor Waste Disposal after 20 mths treating					
Install cell leachate access standpipes for contractor leachate collection			10000	Allowance; leachate drawn from cells directly by contractor for disposal	
Additional cost to decommission contaminated cold wells and water head tanks		allow	30000	Allowance; additional cleaning/disposal costs to decommission reused infrastructure contaminated by storing leachate	
Truck and dispose remaining leachate from HAKK storage to Homebush	4197 t	130 $/t	545640	Cleanaway indicative price	
Testing on leachate to confirm treatment requirements			25000	Leachate suitability for treatment	
Subtotal Option Cost			**$4,042,782**		
Project Management, Design/Spec, Reporting		15 %	$606,417	Cost increase for increased flow option: 1.5 x average flow	
Contingency		30 %	$1,212,835		
Total Option Cost			**$5,900,000**	$1,100,000	
Ongoing annual leachate management fee after 60 months	7 t	260 $/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc	

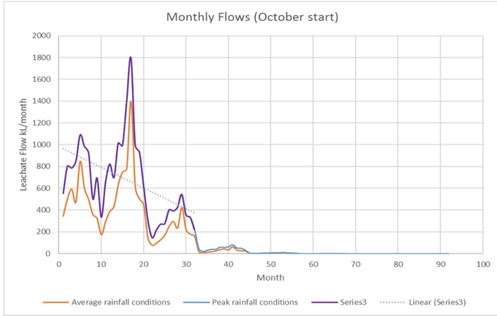
Option 2 - Treat on-site for discharge to trade waste

Basis:

Check cost impact of increased contractor disposal rates

Used to score Sensitivity Analysis Scenario E

5 yrs 50% AEP Volumes used for operating costs
Peak storage requirements consider peak flows
Treatment on site for first 20 mths, contractor removal of leachate after then
20 mths' leachate volume = 11.0ML, remaining 40 mths volume = 2.8ML
Assumes cold wells / water head tanks condition is adequate and materials appropriate for leachate storage and they are available for 20mths

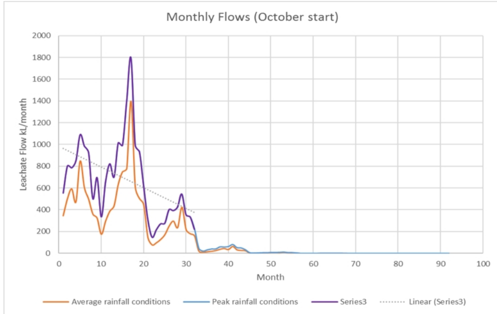


Cost Element	Quantity	Rate	Cost	Comment
Additional tank and pump infrastructure				
Plant feed pump from cold wells	3	15000 allow	45000	1 l/s pump installed
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables
Pipework/valves from cold wells to plant			13000	Mostly above ground PE100-40-12.5, ~200m and valves/fittings
Power pump to plant (11.0ML)	5700 kWh	9 c/kWh	$600	Pump to plant at 1L/s
Water head tanks pump from 1 cold well	3	15000 allow	45000	1 l/s pump installed Water head tanks ~1ML storage. Additional 1.3ML (3m high internal bunds, 1 cell only, 40% porosity) emergency storage in cell for massive rain events. 90% AEP peak month ~2ML
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables
Pipework/valves from cold wells to water head tanks			5000	Mostly above ground PE100-40-12.5, ~100m and valves/fittings
Power pump to water head tanks (25% of 11.0ML)	1500 kWh	9 c/kWh	$200	Pump from cold well at 1L/s, only need to use water head tanks for 25% of water
Pipework/valves from plant to sewage pump station			3250	Mostly above ground PE100-40-12.5, ~50m and valves/fittings
Power sewage pump station (5.1ML)	3100 kWh	9 c/kWh	$300	Pump from sewage pump station at 20L/s (150mm dia pipe), permeate 70% of first 15mth leachate volume
Truck permeate to Kurri Kurri WWTP	2616 t	20 $/t	52318	After sewage pump station demolished in stage 2, say 70% of 3.7ML (mths 16 to 20) assuming pump station demoslished 15mths into demo
Trade waste charges			28200	Assumed equivalent to $3/kL
Truck leachate to plant				
Sump pumps in cell	2	15000 allow	30000	1 l/s stainless pump installed
Pump electrics / controls	2	15000 allow	30000	Installed basic switchboard, level switch to protect pump, cables
Pipework/valves from cell to surface			10000	Above ground PE100-40-12.5, ~50m and valves/fittings
Truck from Cell to CT cold wells (7.6ML)	7630	20 $/t	152600	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm
Truck from CWS to CT Cold Wells (3.3ML)	3338	20 $/t	66760	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm
Pretreatment + membrane container plant				
Pretreatment + membrane container plant, delivered to site			$1,000,000	Osmoflo
Balance tanks at treatment plant			$20,000	Allowance
Interconnecting pipework			$10,000	Allowance
Installation			$50,000	Allowance
Operator Full time	1.7 yrs	80000 $/yr	$133,333	Assume after 20 mths revert to contractor disposal
Chemicals and cartridge filters			$60,000	Previous project $40k for 7.5ML, membranes should last more than 3 yrs so no replacement allowed
Amenities/office hire			$50,000	Possibly able to use existing HAKK offices
Power to treat 11.0ML	109680 kWh	9 c/kWh	$9,900	MMF, UF, NF up front assume 10kWh/kL as the HPRO is the main power draw
Salvage value - sell plant after 2 yrs			-150000	Assume salvage value 15% of new capex, boutique customised plant so not significant demand
Evapoconcentrator - brine treatment				
Mobilisation			$30,000	Previous project
Demobilisation			$5,000	Previous project
Insurance			$5,000	Previous project
Freight to and from site			$20,000	Previous project
Plant Hire Charges	20 month	30000 $/month	$600,000	Previous pı Likely to be able to get lower rate for longer term hire, this is also for larger unit. However, need to be able to find smaller rental unit or just operate periodically
Generator diesel			$357,333	Previous project- EVC has generator included in price [factored up based on total leachate treated, similar recovery]
Salt/Sludge Stabilisation				
Salt Stabilisation - quicklime supply	75 dry t	350 $/t	26265	Previous project estimate - must be testwork conducted to confirm 10.968 ML leachate
Salt Stabilisation - zeolite supply	75 dry t	300 $/t	22513	Previous project estimate - must be testwork conducted to confirm 39 g/L TDS current
Excavator handling/mixing	113 days	300 $/day	33894	1 day per 7t skip load total salt mass t 428
Salt/Sludge Transport				preciptation sudge mass 55 allow another 5g/L for ppt
Salt/sludge transport to cell (per load - 7 t net load)		300 $/7t load		Previous project - 6.0 cubic meter skip, net 7 t stabilisation additives mass t 150
Bin Liners no liquid dripping over site (per liner - 7 t net load)		132 $/7t load		Previous project wet salt mass at 20% moisture t 791
Total transport solids to cell	113 7t load	432 $/7t load	49000	Note the landfill transport contractor likely do this transport; on-site, asbestos certified etc
	Subtotal brine treatment	1,149,006		assume less if using power from TL6, and assume 100k less if no salt stabilisation required, still not more attracttive than contractor disposal
OR				
Brine Contractor Disposal				
Brine Storage tanks tanks for contractor removal	4 unit	10000 $/tank	40000	Poly 30kL tanks
Truck and dispose all brine from HAKK storage to Homebush	3587 t	416 $/t	1,493,613	Cleanaway indicative escalated price for ~3 x TDS - simialr price to evapoconcentrating and disposing of salt in cells
	Subtotal brine disposal	1,533,613		Also the risk of remobilising dissolved contaminants in the cell is avoided.
Contractor Waste Disposal after 20 mths treating				
Install cell leachate access standpipes for contractor leachate collection			10000	Allowance; leachate drawn from cells directly by contractor for disposal
Additional cost to decommission contaminated cold wells and water head tanks		allow	30000	Allowance; additional cleaning/disposal costs to decommission reused infrastructure contaminated by storing leachate
Truck and dispose remaining leachate from HAKK storage to Homebush	2798 t	229 $/t	639937	Cleanaway indicative price
Testing on leachate to confirm treatment requirements			25000	Leachate suitability for treatment
Subtotal Option Cost			**$3,994,012**	
Project Management, Design/Spec, Reporting		15 %	$599,102	
Contingency		30 %	$1,198,204	
Total Option Cost			**$5,800,000**	
Ongoing annual leachate management fee after 60 months	7 t	260 $/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc

Option 2 - Treat on-site for discharge to trade waste

Check cost impact of increased contractor disposal rates

Used to score Sensitivity Analysis Scenario G



Basis:

- 5 yrs 50% AEP Volumes used for operating costs
- Peak storage requirements consider peak flows
- Treatment on site for first 20 mths, contractor removal of leachate after then
- 20 mths' leachate volume = 11.0ML, remaining 40 mths volume = 2.8ML
- Assumes cold wells / water head tanks condition is adequate and materials appropriate for leachate storage and they are available for 20mths

Cost Element	Quantity	Rate	Cost	Comment	
Additional tank and pump infrastructure					
Plant feed pump from cold wells	3	15000 allow	45000	1 l/s pump installed	
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from cold wells to plant			13000	Mostly above ground PE100-40-12.5, ~200m and valves/fittings	
Power pump to plant (11.0ML)	5700 kWh	9 c/kWh	$600	Pump to plant at 1L/s	
Water head tanks pump from 1 cold well	3	15000 allow	45000	1 l/s pump installed	Water head tanks ~1ML storage. Additional 1.3ML (3m high internal bunds, 1 cell only, 40% porosity) emergency storage in cell for massive rain events. 90% AEP peak month ~2ML
Pump electrics / controls	3	15000 allow	45000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from cold wells to water head tanks			5000	Mostly above ground PE100-40-12.5, ~100m and valves/fittings	
Power pump to water head tanks (25% of 11.0ML)	1500 kWh	9 c/kWh	$200	Pump from cold well at 1L/s, only need to use water head tanks for 25% of water	
Pipework/valves from plant to sewage pump station			3250	Mostly above ground PE100-40-12.5, ~50m and valves/fittings	
Power sewage pump station (5.1ML)	3100 kWh	9 c/kWh	$300	Pump from sewage pump station at 20L/s (150mm dia pipe), permeate 70% of first 15mth leachate volume	
Truck permeate to Kurri Kurri WWTP	2616 t	20 $/t	52318	After sewage pump station demolished in stage 2, say 70% of 3.7ML (mths 16 to 20) assuming pump station demoslished 15mths into demo	
Trade waste charges			28200	Assumed equivalent to $3/kL	
Truck leachate to plant					
Sump pumps in cell	2	15000 allow	30000	1 l/s stainless pump installed	
Pump electrics / controls	2	15000 allow	30000	Installed basic switchboard, level switch to protect pump, cables	
Pipework/valves from cell to surface			10000	Above ground PE100-40-12.5, ~50m and valves/fittings	
Truck from Cell to CT cold wells (7.6ML)	7630	20 $/t	152600	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm	
Truck from CWS to CT Cold Wells (3.3ML)	3338	20 $/t	66760	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm	
Pretreatment + membrane container plant					
Pretreatment + membrane container plant, delivered to site			$1,000,000	Osmoflo	
Balance tanks at treatment plant			$20,000	Allowance	
Interconnecting pipework			$10,000	Allowance	
Installation			$50,000	Allowance	
Operator Full time	1.7 yrs	80000 $/yr	$133,333	Assume after 20 mths revert to contractor disposal	
Chemicals and cartridge filters			$60,000	Previous project $40k for 7.5ML, membranes should last more than 3 yrs so no replacement allowed	
Amenities/office hire			$50,000	Possibly able to use existing HAKK offices	
Power to treat 11.0ML	109680 kWh	9 c/kWh	$9,900	MMF, UF, NF up front assume 10kWh/kL as the HPRO is the main power draw	
Salvage value - sell plant after 2 yrs			-150000	Assume salvage value 15% of new capex, boutique customised plant so not significant demand	
Evapoconcentrator - brine treatment					
Mobilisation			$30,000	Previous project	
Demobilisation			$5,000	Previous project	
Insurance			$5,000	Previous project	
Freight to and from site			$20,000	Previous project	
Plant Hire Charges	20 month	30000 $/month	$600,000	Previous pı Likely to be able to get lower rate for longer term hire, this is also for larger unit. However, need to be able to find smaller rental unit or just operate periodically	
Generator diesel			$357,333	Previous project- EVC has generator included in price [factored up based on total leachate treated, similar recovery]	
Salt/Sludge Stabilisation					
Salt Stabilisation - quicklime supply	75 dry t	350 $/t	26265	Previous project estimate - must be testwork conducted to confirm	10.968 ML leachate
Salt Stabilisation - zeolite supply	75 dry t	300 $/t	22513	Previous project estimate - must be testwork conducted to confirm	39 g/L TDS current
Excavator handling/mixing	113 days	300 $/day	33894	1 day per 7t skip load	total salt mass t 428
Salt/Sludge Transport					preciptation suldge mass 55 allow another 5g/L for ppt
Salt/sludge transport to cell (per load - 7 t net load)		300 $/7t load		Previous project - 6.0 cubic meter skip, net 7 t	stabilisation additives mass t 150
Bin Liners no liquid dripping over site (per liner - 7 t net load)		132 $/7t load		Previous project	wet salt mass at 20% moisture t 791
Total transport solids to cell	113 7t load	432 $/7t load	49000	Note the landfill transport contractor likely do this transport; on-site, asbestos certified etc	
	Subtotal brine treatment	1,149,006		assume less if using power from TL6, and assume 100k less if no salt stabilisation required, still not more attracttive than contractor disposal	
OR					
Brine Contractor Disposal					
Brine Storage tanks tanks for contractor removal	4 unit	10000 $/tank	40000	Poly 30kL tanks	
Truck and dispose all brine from HAKK storage to Homebush	3587 t	406 $/t	1,456,026	Cleanaway indicative escalated price for ~3 x TDS - simialr price to evapoconcentrating and disposing of salt in cells	
	Subtotal brine disposal	1,496,026		Also the risk of remobilising dissolved contaminants in the cell is avoided.	
Contractor Waste Disposal after 20 mths treating					
Install cell leachate access standpipes for contractor leachate collection			10000	Allowance; leachate drawn from cells directly by contractor for disposal	
Additional cost to decommission contaminated cold wells and water head tanks		allow	30000	Allowance; additional cleaning/disposal costs to decommission reused infrastructure contaminated by storing leachate	
Truck and dispose remaining leachate from HAKK storage to Homebush	2798 t	369 $/t	1032696	Cleanaway indicative price	
Testing on leachate to confirm treatment requirements			25000	Leachate suitability for treatment	
Subtotal Option Cost			**$4,349,184**		
Project Management, Design/Spec, Reporting		15 %	$652,378		
Contingency		30 %	$1,304,755		
Total Option Cost			**$6,400,000**		
Ongoing annual leachate management fee after 60 months	7 t	260 $/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc	

Option 3 - Store and evaporate (mech assisted) majority of leachate

Basis:

- 5 yrs 50% AEP Volumes used for operating costs
- Peak storage requirements consider peak flows
- Evaporation on site for first 20 mths, contractor removal of leachate after then to enable decomm/rehab evap ponds to reduce liability/security issues
- 20 mths' leachate evaporation = 11.0ML, remaining 40 mths volume = 2.8ML removed by contractor

Water Quality

10.968	ML current	
39	g/L TDS current	
2.194	ML final	Pond 50x20x3m, evap until 500mm deep - ~20% of vol, 0.5m freeboard
195	g/L TDS final	

Cost Element		Quantity	Rate	Cost	Comment	
Evaporation ponds for 20 mths						
Mobilisation/demob/modify/commission/decommission				$48,500	Previous project	
Equipment Hire Charges (2 units)	now 2 units	600 day	800 $/day	$480,000	Previous project: Includes 2 floating evaporator, generators, start panel, weather monitoring/control - cheaper rate/purchase may be available	
Operators - HAKK staff trained by contractor		600 hrs	80 $/hr	$48,000	Previous project to train HAKK staff to attend plant 1h/d	
Generator diesel (1 units@30L/h)	now 2 units	96000 L	1.5 $/L	144000	Previous project rate estimate	
1.2ML lined lagoon		1	70000 each	70000	20*20*3m	
Sump pumps in cell		2	15000 allow	30000	1 l/s stainless pump installed	
Pump electrics / controls		2	15000 allow	30000	Installed basic switchboard, level switch to protect pump, cables	
Power pump to pond (10.1ML)		5200 kWh	9 c/kWh	$500	Assume operating cost similar to diesel since generator already there with spare capacity. Very smal cost anyway. Pump from cell at 1L/s (100kL in 28hrs), 1.3ML (3m high internal bunds, 1 cell only, 40% porosity) emergency storage in cell for massive rain events. 90% AEP peak month	
Pipework/valves from cell to ponds				25000	Above ground PE100-40-12.5, ~500m and valves/fittings	28 hrs
Truck from CWS to evap ponds (3.3ML)		3338	20 $/t	66760	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm	
Decommission new pond after 20 months			allow	35000	Allowance; leachate drawn from cells directly by contractor for disposal, liners and residuals to cell	
Truck and dispose remaining leachate from HAKK storage to Homebush		2391 t	400 $/t	956392	Based on cleanaway indicative price - escalated estimate based on 5 x original concentration	
Contractor Waste Disposal after 20 mths treating						
Install cell leachate access standpipes for contractor leachate collection				10000	Allowance; leachate drawn from cells directly by contractor for disposal	
Truck and dispose remaining leachate from HAKK storage to Homebush		2798 t	130 $/t	363760	Cleanaway indicative price	
Testing on leachate to confirm treatment requirements				10000	Leachate suitability for assisted evap, scaling rates	
Subtotal Option Cost				**$2,317,912**		
Project Management, Design/Spec, Reporting			15 %	$347,687		
Contingency			30 %	$695,374		
Total Option Cost				**$3,400,000**		
Ongoing annual leachate management fee after 60 months		7 t	260 $/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc	
				$1,320,152	**Trucking and disposal total**	
				57%	**Proportion of subtotal cost**	

Option 3 - Store and evaporate (mech assisted) majority of leachate **Check cost impact of 50% more volume**
Basis: **Used to score evaluation criteria: "Cost sentitivity to total leachate volume"**

5 yrs 50% AEP Volumes used for operating costs
Peak storage requirements consider peak flows
Evaporation on site for first 20 mths, contractor removal of leachate after then to enable decomm/rehab evap ponds to reduce liability/security issues
20 mths' leachate evaporation = 11.0ML, remaining 40 mths volume = 2.8ML removed by contractor
Assume additional 50% of leachate volume over same timeframe

Water Quality

10.968	ML current	
39	g/L TDS current	
2.194	ML final	Pond 50x20x3m, evap until 500mm deep - ~20% of vol, 0.5m freeboard
195	g/L TDS final	

Cost Element		Quantity		Rate		Cost	Comment
Evaporation ponds for 20 mths							
Mobilisation/demob/modify/commission/decommission		3 units				$48,500	Previous project
Equipment Hire Charges (2 units)	now 2 units	900	day	800	$/day	$720,000	Previous project: Includes 2 floating evaporator, generators, start panel, weather monitoring/control - cheaper rate/purchase may be available
Operators - HAKK staff trained by contractor		900	hrs	80	$/hr	$72,000	Previous project to train HAKK staff to attend plant 1h/d
Generator diesel (1 units@30L/h)	now 2 units	144000	L	1.5	$/L	216000	Previous project rate estimate
1.2ML lined lagoon		1		70000	each	70000	20*20*3m Same size pond still fits peak inventory
Sump pumps in cell		2		15000	allow	30000	1 l/s stainless pump installed
Pump electrics / controls		2		15000	allow	30000	Installed basic switchboard, level switch to protect pump, cables
Power pump to pond (10.1ML)		7800	kWh	9	c/kWh	$800	Assume operating cost similar to diesel since generator already there with spare capacity. Very smal cost anyway. Pump from cell at 1L/s (100kL in 28hrs), 1.3ML (3m high internal bunds, 1 cell only, 40% porosity) emergency storage in cell for massive rain events. 90% AEP peak month ~ 28 hrs
Pipework/valves from cell to ponds						25000	Above ground PE100-40-12.5, ~500m and valves/fittings
Truck from CWS to evap ponds (3.3ML)		5007		20	$/t	100140	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm
Decommission new pond after 20 months					allow	35000	Allowance; leachate drawn from cells directly by contractor for disposal, liners and residuals to cell
Truck and dispose remaining leachate from HAKK storage to Homebush		3586	t	400	$/t	1434589	Based on cleanaway indicative price - escalated estimate based on 5 x original concentration
Contractor Waste Disposal after 20 mths treating							
Install cell leachate access standpipes for contractor leachate collection						10000	Allowance; leachate drawn from cells directly by contractor for disposal
Truck and dispose remaining leachate from HAKK storage to Homebush		4197	t	130	$/t	545640	Cleanaway indicative price
Testing on leachate to confirm treatment requirements						10000	Leachate suitability for assisted evap, scaling rates
Subtotal Option Cost						**$3,347,668**	
Project Management, Design/Spec, Reporting				15	%	$502,150	Cost increase for increased flow option: 1.5 x average flow
Contingency				30	%	$1,004,300	
Total Option Cost						**$4,900,000**	$1,500,000
Ongoing annual leachate management fee after 60 months		7	t	260	$/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc

Option 3 - Store and evaporate (mech assisted) majority of leachate **Check cost impact of increased contractor disposal rates**
Basis: **Used to score Sensitivity Analysis Scenario E**

5 yrs 50% AEP Volumes used for operating costs
Peak storage requirements consider peak flows
Evaporation on site for first 20 mths, contractor removal of leachate after then to enable decomm/rehab evap ponds to reduce liability/security issues
20 mths' leachate evaporation = 11.0ML, remaining 40 mths volume = 2.8ML removed by contractor

Water Quality
10.968 ML current
39 g/L TDS current
2.194 ML final Pond 50x20x3m, evap until 500mm deep - ~20% of vol, 0.5m freeboard
195 g/L TDS final

Cost Element		Quantity		Rate		Cost	Comment
Evaporation ponds for 20 mths							
Mobilisation/demob/modify/commission/decommission						$48,500	Previous project
Equipment Hire Charges (2 units)	now 2 units	600	day	800	$/day	$480,000	Previous project: Includes 2 floating evaporator, generators, start panel, weather monitoring/control - cheaper rate/purchase may be available
Operators - HAKK staff trained by contractor		600	hrs	80	$/hr	$48,000	Previous project to train HAKK staff to attend plant 1h/d
Generator diesel (1 units@30L/h)	now 2 units	96000	L	1.5	$/L	144000	Previous project rate estimate
1.2ML lined lagoon		1		70000	each	70000	20*20*3m
Sump pumps in cell		2		15000	allow	30000	1 l/s stainless pump installed
Pump electrics / controls		2		15000	allow	30000	Installed basic switchboard, level switch to protect pump, cables
Power pump to pond (10.1ML)		5200	kWh	9	c/kWh	$500	Assume operating cost similar to diesel since generator already there with spare capacity. Very smal cost anyway. Pump from cell at 1L/s (100kL in 28hrs), 1.3ML (3m high internal bunds, 1 cell only, 40% porosity) emergency storage in cell for massive rain events. 90% AEP peak month
Pipework/valves from cell to ponds						25000	Above ground PE100-40-12.5, ~500m and valves/fittings 28 hrs
Truck from CWS to evap ponds (3.3ML)		3338		20	$/t	66760	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm
Decommission new pond after 20 months					allow	35000	Allowance; leachate drawn from cells directly by contractor for disposal, liners and residuals to cell
Truck and dispose remaining leachate from HAKK storage to Homebush		2391	t	573	$/t	1369315	Based on cleanaway indicative price - escalated estimate based on 5 x original concentration
Contractor Waste Disposal after 20 mths treating							
Install cell leachate access standpipes for contractor leachate collection						10000	Allowance; leachate drawn from cells directly by contractor for disposal
Truck and dispose remaining leachate from HAKK storage to Homebush		2798	t	229	$/t	639937	Cleanaway indicative price
Testing on leachate to confirm treatment requirements						10000	Leachate suitability for assisted evap, scaling rates
Subtotal Option Cost						**$3,007,012**	
Project Management, Design/Spec, Reporting				15	%	$451,052	
Contingency				30	%	$902,104	
Total Option Cost						**$4,400,000**	
Ongoing annual leachate management fee after 60 months		7	t	260	$/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc

Brine rate [5 times concentrated] ($400/t) increases by 25%, then include liquid waste levy of $72.7/t on top
Leachate rate ($130/t) increases by 20%, then include liquid waste levy of $72.7/t on top

Option 3 - Store and evaporate (mech assisted) majority of leachate **Check cost impact of increased contractor disposal rates**
Basis: **Used to score Sensitivity Analysis Scenario G**

5 yrs 50% AEP Volumes used for operating costs
Peak storage requirements consider peak flows
Evaporation on site for first 20 mths, contractor removal of leachate after then to enable decomm/rehab evap ponds to reduce liability/security issues
20 mths' leachate evaporation = 11.0ML, remaining 40 mths volume = 2.8ML removed by contractor

Water Quality

10.968	ML current	
39	g/L TDS current	
2.194	ML final	Pond 50x20x3m, evap until 500mm deep - ~20% of vol, 0.5m freeboard
195	g/L TDS final	

Cost Element		Quantity		Rate		Cost	Comment	
Evaporation ponds for 20 mths								
Mobilisation/demob/modify/commission/decommission						$48,500	Previous project	
Equipment Hire Charges (2 units)	now 2 units	600	day	800	$/day	$480,000	Previous project: Includes 2 floating evaporator, generators, start panel, weather monitoring/control - cheaper rate/purchase may be available	
Operators - HAKK staff trained by contractor		600	hrs	80	$/hr	$48,000	Previous project to train HAKK staff to attend plant 1h/d	
Generator diesel (1 units@30L/h)	now 2 units	96000	L	1.5	$/L	144000	Previous project rate estimate	
1.2ML lined lagoon		1		70000	each	70000	20*20*3m	
Sump pumps in cell		2		15000	allow	30000	1 l/s stainless pump installed	
Pump electrics / controls		2		15000	allow	30000	Installed basic switchboard, level switch to protect pump, cables	
Power pump to pond (10.1ML)		5200	kWh	9	c/kWh	$500	Assume operating cost similar to diesel since generator already there with spare capacity. Very smal cost anyway. Pump from cell at 1L/s (100kL in 28hrs), 1.3ML (3m high internal bunds, 1 cell only, 40% porosity) emergency storage in cell for massive rain events. 90% AEP peak month	
Pipework/valves from cell to ponds						25000	Above ground PE100-40-12.5, ~500m and valves/fittings	28 hrs
Truck from CWS to evap ponds (3.3ML)		3338		20	$/t	66760	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm	
Decommission new pond after 20 months					allow	35000	Allowance; leachate drawn from cells directly by contractor for disposal, liners and residuals to cell	
Truck and dispose remaining leachate from HAKK storage to Homebush		2391	t	406	$/t	970666	Based on cleanaway indicative price - escalated estimate based on 5 x original concentration	
Contractor Waste Disposal after 20 mths treating								
Install cell leachate access standpipes for contractor leachate collection						10000	Allowance; leachate drawn from cells directly by contractor for disposal	
Truck and dispose remaining leachate from HAKK storage to Homebush		2798	t	369	$/t	1032696	Cleanaway indicative price	
Testing on leachate to confirm treatment requirements						10000	Leachate suitability for assisted evap, scaling rates	
Subtotal Option Cost						**$3,001,123**		
Project Management, Design/Spec, Reporting				15	%	$450,168		
Contingency				30	%	$900,337		
Total Option Cost						**$4,400,000**		
Ongoing annual leachate management fee after 60 months		7	t	260	$/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc	

Brine rate [5 times concentrated] - 10% more than standard leachate
Leachate rates from Toxfree to Kurri Kurri Facility including liquid waste levy

Cleanaway brine factor for 5x strength: 2.5 Treat at windsor expected to have similar ratio of transport to treatment cost to treat at olympic park

Option 4 - Waste contractor removal and treatment/disposal off site
Basis:
5 yrs 50% AEP Volumes used for operating costs
Peak storage requirements consider peak flows
Assumes cold wells and piping condition suitable

Cost Element	Quantity		Rate		Cost	Comment		
							1200	
1ML lined pond near cell	1		70000	each	70000	Contractor pump out of pond - to optimise and reduce decommissioning/filling pond/liner later could use some big poly tanks given massive storage potential in cells, or if EPA agrees, could utilise storage in cells		
Sump pumps in cell	2		15000	allow	30000	1 l/s stainless pump installed		
Pump electrics / controls	2		15000	allow	30000	Installed basic switchboard, level switch to protect pump, cables		
Power pump to pond (10.1ML)	5200	kWh	9	c/kWh	$500	Assume operating cost similar to diesel since generator already there with spare capacity. Very smal cost anyway. Pump from cell at 1L/s (100kL in 28hrs), 1.3ML (3m high internal bunds, 1 cell only, 40% porosity) emergency storag		
Pipework/valves from cell to pond					25000	Above ground PE100-40-12.5, ~500m and valves/fittings		28 hrs
Truck from CWS to new buffer pond (3.3ML)	3338		20	$/t	66760	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm		
Truck and dispose all leachate from HAKK storage to Homebush	13766	t	130	$/t	1789580	Cleanaway indicative price		
Decommission new pond after 20 months				allow	30000	Allowance; leachate drawn from cells directly by contractor for disposal, liners and residuals to cell		
Install cell leachate access standpipes for contractor leachate collection					10000	Allowance; leachate drawn from cells directly by contractor for disposal		
Testing on leachate to confirm treatment requirements					5000	Leachate suitability for treatment		
Subtotal Option Cost					**$2,056,840**			
Project Management, Design/Spec, Reporting			10	%	$205,684			
Contingency			30	%	$617,052			
Total Option Cost					**$2,900,000**			
Ongoing annual leachate management fee after 60 months	7	t	260	$/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc		

Option 4 - Waste contractor removal and treatment/disposal off site Check cost impact of 50% more volume
Basis: Used to score evaluation criteria: "Cost sentitivity to total leachate volume"

5 yrs 50% AEP Volumes used for operating costs
Peak storage requirements consider peak flows
Assumes cold wells and piping condition suitable
Assume additional 50% of leachate volume over same timeframe

Cost Element	Quantity		Rate		Cost	Comment
						1200
1ML lined pond near cell	1		70000	each	70000	Contractor pump out of pond - to optimise and reduce decommissioning/filling pond/liner later could use some big poly tanks given massive storage potential in cells, or if EPA agrees, could utilise storage in cells
Sump pumps in cell	2		15000	allow	30000	1 l/s stainless pump installed
Pump electrics / controls	2		15000	allow	30000	Installed basic switchboard, level switch to protect pump, cables
Power pump to pond (10.1ML)	7800	kWh	9	c/kWh	$800	Assume operating cost similar to diesel since generator already there with spare capacity. Very smal cost anyway. Pump from cell at 1L/s (100kL in 28hrs), 1.3ML (3m high internal bunds, 1 cell only, 40% porosity) emergency storage i
Pipework/valves from cell to pond					25000	Above ground PE100-40-12.5, ~500m and valves/fittings 28 hrs
Truck from CWS to new buffer pond (3.3ML)	5007		20	$/t	100140	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm
Truck and dispose all leachate from HAKK storage to Homebush	20649	t	130	$/t	2684370	Cleanaway indicative price
Decommission new pond after 20 months				allow	30000	Allowance; leachate drawn from cells directly by contractor for disposal, liners and residuals to cell
Install cell leachate access standpipes for contractor leachate collection					10000	Allowance; leachate drawn from cells directly by contractor for disposal
Testing on leachate to confirm treatment requirements					5000	Leachate suitability for treatment
Subtotal Option Cost					**$2,985,310**	
Project Management, Design/Spec, Reporting			10	%	$298,531	Cost increase for increased flow option: 1.5 x average flow
Contingency			30	%	$895,593	
Total Option Cost					**$4,200,000**	$1,300,000
Ongoing annual leachate management fee after 60 months	7	t	260	$/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc

Option 4 - Waste contractor removal and treatment/disposal off site **Check cost impact of increased contractor disposal rates**
Basis: **Used to score Sensitivity Analysis Scenario E**

5 yrs 50% AEP Volumes used for operating costs
Peak storage requirements consider peak flows
Assumes cold wells and piping condition suitable

Cost Element	Quantity		Rate		Cost	Comment	
							1200
1ML lined pond near cell	1		70000	each	70000	Contractor pump out of pond - to optimise and reduce decommissioning/filling pond/liner later could use some big poly tanks given massive storage potential in cells, or if EPA agrees, could utilise storage in cells	
Sump pumps in cell	2		15000	allow	30000	1 l/s stainless pump installed	
Pump electrics / controls	2		15000	allow	30000	Installed basic switchboard, level switch to protect pump, cables	
Power pump to pond (10.1ML)	5200	kWh	9	c/kWh	$500	Assume operating cost similar to diesel since generator already there with spare capacity. Very smal cost anyway. Pump from cell at 1L/s (100kL in 28hrs), 1.3ML (3m high internal bunds, 1 cell only, 40% porosity) emergency storag	28 hrs
Pipework/valves from cell to pond					25000	Above ground PE100-40-12.5, ~500m and valves/fittings	
Truck from CWS to new buffer pond (3.3ML)	3338		20	$/t	66760	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm	
Truck and dispose all leachate from HAKK storage to Homebush	13766	t	229	$/t	3148284.2	Cleanaway indicative price	
Decommission new pond after 20 months				allow	30000	Allowance; leachate drawn from cells directly by contractor for disposal, liners and residuals to cell	
Install cell leachate access standpipes for contractor leachate collection					10000	Allowance; leachate drawn from cells directly by contractor for disposal	
Testing on leachate to confirm treatment requirements					5000	Leachate suitability for treatment	
Subtotal Option Cost					**$3,415,544**		
Project Management, Design/Spec, Reporting			10	%	$341,554		
Contingency			30	%	$1,024,663		
Total Option Cost					**$4,800,000**		
Ongoing annual leachate management fee after 60 months	7	t	260	$/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc	

Option 4 - Waste contractor removal and treatment/disposal off site

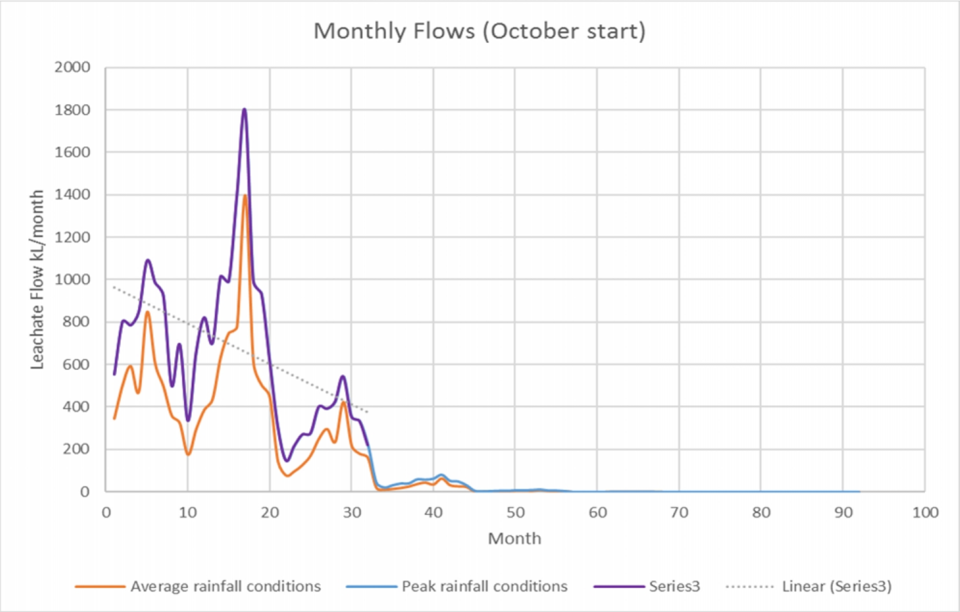
Basis:

5 yrs 50% AEP Volumes used for operating costs
Peak storage requirements consider peak flows
Assumes cold wells and piping condition suitable

Check cost impact of increased contractor disposal rates
Used to score Sensitivity Analysis Scenario G

Cost Element	**Quantity**	**Rate**	**Cost**	**Comment**	**1200**
1ML lined pond near cell	1	70000 each	70000	Contractor pump out of pond - to optimise and reduce decommissioning/filling pond/liner later could use some big poly tanks given massive storage potential in cells, or if EPA agrees, could utilise storage in cells	
Sump pumps in cell	2	15000 allow	30000	1 l/s stainless pump installed	
Pump electrics / controls	2	15000 allow	30000	Installed basic switchboard, level switch to protect pump, cables	
Power pump to pond (10.1ML)	5200 kWh	9 c/kWh	$500	Assume operating cost similar to diesel since generator already there with spare capacity. Very smal cost anyway. Pump from cell at 1L/s (100kL in 28hrs), 1.3ML (3m high internal bunds, 1 cell only, 40% porosity) emergency storag	
Pipework/valves from cell to pond			25000	Above ground PE100-40-12.5, ~500m and valves/fittings	28 hrs
Truck from CWS to new buffer pond (3.3ML)	3338	20 $/t	66760	Similar order of magnitude to installing pumps electrical/pipe, no pipline obstruction during decomm	
Truck and dispose all leachate from HAKK storage to Homebush	13766 t	369 $/t	5080530	Cleanaway indicative price	
Decommission new pond after 20 months		allow	30000	Allowance; leachate drawn from cells directly by contractor for disposal, liners and residuals to cell	
Install cell leachate access standpipes for contractor leachate collection			10000	Allowance; leachate drawn from cells directly by contractor for disposal	
Testing on leachate to confirm treatment requirements			5000	Leachate suitability for treatment	
Subtotal Option Cost			**$5,347,790**		
Project Management, Design/Spec, Reporting		10 %	$534,779		
Contingency		30 %	$1,604,337		
Total Option Cost			**$7,500,000**		
Ongoing annual leachate management fee after 60 months	7 t	260 $/t	1820	Leachate drawn from cells directly by contractor via standpipe, reducing annually. Allow 100% increase in rate for very low volumes, unfilled tankers etc	

HAKK Leachate Management Option Summary
Option 1 - Treat on-site and use for irrigation/dust suppression
Truck leachate from Cell and CWS to CT cold wells / head tanks
Pretreatment + membranes - irrigate permeate via North Dams
Waste contractor disposal of sludge and brine
Contractor waste disposal of all leachate after 20 mths treating
Option 2 - Treat on-site for discharge to trade waste
Truck leachate from Cell and CWS to CT cold wells / head tanks
Pretreatment + membranes - tradewaste discharge via sewage pump station, then truck to tradewaste once sewage system decommissioned
Waste contractor disposal of sludge and brine
Contractor waste disposal of all leachate after 20 mths treating
Option 3 - Store and evaporate (mech assisted) majority of leachate
Floating evaporator units in lined evap pond- weather station controlled
Waste contractor removal of residual brine after majority of water evaporated
Contractor waste disposal of all leachate after 20 mths treating
Option 4 - Waste contractor removal and treatment/disposal off site
Contractor removal and disposal of all leachate



Appendix E Option Assessment

145 Ann Street Brisbane QLD Australia 4000	**Leachate Treatment Options Matrix**	**COVER SHEET** **Sheet 1 of 5**

Project	**Kurri Kurri Leachate Management**				
Job Number	**22/18015**	Sheet	1	of	5
Client	**HAKK**	**Discipline**		**Process**	

ITEM OF DESIGN Leachate Management Options

DESIGN DESCRIPTION Options Scoring and Sensitivity Analysis

This transmittal comprises: 5 sheets numbered 1 to 5

REV 1	**25/05/2017**	**Additional Contract Removal Rates Included**	**PFM**	**BMG**	
FINAL	**24/11/2016**	**Post-Workshop incorporating workshop comments**	**PFM**	**BMG**	
DRAFT	**7/11/2016**	**Draft Pre-Workshop**	**PFM**		
Revision	Date	Description	Originator	Checked	Approved

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Client:	**HAKK**	Job no.:	**22/18015**	Sheet **2** of **5**	
Project:	**Kurri Kurri Leachate Management**	Options by:	**P McFadyen**	Date:	**24/02/2017**
Subject:	**Leachate Management Options**	Checked by:	**B Goebel**	Date:	**25/05/2017**

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Options Matrix

Client:	HAKK	Job no.:	22/18015	Sheet	3 of 5
Project:	Kurri Kurri Leachate Management	Options by:	P McFadyen	Date:	24/02/2017
Subject:	Leachate Management Options	Checked by:	B Goebel	Date:	25/05/2017

	Option	Ability to meet water quality (Irrigation, tradewaste, contractor removal)	Cost sensitivity to total leachate volume	Environmental impact and risk (energy and waste streams)	Social (eg noise, odour)	Total cost - CAPEX/OPEX	HAKK staff resourcing requirement	Health and safety risk	Option Score	Comment
	Criteria Weighting:	25%	10%	15%	5%	15%	5%	25%		
1	**Option 1 - Treat on-site and use for irrigation/dust suppression**	2	5	3	4	1	1	4	2.85	
2	**Option 2 - Treat on-site for discharge to trade waste**	2	4	2	3	1	1	3	2.30	
3	**Option 3 - Store and evaporate (mech assisted) majority of leachate**	3	2	2	3	4	3	2	2.65	
4	**Option 4 - Waste contractor removal and treatment/disposal off site**	5	3	2	2	5	5	3	3.70	

Option Scoring Costs	Total
Option 1 - Treat on-site and use for irrigation/dust suppression	$4,800,000
Option 2 - Treat on-site for discharge to trade waste	$4,800,000
Option 3 - Store and evaporate (mech assisted) majority of leachate	$3,400,000
Option 4 - Waste contractor removal and treatment/disposal off site	$2,900,000

Criteria Scoring

Client:	HAKK	Job no.:	22/18015	Sheet	4 of 5
Project:	Kurri Kurri Leachate Management	Options by:	P McFadyen	Date:	24/02/2017
Subject:	Leachate Management Options	Checked by:	B Goebel	Date:	25/05/2017

			50-500	500-1M	1M-2M	
Evaluation Criteria	**Weighting**	**(Good)**		**Score**		**(Bad)**
		5	**4**	**3**	**2**	**1**
Ability to meet water quality (Irrigation, tradewaste, contractor removal)	25%	Almost certain but specific contractor testwork required to confirm costs/duratrion	Very likely but specific contractor testwork required to confirm feasibility and costs/duratrion	Likely but specific contractor testwork required to confirm feasibility and costs/duratrion	Likely but specific contractor testwork required to confirm feasibility and costs/duratrion, multiple risk elements to feasibility and duration/cost	Effectiveness unknown - specific contractor testwork required to confirm feasibility and costs/duratrion
Cost sensitivity to total leachate volume	10.0%	Low sensitivity to 50% increase in volume - results in cost increase ≤$1.0M	Minimal sensitivity to 50% increase in volume - results in cost increase $1.0 to $1.2M	Moderate sensitivity to 50% increase in volume - results in cost increase $1 .2to $1.4M	Considerable sensitivity to 50% increase in volume - results in cost increase $1.4 to $1.6M	Significant sensitivity to 50% increase in volume - results in cost increase >$1.6
Environmental impact and risk (energy and waste streams)	15%	Negligible environmental impact (energy/waste) or risk of environmental harm (leaching and spills)	Minimal environmental impact (energy/waste) or risk of environmental harm (leaching and spills)	Moderate environmental impact (energy/waste) or risk of environmental harm (leaching and spills)	Considerable environmental impact (energy/waste) or risk of environmental harm (leaching and spills)	Significant environmental impact (energy/waste) or risk of environmental harm (leaching and spills)
Social (eg noise, odour)	5%	Negligible social impact	Minimal social impacts	Moderate social impacts	Considerable social impacts	Significant social impacts
Total cost - CAPEX/OPEX	15.0%	≤$3M	$3 to $3.5M	$3.5 to $4M	$4 to $4.5M	>$4.5M
HAKK staff resourcing requirement	5%	Negligible input from operations staff	Limited attendance by operations staff required (up to 3hr per week)	Moderate attendance by operations staff required (up to 2 hr per day)	Frequent attendance by operations staff required (2 - 5 hr per day)	Additional operational staff required full time.
Health and safety risk	25%	Negligible health and safety risks to contractor or HAKK operating staff - risks readily managed	Minimal health and safety risks to contractor or HAKK operating stafff - risks readily managed	Moderate health and safety risks to contractor or HAKK operating staff - risk management requiring frequent attention	Considerable health and safety risks to contractor or HAKK operating staff - significant risk management attention required	High risk operations are required and significant risk mitigation measures will be required
	100%					

Sensitivity Analysis

Client:	HAKK	Job no.:	22/18015	Sheet	5	of	5
Project:	Kurri Kurri Leachate Management	Options by:	P McFadyen	Date:	24/02/2017		
Subject:	Leachate Management Options	Checked by:	B Goebel	Date:	25/05/2017		

Criteria Weighting Sensitivity Analysis

Criteria Scenario	A	B	C	D	E	F	G	H
Ability to meet water quality (Irrigation, t	25%	25%	25%	20%	25%	25%	25%	25%
Cost sensitivity to total leachate volume	10%	10%	10%	10%	10%	10%	10%	10%
Environmental impact and risk (energy a	15%	15%	15%	15%	15%	15%	15%	15%
Social (eg noise, odour)	5%	5%	5%	5%	5%	5%	5%	5%
Total cost - CAPEX/OPEX	15%	15%	15%	15%	15%	15%	15%	15%
HAKK staff resourcing requirement	5%	5%	5%	5%	5%	5%	5%	5%
Health and safety risk	25%	25%	25%	30%	25%	25%	25%	25%

						Cleanaway	Toxfree	Windsor
Options - Total Scores	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**
1	2.9	2.9	2.85	3.0	2.9	3.0	3.0	3.00
2	2.3	2.3	2.3	2.4	2.3	2.5	2.45	2.45
3	2.7	2.4	2.90	2.6	2.7	2.8	2.8	2.8
4	3.7	3.7	3.7	3.6	3.4	3.6	3.1	2.85
Margin to next highest score	0.9	0.9	0.8	0.7	0.6	0.6	0.1	0.2
Margin to next highest score	23%	23%	22%	18%	16%	15%	3%	5%

Green Cells = highest score

Orange text = second highest score

Scenario descriptions:

A Workshop agreed weightings and scores

B Option 3 HSE score of 1 instead of 2

C Option 3 HSE score of 3 instead of 2

D HSE to 30%, meet water quality criteria to 20%

E Leachate transport and disposal rate doubles from \$130/t to 260/t, brine transport and disposal rate increases by 50% and re-spanned cost score brackets to 4-4.5, 4.5-5, 5-5.5, 5.5-6, 6-6.5 (Opt 1:1, Opt 2:1, Opt 3:4, Opt 4:3). Assumes same relative cost sensitivity scores as original total costs scenario.

F Leachate transport and disposal rates advised by cleanaway increase by 20-25% and add liquid waste levy and re-spanned cost score brackets to 4-4.5, 4.5-5, 5-5.5, 5.5-6, 6-6.5 (Opt 1:2, Opt 2:2, Opt 3:5, Opt 4:4). Assumes same relative cost sensitivity scores as original total costs scenario.

G Leachate transport and disposal rates from **toxfree** for **Windsor** facility including liquid waste levy and re-spanned cost score brackets to 3-4, 4-5, 5-6, 6-7, 7-8 (Opt 1:2, Opt 2:2, Opt 3:5, Opt 4:1). Assumes same relative cost sensitivity scores as original total costs scenario.

H Leachate transport and disposal rates from **toxfree** for **Windsor** facility including liquid waste levy (per scenario G) But reduce score from 5 to 4 for criteria: Ability to Meet Water Quality (Irrigation, tradewaste, contractor removal) as some risk that discharge from Toxfree treatment process not able to be sent to sewer

Re-ranged cost scoring notes:

		Cost	Score
F:	Option 1	\$5,800,000	2
	Option 2	\$5,800,000	2
	Option 3	\$4,400,000	5
	Option 4	\$4,800,000	4
G & H:	Option 1	\$6,300,000	2
	Option 2	\$6,400,000	2
	Option 3	\$4,400,000	5
	Option 4	\$7,500,000	1

Option Description

Option 1 - Treat on-site and use for irrigation/dust suppression

Option 2 - Treat on-site for discharge to trade waste

Option 3 - Store and evaporate (mech assisted) majority of leachate

Option 4 - Waste contractor removal and treatment/disposal off site

Leachate transport and disposal budget pricing:

Toxfree - Kurri Kurri Facility

Transport and disposal budget pricing:

				$/kL	
Transport – Semi Tanl	Hour	\$170.00/hr	Estimated time per trip, 2 hours, \$340.00 per trip	15	
Disposal	Litre	\$0.25/litre		250	
Liquid Waste Levy	Litre	\$0.0727/litr	Subject to waste classification, reviewed July each year	73	actually per tonne but within 10%
				338	**$/kL to Kurri Kurri**

Notes: Toxfree have a property at **Mitchell Avenue, Kurri Kurri** that has been **DA approved and EPA licenced** for bulk liquid waste treatment.
We are currently working through the **design, costing and construction** phase of this site but expect it be **completed in approximately 12 months.**
Disposal rate for 3 x concentrations and 5 x concentrations: plus 10% maximum on base rate

Toxfree - Windsor Facility

Transport and disposal budget pricing:

				$/kL	
Transport – Semi Tanl	Hour	\$170.00/hr	Estimated time per trip, 6 hours, \$1,020.00 per trip	46	
Disposal	Litre	\$0.25/litre		250	
Liquid Waste Levy	Litre	\$0.0727/litr	Subject to waste classification, reviewed July each year	73	actually per tonne but within 10%
				369	**$/kL to Windsor**

Notes: Toxfree **own and operate** a major integrated liquid and sludge facility at **South Windsor.**
We could **upgrade this facility** quite easily as the existing infrastructure would be beneficial to handle the leachate waters from Hydro Aluminium.
In order for Toxfree proceed with the above we would need to work with GHD and Hydro Aluminium to **finalise the scope, volume and requirements of the program.**
This will effect the **sizing of the plant and equipment required** to complete the works.
In reference to transport Toxfree have the largest fleet of liquid vacuum tankers in NSW and therefore could easily handle the movements of this material.
Disposal rate for 3 x concentrations and 5 x concentrations: plus 10% maximum on base rate

Key Risks: Trade Waste Acceptance of high salinity water by Hawkesbury or Kurri Kurri Council
Councils want modelling done by Toxfree to assess impact of high salinity discharge blended into their sewer
May need to add storage capacity to enable bleeding the discharge to sewer to meet load limits for trade waste
Alternatively they have an existing industrial customer who could accept the quantity and quailty of proposed discharge - based on a specific phone conversation with the customer about it.
DA/EPA licence amendment not able to be secured for Kurri Kurri facility construction - Toxfree comment: Very low risk as the DA and Licence has been granted
DA/EPA licence amendment not able to be secured for system modifications required at Windsor facility - Toxfree comment: very low risk

Cleanaway - Olympic Park Facility

- rate for transport and disposal based on removing >10ML leachate over 5 yrs at variable monthly volumes?
  - \$130/tonne (+GST) **Estimated Variation: (+20%, -40%)**
- rate for transport and disposal based on removing 1/3 of this volume at 3 times the concentration over 5 yrs at variable monthly volumes?
  - \$275/tonne (+GST) **Estimated Variation: (+25%)**
- rate for transport and disposal based on removing 1/5 of this volume at 5 times the concentration over 5 yrs at variable monthly volumes?
  - \$400/tonne (+GST) **Estimated Variation: (+25%)**

Base rate + variation % + liquid waste levy included for scenario F

Options Matrix Scoring Notes

Option 1 - Treat on-site and use for irrigation/dust suppression

Criteria 1: Ability to meet water quality (Irrigation, tradewaste, contractor removal)
Treatment process should be feasible to achieve targets, testing required to confirm - some risk to cost if more complex treatment or pre-treatment required.
Still some risk around irrigation basis target.
Solids stabilisation may be required to avoid contaminant remobilisation in landfill but quantity/type of additives to be tested - or contractor removal.
Multiple risk elements - process, irrrig.

Criteria 2: Cost sensitivity to total leachate volume
$1.0 M increase

Criteria 3: Environmental impact and risk (energy and waste streams)
Water reuse for irrigation under licence, still some risk around irrigation basis target- risk of irrigation area damage.
High energy treatment.
Lower risk of spills as limited material transported off site - managed reg waste process.

Criteria 4: Social (eg noise, odour)
Moderate diesel generator exhaust, unless LT6 power used for all supply.
Traffic - moderate trucking

Criteria 6: HAKK staff resourcing requirement
Full time operator.

Criteria 7: Health and safety risk
Materials handling precautions and risk assessments for hazardous materials (water/sludge/asbestos).
Some trucking increasing driving hazards.

Option 2 - Treat on-site for discharge to trade waste

Criteria 1: Ability to meet water quality (Irrigation, tradewaste, contractor removal)
Treatment process should be feasible to achieve targets, testing required to confirm - some risk to cost if more complex treatment or pre-treatment required.
Numerous contaminants in permeate may be of concern to Hunter Water which may mean not feasible.
Solids stabilisation may be required to avoid contaminant remobilisation in landfill but quantity/type of additives to be tested.
Multiple risk elements - process, trade waste acceptance.

Criteria 2: Cost sensitivity to total leachate volume
$1.1 M increase

Criteria 3: Environmental impact and risk (energy and waste streams)
High energy treatment.
Slightly higher risk of spills than option 1 as more material transported off site - managed reg waste process.
More trucking than option 1.

Criteria 4: Social (eg noise, odour)
Moderate diesel generator exhaust, unless LT6 power used for all supply.
More trucks on road than option 1 when trucking to WWTP necessary.

Criteria 6: HAKK staff resourcing requirement
Full time operator.

Criteria 7: Health and safety risk
Materials handling precautions and risk assessments for hazardous materials (water/sludge/asbestos).
More trucks on road than option 1 when trucking to WWTP necessary.

<u>Option 3 - Store and evaporate (mech assisted) majority of leachate</u>

Criteria 1: Ability to meet water quality (Irrigation, tradewaste, contractor removal)
Contractor expected to be able to handle concentrated residual.
Evaporation rates may vary from design assumptions so duration or cost may be affected and scaling may become problematic leading to earlier commencement of contractor removal (higher cost).High ammonia may accelerate corrosion.

Criteria 2: Cost sensitivity to total leachate volume
$1.5 M increase

Criteria 3: Environmental impact and risk (energy and waste streams)
Low energy treatment.
Similar risk of spills to options 1 and 2 as limited material transported off site - managed reg waste process.
Overspray from surface evaporator may cause damage to trees - weather station controller to limit operation of evaporator to appropriate weather conditions.
Considerable trucking.
Higher risk of ammonia and other odours from spraying.
Liner breach and brine contamination of soil/groundwater.

Criteria 4: Social (eg noise, odour)
Surface evaporator may drive off some NH3 gas (liquor at high pH and NH3 species dominant causing odour issues - may reduce evaporator operating time to when wind direction is away from sensitive receptors.
Higher diesel generator exhaust as located away from fixed power supply.
Limited trucking.

Criteria 6: HAKK staff resourcing requirement
1 h/d operator.

Criteria 7: Health and safety risk
Ammonia / other odour emissions.
Asbestos fibres risk as no filtration prior.
Materials handling precautions and risk assessments for hazardous materials (water/sludge).
Overspray from surface evaporator may cause OH&S issues (particularly with landfill activities in the area) - weather station controller to limit operation of evaporator to appropriate weather conditions.
Considerable trucking - additional driving hazards.

<u>Option 4 - Waste contractor removal and treatment/disposal off site</u>

Criteria 1: Ability to meet water quality (Irrigation, tradewaste, contractor removal)
Contractor expected to be able to handle leachate.

Criteria 2: Cost sensitivity to total leachate volume
$1.3 M increase

Criteria 3: Environmental impact and risk (energy and waste streams)
Low energy solution.
Higher risk of spills as all leachate is transferred off site - managed reg waste process.
Significant trucking

Criteria 4: Social (eg noise, odour)
Highest and longest trucking.

Criteria 6: HAKK staff resourcing requirement
Negligible HAKK operator involvement.

Criteria 7: Health and safety risk
Ammonia / other odour emissions.
Materials handling precautions and risk assessments for hazardous materials (water/sludge).
Significant trucking - additional driving hazards.

Appendix F Safety in Design

Safety in Design

1. What is ‘Safety in Design’?

Safe design is a process defined as:

“The integration of hazard identification and risk assessment methods early in the design process to eliminate or minimise the risks of injury throughout the life of the product being designed.”

A safety in design approach begins in the conceptual and planning phases within a design’s lifecycle, with an emphasis on making choices about design, materials and methods of manufacture or construction, to enhance safety. The designer needs to consider how safety can best be achieved in each of the lifecycle phases (construction, use, maintenance, demolition).

Safety in design is part of a broader range of design objectives, including practicality, aesthetics, cost and the functionality of the plant, building or structure. A safety in design approach involves successfully achieving a balance of these sometimes competing objectives, without compromising the health and safety of those potentially affected by the plant, building or structure over its lifecycle.

2. What are the principles of Safety in Design?

The key elements that impact on implementing safety in design are:

Principle 1: Persons with Control – persons who make decisions affecting the design of products, facilities or processes are able to promote health and safety at the source.

Principle 2: Product Lifecycle – safe design applies to every stage in the lifecycle from conception through to demolition. It involves eliminating hazards or minimising risks as early in the lifecycle as possible.

Principle 3: Systematic Risk Management– the application of hazard identification, risk assessment and risk control processes to achieve safe design.

Principle 4: Safe Design Knowledge and Capability – should be either demonstrated or acquired by persons with control over design and should reflect the knowledge that a competent designer would be expected to have.

Principle 5: Information Transfer – effective communication and documentation of design and risk control information between all persons involved in the phases of the lifecycle is essential for the safe design approach.

3. Context for this report

The inclusion of safety in design principles within legislation means that it is no longer sufficient to assume that compliance with a code or standard is enough.

If engaged to undertake detailed design, GHD can implement safety in design processes to identify those health and safety issues in the design phase of a job that may have an effect on the construction, maintenance or end use of the final product. In some cases, the safety in design risk assessment will take the form of a HAZOP study.

Under Health and Safety legislation, a client who commissions construction work must consult with the designer of the structure about how to ensure that risks arising from the design during the construction work are eliminated or minimised.   The designer of a structure must give the client a written report that specifies the hazards associated with the particular design and not with other designs of the same type of structure.

As the current scope of work is very preliminary, structures have yet to be designed and this document does not specify safety issues in detail. As part of a more comprehensive safety in design risk assessment, risks should be identified and addressed for each of the following:

- Construction (eg. Site conditions)
- Installation (eg. Locating water and sludge extraction equipment without damaging containment cell or buffer storage structure or lining)
- Operation (eg. potential confined spaces, access and egress, gaseous emissions, road transport)
- Maintenance (eg. Operational limits during partial maintenance shut down)
- Demolition (eg. Material safe disposal)
- Users (eg. Services and Equipment; ie space for the operator)
- Community (eg. Access and security)

4. Preliminary OHS&E risks identified

A number of OHS&E risks were identified through development of the options and were listed in the option scoring notes associated with the scoring matrix. A summary of these high level risks is provided below:

- Contractor treatment processes or treatment on site of the leachate may adjust the equilibrium of dissolved ammonium ions and ammonia gas in the water or sludge causing release of ammonia gas. Potential environmental, safety and odour issues associated with release of ammonia gas would need to be managed by the contractor.
- The leachate and associated solids residues may be alkaline and toxic and may also contain asbestos fibres. Risks associated with handling and disposal of the asbestos contaminated leachate and associated solids residues will need to be managed.
- If contractors use assisted evaporation technologies, environmental impact must be managed through restricting spray drift to fall inside the dam footprint under all climatic conditions. Other risk mitigation may also be required regarding management of OH&S and odour risks including limiting operations to when the wind direction is away from sensitive receptors. Storage of evaporatively concentrated leachate in a lined evaporation pond also increases the consequences of liner failure and brine contamination of soil/groundwater.
- Ammonia emissions may occur during leachate treatment operations either on site or at contractors' facilities: It is considered unlikely that EPA will require a temporary emissions licence or transitional environmental program to permit the release of ammonia from the temporary treatment processes on site but it is recommended that Hydro discuss this with EPA in the context of the project as specific EPA requirements for this exercise are difficult to predict with certainty.
- Damage to irrigation area soils and vegetation through inadequate treatment of leachate and delivery of off-spec water to the North Dams.
- Regulated waste material spills on site, during transport and during unloading at destinations.
- Inadequate stabilisation of solids material resulting in leaching of toxic contaminants from the waste.
- Potentially significant trucking requirements and associated driving hazards.

No formal risk identification and assessment process has been undertaken at this stage (ie a HAZID workshop) to identify all potential hazards. The solutions tendered (and therefore the selected approach) may include other processes not covered in the assessment of options so a formal risk assessment of the preferred tender will need to be conducted to ensure risks are mitigated adequately.

It is recommended that Contractors be required to submit a preliminary risk assessment with their tender based on their proposed process/methodology including identification of how the Contractor would mitigate and manage those risks. Once the preferred tenderer is awarded the contract, they should be required to attend formal HAZID and HAZOP workshops.

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Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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Appendix D Geotechnical Investigation

Hydro Aluminium Kurri Kurri

Containment Cell Detailed Design and Associated Services

Supplementary Geotechnical Investigation Factual Report

May 2016

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Appendices

1. Introduction

GHD Pty Ltd (GHD) has been engaged by Hydro Aluminium Kurri Kurri Pty Ltd (Hydro) to perform and complete the Containment Cell Design and Associated Services for the HAKK Demolition and Remediation Project (the Project). GHD's Scope of Services covers the detailed design, constructability review, quality specifications, project cost estimate, schedule and other related requirements.

As part of the Scope of Services, additional geotechnical investigation was undertaken within the existing 'clay borrow pit' area to supplement the available geotechnical and hydrogeological information that was reviewed as part of the gap analysis phase (Ref GHD report 1916)

This report provides the factual results of the additional geotechnical investigation, incorporating:

- A methodology of the fieldwork undertaken at the site
- Borehole logs and a test location plan
- A summary of the subsurface conditions encountered
- Laboratory report sheets
- A summary of material index property laboratory test results
- Installed groundwater well completion details
- Groundwater and rock levels measured during the investigation

1.1 Project description

The HAKK Demolition and Remediation Project involves proposed demolition, remediation and material management activities within the former Hydro Aluminium Smelter as well as the surrounding buffer lands. The design and construction of a containment cell within the previous 'clay borrow pit' area is proposed as part of the remediation and material management strategy for the Project. The containment cell is proposed to cover an area of approximately 5 hectares, with an excavation depth of approximately 8m.

1.2 Limitations

This report: has been prepared by GHD for Hydro Aluminium Kurri Kurri and may only be used and relied on by Hydro Aluminium Kurri Kurri for the purpose agreed between GHD and the Hydro Aluminium Kurri Kurri as set out in Section 1 of this report.

GHD otherwise disclaims responsibility to any person other than Hydro Aluminium Kurri Kurri arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

GHD has prepared this report on the basis of information provided by Hydro Aluminium Kurri Kurri, which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Site description and regional geology

2.1 Site description

The clay borrow pit area is located approximately 250 m west of the north eastern corner of the HAKK facility, which lies to the north east of the Hunter Expressway, approximately 3 km north of the township of Kurri Kurri.

The site comprises an irregular shaped area of approximately 4 ha, which has been cleared of vegetation and disturbed by past activities associated with the HAKK facility. The surrounding land surface generally slopes gently downwards towards the east. At the time of the investigation, the site was relatively flat with several stockpile mounds up to .6 m in high located around the perimeter of the open area. The site is surrounded on all sides by dense bush land.

2.2 Regional geology and soils

Reference to the 1:250,000 scale Singleton Geological Series Sheet SI 56-1, 1969 shows the site to be underlain by the early Permian aged Rutherford Formation of the Dalwood Group, comprising mudstone, siltstone, conglomeratic sandstone, sandstone, shale and marl deposited in a front delta environment. The apex of an anticline (i.e. a fold that is convex up) crosses the site in the east-west direction.

Reference to the relevant soils maps and data (refer reliance data in the gap analysis report – (Ref GHD report 1916) shows that the site is located within the Neath soil landscape located on gently undulating rises and swamps of the Permian siltstone, sandstone and coal units with local relief up to 30 m and slopes up to 3%. Surface soils shown to be are solodic, with a strong textural contrast between the A (topsoil) and strongly acid B (subsoil) horizons. At least one of the subsoil horizons (B2) within the soil landscape has been shown to be sodic (i.e. dispersive).

There are no known occurrences of acid sulfate soils at the site.

3. Investigation methodology

3.1 Preliminaries

A 'Dial-Before-You-Dig' buried services enquiry was made for each of the proposed test locations prior to the commencement of the fieldwork. To manage the risks of underground services, a qualified services locator was engaged to scan and confirm that all test positions were clear of any services.

A Safety Plan, including a Job Safety and Environment Analysis (JSEA) was prepared prior to conducting the fieldwork. All project site staff were inducted in to the Safety Plan prior to commencing fieldwork by the GHD supervisor, who also conducted daily pre-start safety assessments throughout the fieldwork.

3.2 Fieldwork

A total of nine (9) boreholes were drilled across the clay borrow pit area, incorporating four pairs of groundwater monitoring wells about the perimeter of the area and one central borehole to supplement existing geotechnical data.

Borehole drilling was carried out at the site between 9 and 10 March 2016. Boreholes were drilled using a 4WD truck mounted specialist geotechnical drilling rig, adopting solid flight auger drilling techniques, to depths of between 4.3 m and 12 m below the existing surface level.

The four pairs of groundwater wells each incorporated one shallow well to target perched water levels within the clay profile and one deep well to target groundwater levels within the underlying bedrock. The shallow wells (BH01 to BH04) were drilled / installed to depths of between 3.5 and 7.0 m below the existing surface, while the deep wells (BH01A to BH04A) were drilled / installed to 12 m depth.

The centrally located borehole (BH05) was drilled to a depth of 4.3 m.

Standard penetration tests (SPTs) were carried out at regular depth intervals (1.0 to 1.5 m) within the soil profile to provide an assessment of the relative soil 'strength' and correlation with geotechnical parameters. Soil samples recovered from the SPT sampler and disturbed samples taken from the auger were collected for laboratory testing purposes.

Standpipe piezometers / monitoring wells were installed with a 3m machine slotted section at the base of the hole and a sand 'screen'. A bentonite plug was used to isolate the screened section from the remainder of the un-slotted well section. The annuls of the remainder of the well was backfilled with soil cuttings.

Upon completion of drilling, BH05 was backfilled to the surface with drill cuttings.

Subsurface investigations were supervised on a full time basis by an experienced geotechnical engineer, who was responsible for locating the boreholes, logging the encountered strata, directing/conducting in-situ testing and collecting representative samples for laboratory testing. The logging was generally carried out in accordance with Australian Standard, AS1726-1993.

The locations of each the boreholes were recorded using a hand held 'Trimble' GPS unit (typically accurate to +/- 0.5 m) in MGA format. Surface RLs have been interpolated from the recent Airsight 'lidar' survey data provided for the site, again typically accurate to within +/- 0.5 m. Direct (eg total station) survey of the monitoring wells will be necessary to obtain surface levels to an accuracy sufficient to determine groundwater gradients across the site, if required.

The borehole locations are presented on the Geotechnical test location plan presented as Figure 1 in Appendix A and are summarised in Table 3-1 below.

Table 3-1 Borehole summary

Test Location	Surface RL * (m)	Easting (MGA)	Northing (MGA)	Termination Depth (m)
BH01	19.5	357079	6371322	4.5
BH01A	19.5	357079	6371321	12
BH02	22.3	356898	6371351	7.24
BH02A	22.2	356900	6371351	12
BH03	23.0	357013	6371563	4
BH03A	23.0	357014	6371563	12
BH04	22.1	357134	6371538	3.5
BH04A	22.0	357131	6371538	12
BH05	24.1	357034	6371462	4.27

Based on recent Airsight lidar survey

The borehole logs are provided in Appendix C. The logs should be read in conjunction with the attached Standard Sheets (refer Appendix B), which explain the terms, abbreviations and symbols used together with the interpretations and limitations of the logging procedure.

3.3 Laboratory testing

Geotechnical soil samples recovered from the site were transported to GHD's NATA accredited laboratory in Artarmon for materials testing. The following geotechnical laboratory testing was undertaken:

- Moisture Content (5 tests)
- Atterberg Limits and linear shrinkage (5 tests)
- Particle Size Distribution and hydrometer (2 tests)
- California bearing ratio with standard compaction (2 tests)
- Emmerson class test (5 tests)

4. Subsurface conditions

4.1 Subsurface profile

General descriptions of the encountered subsurface units are provided below. Reference to the individual borehole log sheets (Appendix C) should be made for a full description of the subsurface conditions encountered at each test location.

In general terms, the subsurface profiles encountered at the borehole locations comprised an upper layer of residual clay soil, overlying weathered siltstone bedrock. At some locations the residual clay was overlain by fill or topsoil material. The more pertinent aspects of general occurrences of these strata are summarised as follows:

- **Topsoil -** comprising sandy clay with some roots, encountered in boreholes BH01 and BH03 only and extending to depths of 0.15 m and 0.3 m respectively.
- **Fill -** identified in BH02 only to a depth of 0.4 m, comprising clayey sand.
- **Residual Clay -** comprising an upper layer of red-brown and orange brown medium to high plasticity clay, encountered from the surface or underlying the fill or topsoil strata to depths ranging from 0.4 m to 2.4 m; underlain by pale grey medium to high plasticity clay layer.
- **Bedrock -** encountered underlying the predominantly medium plasticity residual clay layer, at depths ranging from 3.7 m to 7 m and comprising extremely to highly weathered, very low to low strength siltstone. A 1.5 m thick bed of extremely to completely weathered, very low to low strength sandstone layer was encountered above the siltstone bedrock in BH01.

Depths to the top of the bedrock encountered in the recent boreholes are summarised in the following Table 4.1.

Table 4-1 Measured depth to top of bedrock strata

Well ID	Depth to bedrock (mbgl)	Approximate RL of top of bedrock (m AHD)
BH01A	4.0	15.5
BH02A	7.0	15.2
BH03	4.3	18.7
BH04	3.9	18.1
BH05	3.7	20.4

4.1 Groundwater

Groundwater was not encountered within any of the boreholes (BH01 to BH05) during drilling and well installation. Groundwater level readings were recorded in most of the installed wells during a subsequent site visit on 4 April 2016 and are summarised in Table 4-2.

Table 4-2 Measured groundwater level summary

Well ID	Groundwater level (mbgl)	Approximate groundwater RL (m AHD)
BH01	3.41	16.1
BH01A	6.80	12.7
BH02	4.93	17.4
BH02A	4.61	17.6
BH03	Dry	-
BH03A	4.83	18.2
BH04	Dry	-
BH04A	Dry	-

The similar groundwater levels measured in BH02 and BH02A may suggest that both instruments are recording groundwater levels from the same aquifer.

Groundwater levels within selected accessible pre-existing monitoring wells (from investigations carried out in 2012 and 2014) were also measured during the site investigation. The results are presented in the table below.

Table 4-3 Groundwater level summary of existing wells

Well ID*	Groundwater level (mbgl)	Approximate groundwater RL (m AHD)*
MW03	5.2	18.3
CBP3	4.74	16.3
CBP4	3.34	16.2
MW04	2.1	16.6
MW01	Unable to take a reading	-
CBP1	14.2	9.9
CBP2	4.23	19.9

RL based on recent Airsight lidar survey

It should be noted that groundwater levels fluctuate and that no long term monitoring of groundwater levels has been undertaken as part of this investigation. Also, sampling or testing for groundwater quality or geochemistry was not undertaken within the scope of this investigation.

5. Laboratory test results

The geotechnical laboratory results are summarised in the following tables, while the laboratory test report sheets presented in Appendix D.

Table 5-1 Moisture content and Atterberg Limits test results

Sample Location	Sample Depth (m)	Material	FMC (%)	Atterberg Limits			
				LL (%)	PL (%)	PI (%)	LS (%)
BH01	1.0-1.45	Clay	11.5	39	15	24	13.0
BH02	2.5-2.95	Clay	6.8	51	19	32	15.0
BH03A	5.5-5.92	Siltstone	16.3	44	19	25	10.5
BH04A	1.0-1.45	Sandy Clay	15.4	39	17	22	13.0
BH04A	4.0-4.45	Siltstone	13.5	39	17	22	10.5

Where: FMC = field moisture content LL = liquid limit
PL = plastic limit PI = plasticity index

The above moisture content and plasticity results confirm the logging of the tested soil as typically medium to high plasticity. Field moisture contents in the tested samples were generally dry of the plastic limit.

The above Atterberg Limits data, along with the previous results extracted during the gap analysis, is plotted on a plasticity chart in Figure 5-1 below.

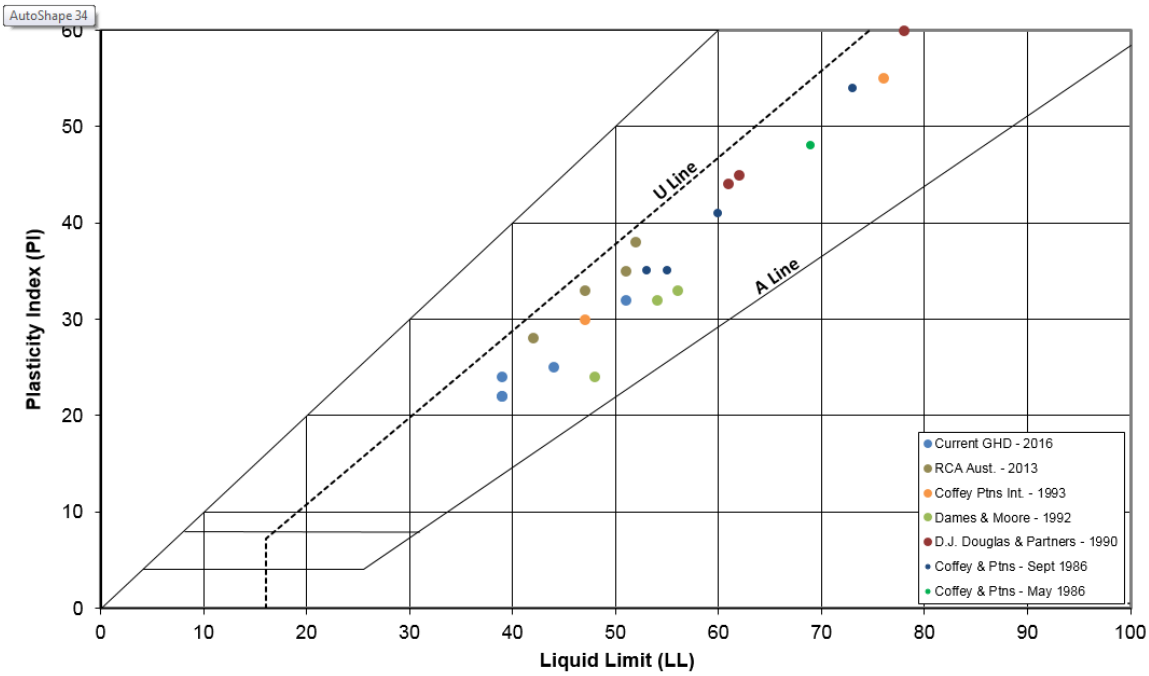

Figure 5-1 Plasticity Chart

Table 5-2 Particle size distribution test results

Sample Location	Sample Depth (m)	Material	% Fines (<0.075mm)	Sand (% 0.075mm to 2.36mm)	Gravel (% > 2.36mm)
BH03A	3.5-3.6	Clay	94	5	1
BH05	4.0-4.12	Siltstone	54	46	0

Table 5-3 Emerson class test results

Sample Location	Sample Depth (m)	Material	Emerson Class Number
BH01	2.5-2.95	Clay	1
BH02	0.5-0.6	Clay	3
BH02	7.0-7.24	Siltstone	1
BH03A	2.5-2.95	Clay	1
BH05	3.7-3.8	Siltstone	2

The above Emerson Class test results indicate that the tested soils are dispersive in nature (i.e. they will break down in contact with water and form a cloudy colloidal suspension).

Table 5-4 Standard compaction and California Bearing Ratio test results

Sample Location	Sample Depth (m)	Material	FMC (%)	MDD t/m3	OMC (%)	CBR (%)
BH01	0.5-1.5	Clay	16.4	1.75	17.3	3
BH04	0.3-1.5	Clay	22.1	1.72	18.2	4

Where: FMC = field moisture content MDD = maximum dry density
OMC = optimum moisture content CBR = California bearing ratio

6. Summary of factual findings

The additional subsurface investigations identified a typical profile of residual clay strata overlying weathered siltstone bedrock. Limited topsoil and fill materials were also encountered at the site The residual clays were typically stiff to very stiff and comprised an upper layer of red-brown and orange brown medium to high plasticity clay overlying pale grey predominantly medium to high plasticity clay. Siltstone and sandstone bedrock (belonging to the early Permian aged Rutherford Formation) was generally extremely to highly weathered and very low to low strength within the depth of the investigation.

Laboratory testing of the site soils show them to be generally dry of the plastic limit, of medium to high plasticity and highly dispersive.

Bedrock was encountered at depths ranging from 3.7 m to 7 m. Approximate reduced levels at the top of the bedrock strata suggest that the rock surface typically dips to the north and south from a local high point near the centre of the site (in the vicinity of BH5). Further assessment of the approximate depths to rock across the site, if critical to the cell design, could be undertaken by means of additional boreholes and / or geophysical survey (e.g. seismic refraction survey).

Groundwater was not encountered during the drilling and well installation. Subsequent measurements in the recently installed wells on 4 April 2016 identified groundwater levels at between 3.4 m and 4.9 m below the existing surface (approximate RL 18.2 m to RL 12.7 m).

Appendices

Appendix A – Geotechnical test location plan

Figure 1 – Borehole locations

Paper Size A4

0 10 20 40 60 80

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Site boundary
- Cadastre
- Current investigation borehole test locations

Previous test locations (approximate locations)

- Borehole (2012)
- Test pit (2012)
- Borehole (2014)
- Test pit (2014)

Hydro Aluminium Kurri Kurri Ltd
Containment Cell Design
Supplementary Geotechnical Investigation

Job Number	22-18015
Revision	0
Date	28 Apr 2016

Geotechnical test location plan

Figure 1

G:\22\18015\GIS\Maps\Deliverables\Geotech\2218015_G001_BoreholeLocations_0.mxd

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

Data source: HAKK: Imagery, 2015. Environ: Existing monitoring locations, 2015. Commonwealth of Australia (Geoscience Australia): 250K Topographic Data Series 3, 2006. Created by: tmorton, fmackay

Appendix B – General notes and standard sheets

GENERAL NOTES

The report contains the results of a geotechnical investigation or study conducted for a specific purpose and client. The results may not be used or relied on by other parties, or used for other purposes, as they may contain neither adequate nor appropriate information. In particular, the investigation does not cover contamination issues unless specifically required to do so by the client.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the report are excluded unless they are expressly stated to apply in the report.

TEST HOLE LOGGING

The information on the test hole logs (boreholes, test pits, exposures etc.) is based on a visual and tactile assessment, except at the discrete locations where test information is available (field and/or laboratory results). The test hole logs include both factual data and inferred information. Moreover, the location of test holes should be considered approximate, unless noted otherwise (refer report). Reference should also be made to the relevant standard sheets for the explanation of logging procedures (Soil and Rock Descriptions, Core Log Sheet Notes etc.).

GROUNDWATER

Unless otherwise indicated, the water levels presented on the test hole logs are the levels of free water or seepage in the test hole recorded at the given time of measuring. The actual groundwater level may differ from this recorded level depending on material permeabilities (i.e. depending on response time of the measuring instrument). Further, variations of this level could occur with time due to such effects as seasonal, environmental and tidal fluctuations or construction activities. Confirmation of groundwater levels, phreatic surfaces or piezometric pressures can only be made by appropriate instrumentation techniques and monitoring programmes.

INTERPRETATION OF RESULTS

The discussion or recommendations contained within this report normally are based on a site evaluation from discrete test hole data, often with only approximate locations (e.g. GPS). Generalised, idealised or inferred subsurface conditions (including any geotechnical cross-sections) have been assumed or prepared by interpolation and/or extrapolation of these data. As such these conditions are an interpretation and must be considered as a guide only.

CHANGE IN CONDITIONS

Local variations or anomalies in the generalised ground conditions do occur in the natural environment, particularly between discrete test hole locations. Additionally, certain design or construction procedures may have been assumed in assessing the soil-structure interaction behaviour of the site. Furthermore, conditions may change at the site from those encountered at the time of the geotechnical investigation through construction activities and constantly changing natural forces.

Any change in design, in construction methods, or in ground conditions as noted during construction, from those assumed or reported should be referred to this firm for appropriate assessment and comment.

GEOTECHNICAL VERIFICATION

Verification of the geotechnical assumptions and/or model is an integral part of the design process - investigation, construction verification, and performance monitoring. Variability is a feature of the natural environment and, in many instances, verification of soil or rock quality, or foundation levels, is required. There may be a requirement to extend foundation depths, to modify a foundation system and/or to conduct monitoring as a result of this natural variability. Allowance for verification by appropriate geotechnical personnel must be recognised and programmed for construction.

FOUNDATIONS

Where referred to in the report, the soil or rock quality, or the recommended depth of any foundation (piles, caissons, footings etc.) is an engineering estimate. The estimate is influenced, and perhaps limited, by the fieldwork method and testing carried out in connection with the site investigation, and other pertinent information as has been made available. The material quality and/or foundation depth remains, however, an estimate and therefore liable to variation. Foundation drawings, designs and specifications should provide for variations in the final depth, depending upon the ground conditions at each point of support, and allow for geotechnical verification.

REPRODUCTION OF REPORTS

Where it is desired to reproduce the information contained in our geotechnical report, or other technical information, for the inclusion in contract documents or engineering specification of the subject development, such reproductions must include at least all of the relevant test hole and test data, together with the appropriate Standard Description sheets and remarks made in the written report of a factual or descriptive nature.

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This procedure involves the description of a soil in terms of its visual and tactile properties, and relates to both laboratory samples and field exposures as applicable. A detailed soil profile description, in association with local geology and experience, will facilitate the initial (and often complete) site assessment for engineering purposes.

The method involves an evaluation of each of the items listed below and is in general agreement with both Australian Standard AS 1726 (the Site Investigation Code) and ASTM D2487 and D2488.

MOISTURE

The moisture condition of the soil is most applicable for cohesive soils as a precursor to the assessment of consistency and workability. The moisture condition is described as:-

Dry (dusty, dry to the touch) ***Slightly Moist*** ***Moist*** (damp, no visible water) ***Very Moist*** or ***Wet*** (visible free water, saturated condition)

In addition, the presence of any seepage or free water is noted on the testhole logs.

COLOUR

Colour is important for correlation of data between testholes and during subsequent excavation operations. The prominent colour is noted, followed by (spotted, mottled, streaked etc.) then secondary colours as applicable. Colour is usually described at as-received moisture condition, though both wet and dry colours may also be appropriate.

CONSISTENCY / DENSITY INDEX

This assessment is based on the effort required to penetrate and/or mould the soil, and is an indicator of shear strength.

Granular soils are generally described in terms of density index as listed in AS 1726. These soils are inherently difficult to assess and normally a penetration test procedure (SPT, DCP or CPT) is used in conjunction with published correlations. Alternatively, in-situ density tests can be conducted in association with minimum and maximum densities performed in the laboratory.

Term	Symbol	Density Index (%)
Very Loose	VL	< 15
Loose	L	15 - 35
Medium Dense	MD	35 - 65
Dense	D	65 - 85
Very Dense	VD	>85

Cohesive soils can be assessed by direct measurement (shear vane, CPT etc), or estimated approximately by tactile means and/or the aid of a geological pick as given on the following table. It is emphasised that a "design shear strength" must take cognisance of the mode of testing and the in-situ moisture content with the possible variations of moisture with time.

Term	Symbol	Tactile Properties	Undrained Strength S_u (kPa)
Very Soft	VS	Extrudes between fingers when squeezed in hand	<12
Soft	S	Easily penetrated by thumb about 30-40 mm. Pick head can be pushed in up to shaft.	12-25
Firm	F	Penetrated by thumb 20-30mm with moderate effort. Sharp end of pick pushed in 30-40mm.	25-50
Stiff	St	Indented by thumb about 5mm with moderate effort. Pick pushed in up to 10mm.	50-100
Very Stiff	VSt	Readily indented by thumb nail. Slight indentation produced by pushing pick into soil.	100-200
Hard	H	Difficult to indent with thumb nail. Requires power tools for excavation.	>200

STRUCTURE/OTHER FEATURES

The soil structure is generally applicable to cohesive soils and mainly refers to the presence or absence of joints and layering. Typical terms use are intact (no joints), fissured (closed joints), shattered (open joints), slickensided (polished joints indicative of movement), and stratified/laminated. In addition, the presence of other features (ferricrete nodules, timber inclusions) should also be noted as applicable.

For granular soils, an assessment of grading (well, uniform or poor), particle size (fine, medium etc.) and angularity and shape may also be given.

SOIL TYPE

The soil is described in terms of its estimated grain size composition and the tactile behaviour (plasticity of any fines (less than *0.06 mm)). This system does not differentiate on grading below 0.06 mm, in accordance with the Unified Soil Classification (USC) procedure.

However, in some situations a soil can exhibit different characteristics between the undisturbed and disturbed/remolded condition (eg. 'sand' sized particles which break down a clay). The Soil Type generally relates to the latter state but the former condition should be noted where applicable.

Furthermore, as most natural soils frequently are combinations of various constituents, the primary soil is described and modifed by minor components. In brief, the system is as follows:-

Coarse Grained Soils		Fine Grained Soils	
% Fines	Modifier	% Coarse	Modifier
<5	omit, or use "trace"	<15	omit, or use "trace"
5-12	describe as "with clay/silt" as applicable	15-30	described as "with sand/gravel" as applicable
>12	prefix soil as "silty/clayey" as applicable	>30	prefix soil as "sandy/gravelly" as applicable

(*The 200# sieve (0.075 mm) is commonly used in practice to differentiate between fine and coarse grained soils).

Note: For soils containing both sand and gravel the minor coarse fraction is omitted if less than 15%, or described as "with sand/gravel" as applicable when greater than 15%.

The appropriate USC symbol may also be given after the soil type description in accordance with ASTM D2487 and D2488.

ORIGIN

An attempt is made, where possible, to assess origin (transported, residual, pedogenic, or fill etc.) since this assists in the judgement of probable engineering behaviour. This assessment is generally restricted to field logging activities. An interpretation of landform is a useful guide to the origin of transported soils (e.g. colluvium, talus, slide debris, slope wash, alluvium, lacustrine, estuarine, aeolian and littoral deposits) while local geology and remnant fabric will assist identification of residual soils.

Ref: DS6.5.1.1 Issue 1.6 Date: 19/11/2008

ROCK DESCRIPTION

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This method is based on Australian Standard AS 1726 and is orientated to the field logging of diamond drill core, but may be used for the profiling of natural exposures and cuttings, as applicable. The procedure involves a visual and tactile assessment of the rock mass and the nature of defects within it in order to facilitate a prediction of engineering behaviour.

DESCRIPTION: Rock Type is described on the basis of origin (sedimentary, metamorphic and igneous) with the common types listed below:-

Sedimentary				Metamorphic	Igneous				
Clastic	**Non clastic (chemical)**	**Non clastic (organic)**	**Pyroclastic**			**Acid**	**Intermediate**		**Basic**
Conglomerate Sandstone Siltstone Shale Claystone	Limestone Chert Gypsum Salt	Coal Some Limestone	Tuff Agglomerate Volcanic Breccia	Slate Phyllite Schist Quartzite Gneiss	Extrusive	Rhyolite	Trachyte	Andesite	Basalt
					Intrusive (medium grained)	Quartz Porphyry	Porphyry	Porphyrite	Dolerite
					(coarse grained)	Granite	Syenite	Diorite	Gabbro

Colour is given to assist in rock identification and the interpolation of field data. Colour is usually described at as-received moisture condition, though both wet and dry colours may also be appropriate.

Texture refers to the degree of crystallinity and granularity (grain size) and the fabric relationship between the constituents of a rock. Often only grain size is given for simplified descriptions of certain sedimentary rocks.

Structure and texture are commonly used synonymously in describing rocks since there is no clear delineation between terms. In general, structure refers to large-scale features recognisable in the field (banding, lineation, massive, porphyritic, schistose etc.). For sedimentary rocks in particular, the thickness of sedimentary layering (bedding) is described as:-

Thinly laminated	<6mm	very thinly bedded	20-60mm	medium bedded	0.2-0.6m	very thickly bedded	>2m
Laminated	6-20mm	thinly bedded	60-200mm	thickly bedded	0.6-2m		

In addition, mineral composition, hardness, alteration, cementation is given as applicable.

WEATHERING: The assignment of weathering is somewhat subjective. Weathering assists identification and does not imply engineering behaviour. No distinction is drawn between chemical weathering and alteration for most engineering purposes. These procedures are collectively described as "weathering" using the following terms which do not describe the related strength change. This system is general, and in this format may not apply to all rock types. Carbonate rocks generally do not conform to this classification.

Term	Symbol	Definition
Completely Weathered	CW	Residual soil with rock fabric not visible.
Extremely Weathered	EW	The rock exhibits soil-like properties though the texture of the original rock is still evident.
Highly Weathered	HW	Limonite staining or colour change affects the whole of the rock mass and other signs of chemical or physical decomposition are evident.
Moderately Weathered	MW	Staining extends throughout the whole of the rock mass and the original colour is no longer recognisable.
Slightly Weathered	SW	Partial staining or discolouration of the rock mass, usually by limonite, has taken place.
Fresh	Fr	Rock mass unaffected by weathering.

ESTIMATED STRENGTH: This refers to the strength of the rock substance and not that of the rock mass. The strength of the rock substance is estimated by the Point Load Strength Index $I_S(50)$ and refers to the strength measured in the direction normal to the bedding for sedimentary rocks. A field guide is given below:-

Term	Symbol	$I_S(50)$ MPa	Field Guide (The core refers to a 150mm long x 50mm dia. sample)
Extremely Low	EL	<0.03	Remoulded by hand to a material with soil properties.
Very Low	VL	0.03-0.1	May be crumbled in the hand. Sandstone is "sugary" and friable.
Low	L	0.1-0.3	The core may be broken by hand and easily scored with a knife. Sharp edges of core may be friable and break during handling.
Medium	M	0.3-1.0	The core may be broken by hand with considerable difficulty. Readily scored with knife.
High	H	1-3	The core cannot be broken by unaided hands, can be slightly scratched or scored with knife.
Very High	VH	3-10	The core may be broken readily with hand held hammer. Cannot be scratched with knife.
Extremely High	EH	>10	The core is difficult to break with hand held hammer. Rings when struck with a hammer.

DEFECTS: This important feature can control the overall engineering behaviour of a rock mass. All types of natural fractures across which the core is discontinuous are noted. These fractures include bedding plane partings, joints and other defects but exclude artificial fractures such as drilling breaks. The nature of the defects (joints, bedding partings, seams, zones and veins) is also noted with description, orientation, infilling or coating, shape, roughness, thickness, etc. given generally in accordance with AS 1726. The spacing of natural fractures excludes bedding partings unless there is evidence that they were separated prior to drilling. This notwithstanding, bedding partings maybe considered as planes of weakness in an engineering assessment.

Ref: DS6.5.2.1 Issue 1.6 Date: 04/06/2008

GLOSSARY OF SYMBOLS

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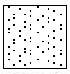
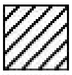
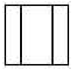
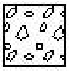
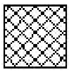
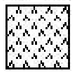
This standard sheet should be read in conjunction with all test hole log sheets and any idealised geological sections prepared for the investigation report.

GENERAL

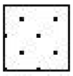
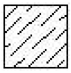
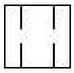
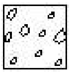
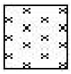
Symbol	Description	Symbol	Description
D	Disturbed Sample	PZ	Piezometer Installation
U	Undisturbed Sampled (suffixed by sample size or tube diameter in mm if applicable)	R	Rising Head Permeability Test
		F	Falling Head Permeability Test
C	Core Sample (suffixed by diameter in mm)	PBT	Plate Bearing Test
SV	Shear Vane Test (suffixed by value in kPa)	▸—	Water Inflow (make)
SPT	Standard Penetration Test (with blows per 0.15m)	—◂	Water Outflow (loss)
N	SPT Value	▽	Temporary Water Level
HB	SPT hammer bouncing	▼	Final Water Level
PM	Pressuremeter Test	●	Point Load Test (axial)
PP	Pocket Penetrometer (suffixed by value in kPa)	○	Point Load Test (diametric)
PK	Packer Test	IMP	Impression Device Test

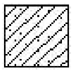
SOIL SYMBOLS

Main Components

 SAND
 CLAY
 SILT
 GRAVEL
 FILL
 TOPSOIL

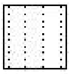
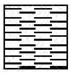
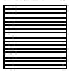
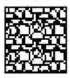
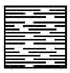
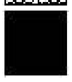
Minor Components

 sandy
 clayey
 silty
 gravelly
 vegetation, roots

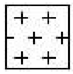
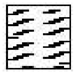
Note: Natural soils are generally a combination of constituents, e.g.  sandy CLAY

ROCK SYMBOLS

Sedimentary

 SANDSTONE
 SHALE
 CLAYSTONE
 CONGLOMERATE
 SILTSTONE
 COAL

Igneous

 GRANITIC ROCK
 IGNEOUS DYKE
 BASALTIC ROCK

Note: Additional rock symbols may be allocated for a particular project.

NATURAL FRACTURES (Coding)

Fracture Type
JT Joint
BP Bedding Plane
Cb Cross Bed
SS Sheared Surface
SM Seam
CS Crushed Seam
FZ Fragmented Zone
SZ Shear Zone
VN Vein

Orientation
For vertical non-oriented core ... "Dip" angle (eg. 5°) measured relative to horizontal
For inclined non-oriented core ... "Angle" measured relative to core axis.
For inclined oriented core ... "Dip" angle and "Dip Direction" angle (eg. 45°/225° mag.)

VT Vertical
HZ or 0° Horizontal
d degrees

Infilling or Coating
CN Clean
X Carbonaceous
CLAY Clay
KT Chlorite
CA Calcite
FE Iron Oxide
MI Micaceous
Mn Manganese
Py Pyrite
QZ Quartz
VE Veneer

Shape
PLN Planar
CU Curved
UN Undulating
ST Stepped
IR Irregular

Roughness
POL Polished
SLK Slickensided
SO Smooth
RF Rough
VR Very Rough

Others
DIS Discontinuous
OP Open
CL Closed
TI Tight

Ref: DS6.5.1 Issue 1.7 Date: 20/09/2010

LABORATORY TESTING

GENERAL

Samples extracted during the fieldwork stage of a site investigation may be “disturbed” or “undisturbed” (as generally indicated on the trial hole logs) depending upon the nature and purpose of the sample as well as the method of extraction, transportation, extrusion and testing. This aspect should be taken into account when assessing test results, which must of necessity reflect the effects of such disturbance.

All soil properties (as measured by laboratory testing) exhibit inherent variability and thus a certain statistical number of tests is required in order to predict an average property with any degree of confidence. The site variability of soil strata, future changes in moisture and other conditions and the discrete sampling positions must also be considered when assessing the representative nature of the laboratory programme.

Certain laboratory test results provide interpreted soil properties as derived by conventional mathematical procedures. The applicability of such properties to engineering design must be assessed with due regard to the site, sample condition, procedure and project in hand.

TESTING

Laboratory testing is normally carried out in accordance with Australian Standard AS 1289 as amended, or RTA Standards when specified. The routine Australian Standard tests are as follows:-

Moisture Content	AS1289 2.1.1	
Liquid Limit	AS1289 3.1.1)	
Plastic Limit	AS1289 3.2.1)	collectively known as Atterberg Limits
Plasticity Index	AS1289 3.3.1)	
Linear Shrinkage	AS1289 3.4.1	
Particle Density	AS1289 3.5.1	
Particle Size Distribution	AS1289 3.6.1, 3.6.2 and 3.6.3	
Emerson Class Number	AS1289 3.8.1)	
Percent Dispersion	AS1289 3.8.2)	collectively, Dispersive Classification
Pinhole Dispersion Classification	AS1289 3.8.3)	
Hole Erosion (HE)	GHD Method	
No Erosion Filter (NEF)	GHD Method	
Organic Matter	AS1289 4.1.1	
Sulphate Content	AS1289 4.2.1	
pH Value	AS1289 4.3.1	
Resistivity	AS1289 4.4.1	
Standard Compaction	AS1289 5.1.1	
Modified Compaction	AS1289 5.2.1	
Dry Density Ratio	AS1289 5.4.1	
Minimum Density	AS1289 5.5.1	
Density Index	AS1289 5.6.1	
California Bearing Ratio	AS1289 6.1.1 and 6.1.2	
Shear Box	AS1289 6.2.2	
Undrained Triaxial Shear	AS1289 6.4.1 and 6.4.2	
One Dimensional Consolidation	AS1289 6.6.1	
Permeability Testing	AS1289 6.7.1, 6.7.2 and 6.7.3	

Where tests are used which are not covered by appropriate standard procedures, details are given in the report.

LABORATORY

Our laboratory is NATA accredited to AS ISO / IEC17025 for the listed tests.

The oedometer, triaxial and shear box equipment are fully automated for continuous operation using computer controlled data acquisition, processing and plotting systems.

Appendix C – Borehole Logs

BH01 to BH05

BOREHOLE LOG SHEET

HOLE No. BH01

SHEET 1 OF 1

Client :	Hydro Aluminium Kurri Kurri
Project :	Supplementary Geotechnical Investigation
Location :	Kurri Kurri, NSW
Position :	357079.0 E 6371322.3 N MGA94
Surface RL:	19.5m
Angle from Horiz. :	90°
Processed :	VW
Rig Type :	Scout
Mounting:	Truck
Contractor :	Total Drilling Pty Ltd
Driller :	Ryan Whyte
Checked :	SA
Date Started :	9/3/2016
Date Completed :	9/3/2016
Logged by :	VW
Date:	15/04/2016

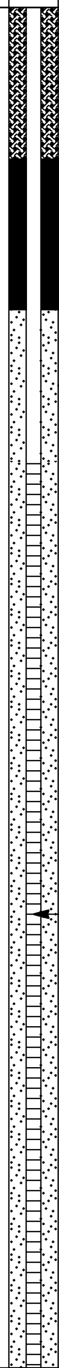
Note: * indicates signatures on original issue of log or last revision of log

DRILLING / **MATERIAL** / **BOREHOLE**

Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	USC Symbol	Description (SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength)	Moisture Condition	Consistency / Density Index	Comments/ Observations
TC-bit auger 200Ø (0–1.0m)	Nil			0.15 (19.35)	SC	Clayey SAND, pale grey, fine grained, low plasticity, trace fine, sub-rounded gravel (topsoil).	D	-	
					CH	CLAY, red brown, mottled pale grey and minor orange, high plasticity (MC>=PL), trace fine to medium, sub-angular, iron indurated gravel (residual).	M	St	
			B		CI	From 0.5m, grading to pale grey, minor red and orange mottling, medium plasticity (MC<=PL), trace silt.	SM		0.5-1.5m, Bulk sample taken
TC-bit auger 150Ø (1.0–4.5m)			SPT 2/6/9 N=15						1.7-2.1m, increased resistance to drilling from possible minor bands of weak cementation/gravels
			SPT 6/13/16 N=29	2.40 (17.10)	CI	CLAY, pale grey minor orange mottling, medium plasticity (MC<PL), trace sand, trace iron cementation, relic rock fabric visible (residual).	SM	VSt	
		▽ (4/4/16)	D			From 3.3m, bands of orange brown, weakly cemented, completely weathererd to extremely weathered sandstone.			3.3m, poor recovery on auger 3.41m, groundwater level recorded ~4 weeks following completion of drilling. Note, no groundwater was observed during drilling.
						From 4.0m, sand content increasing.			
			SPT 10/19/26 for 130mm N=ref	4.20 (15.30)	-	SANDSTONE, orange brown minor pale grey, fine grained, extremely to completely weathered, very low to low strength.			4.2m, remoulds to medium to low plasticity sandy CLAY.
				4.50 (15.00)		End of borehole at 4.5 metres. Target Depth.			

SCALE (m): 1, 2, 3, 4, 5

BOREHOLE Log / **Components**



Components
Monument cover, 0.8m stick up
Cuttings
Bentonite
Sand Backfill
Slotted Pipe

GEO_BOREHOLE 22180150302_HYDRO ALUMINIUM KURRI KURRI.GPJ GHD_GEO_TEMPLATE.GDT 2/5/16

BOREHOLE LOG SHEET

Client : Hydro Aluminium Kurri Kurri			**HOLE No. BH01A**
Project : Supplementary Geotechnical Investigation			
Location : Kurri Kurri, NSW			**SHEET 1 OF 3**
Position : 357079.5 E 6371321.3 N MGA94	**Surface RL:** 19.5m	**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout **Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd	**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 9/3/2016	**Date Completed :** 9/3/2016	**Logged by :** VW	**Date:** 15/04/2016

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DRILLING					MATERIAL							BOREHOLE	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	BOREHOLE Log	**Components**
0	TC-bit auger 200Ø (0–1.5m)	Nil		B (0.2–1.1m)			SC	Clayey SAND, pale grey, fine grained, low plasticity, trace rootlets (topsoil).	D	-			Monument cover, 0.8m stick up
					0.20 (19.30)		CH	CLAY, red brown mottled pale grey and orange, high plasticity (MC>=PL), trace fine, sub-angular, iron indurated, gravel (residual). From 0.4m, grading to pale grey mottled red brown and orange.	M	St			
1								From 1.0m, moisture decreasing.	SM				
2	TC-bit auger 150Ø (1.5–5m)										2.4m, band of higher resitance, possibly cementation/gravels		
3											From 3.0m, poor recovery on auger		
					3.30 (16.20)		CI	CLAY, pale brown/brown, medium plasticity (MC>=PL), trace sand, bands of pale grey clay (residual).	SM-M	St			
4					4.00 (15.50)		-	SANDSTONE, brown, extremely to completely weathered, very low to low strength.	-	-	4.0m, increased resistance to penetration 4.0m, remoulds to medium to low plasticity sandy CLAY.		Cuttings
5													

GEO_BOREHOLE 22180150302_HYDRO ALUMINIUM KURRI KURRI.GPJ GHD_GEO_TEMPLATE.GDT 2/5/16

Client : Hydro Aluminium Kurri Kurri		**HOLE No. BH01A**	
Project : Supplementary Geotechnical Investigation			
Location : Kurri Kurri, NSW		**SHEET 2 OF 3**	
Position : 357079.5 E 6371321.3 N MGA94	**Surface RL:** 19.5m	**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout **Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd	**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 9/3/2016	**Date Completed :** 9/3/2016	**Logged by :** VW	**Date:** 15/04/2016

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DRILLING					MATERIAL							BOREHOLE	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	**Description** SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	**Comments/ Observations**	BOREHOLE Log	**Components**
	TC-bit auger 150Ø	Nil						SANDSTONE, as previous.	-	-			
					5.50 (14.00)		-	SILTSTONE, grey, extremely to highly weathered, very low strength. 5.8-6.0m, brown bands, possibly sandstone as above.	-	-	5.50m, remoulds to low to medium plasticity clay with silt.		
6													
7			▽ (4/4/16)								6.80m, groundwater level recorded ~4 weeks following completion of drilling. Note, no groundwater was observed during drilling. 7.0m, water added approximately every 1-1.5m to aid in cutting returns		
8													Bentonite
													Sand Backfill
9													
10													

See standard sheets for details of abbreviations & basis of descriptions

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Job No. 22-18015-03-02

BOREHOLE LOG SHEET

Client : Hydro Aluminium Kurri Kurri
Project : Supplementary Geotechnical Investigation
Location : Kurri Kurri, NSW

HOLE No. BH01A

Position : 357079.5 E 6371321.3 N MGA94		**Surface RL:** 19.5m	**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout	**Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd	**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 9/3/2016		**Date Completed :** 9/3/2016	**Logged by :** VW	**Date:** 15/04/2016

Note: * indicates signatures on original issue of log or last revision of log

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	BOREHOLE Log	Components
	TC-bit auger 150Ø	Nil						SILTSTONE, as previous.	-	-			Slotted Pipe
11								From 11.2m, grading to dark grey, highly weathered.			11.2m, remoulds to medium plasticity clay.		
12					12.00 (7.50)			End of borehole at 12 metres. Target Depth.			Auger dry at base of hole		
13													
14													
15													

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Job No. **22-18015-03-02**

BOREHOLE LOG SHEET

Client : Hydro Aluminium Kurri Kurri
Project : Supplementary Geotechnical Investigation
Location : Kurri Kurri, NSW

HOLE No. BH02

SHEET 1 OF 2

Position : 356898.9 E 6371351.4 N MGA94	**Surface RL:** 22.3m	**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout **Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd	**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 9/3/2016	**Date Completed :** 9/3/2016	**Logged by :** VW	**Date:** 15/04/2016

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DRILLING				MATERIAL							BOREHOLE
Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	SCALE (m)	Components
TC-bit auger 150Ø	Nil			0.00	SC	Clayey SAND, grey/pale grey, fine grained, low plasticity, with fine, sub-rounded gravels (fill).	D	-	Appears moderatly to well compacted.	0	Monument cover, 0.8m stick up
			D	0.40 (21.90)	CH	CLAY, yellow brown and grey, high plasticity (MC>=PL), trace fine, sub-rounded gravel (residual).	M	St			
			D								
										1	
			SPT 2/5/18 N=23	1.20 (21.10)	CH	CLAY, pale grey mottled red and minor orange, high plasticity (MC<=PL), trace fine iron indurated, weakly cemented gravel (residual).	SM	VSt	At 1.1m, sandy clay completely weathered sandstone layer (100mm)		Cuttings
			D							2	
			SPT 8/11/19 N=30			From 2.5m, grading to pale grey minor red and orange, increasing relic rock fabric visible.					
										3	Bentonite
			D								Sand Backfill
			SPT 5/11/14 N=25			From 4.0m, trace iron indurated, fine, sub-angular gravel, trace sand, relic rock fabric becoming more apparent.	M-SM			4	
		(4/4/16)							4.93m, groundwater	5	

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Job No. 22-18015-03-02

BOREHOLE LOG SHEET

Client : Hydro Aluminium Kurri Kurri		**HOLE No. BH02**	
Project : Supplementary Geotechnical Investigation			
Location : Kurri Kurri, NSW		**SHEET 2 OF 2**	
Position : 356898.9 E 6371351.4 N MGA94	**Surface RL:** 22.3m	**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout **Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd	**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 9/3/2016	**Date Completed :** 9/3/2016	**Logged by :** VW	**Date:** 15/04/2016

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SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	BOREHOLE Log	Components
	TC-bit auger 150Ø	Nil		D (possible mixed sample from cuttings)			CH	CLAY, as previous.	SM	VSt	level recorded ~4 weeks following completion of drilling. Note, no groundwater was observed during drilling.		Slotted Pipe
6				SPT 10/15/22 N=37	5.60 (16.70)		CH	CLAY, pale grey mottled orange brown, medium to high plasticity (MC<=PL), relic rock fragment visible, minor zones of weak cementation (residual).	SM	H			
7				SPT 16 25 for 90mm N=ref	7.00 (15.30)		-	SILTSTONE, grey/dark grey, extremely to highly weathered, very low to low strength. From 7.2m, highly weathered, low strength.					
					7.24 (15.06)			End of borehole at 7.24 metres. Target Depth.					
8													
9													
10													

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BOREHOLE LOG SHEET

Client : Hydro Aluminium Kurri Kurri			**HOLE No. BH02A**
Project : Supplementary Geotechnical Investigation			
Location : Kurri Kurri, NSW			**SHEET 1 OF 3**
Position : 356900.6 E 6371351.2 N MGA94	**Surface RL:** 22.2m	**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout **Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd	**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 10/3/2016	**Date Completed :** 10/3/2016	**Logged by :** VW	**Date:** 15/04/2016

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DRILLING					MATERIAL							BOREHOLE	
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	BOREHOLE Log	Components
	TC-bit auger 200Ø	Nil					SC	Clayey SAND, grey/pale grey, fine grained, low plasticity, with fine, sub-rounded gravels (fill).	D	-	Appears moderatly to well compacted.		Monument cover, 0.8m stick up
				B	0.30 (21.90)		CH	CLAY, dark grey, with minor red and orange mottling, high plasticity (MC>=PL), trace fine, sub-angular to sub-rounded gravel (residual).	M	St			
1								From 1.1-1.3m, Sandy CLAY layer, possibly completely weathered cemented sandstone.	SM				
					1.30 (20.90)		CH	CLAY, pale grey mottled red and minor orange, high plasticity (MC<=PL), trace fine, iron indurated gravel (residual).	M	VSt			
2	TC-bit auger 150Ø												
									SM				
3													
4													◄ Cuttings
			∇ (4/4/16)								4.5m, water added to aid with cutting recovery 4.61m, groundwater level recorded ~4 weeks following		
5													

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Client : Hydro Aluminium Kurri Kurri			**HOLE No. BH02A**
Project : Supplementary Geotechnical Investigation			
Location : Kurri Kurri, NSW			**SHEET 2 OF 3**
Position : 356900.6 E 6371351.2 N MGA94	**Surface RL:** 22.2m	**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout **Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd	**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 10/3/2016	**Date Completed :** 10/3/2016	**Logged by :** VW	**Date:** 15/04/2016

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SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	BOREHOLE Log	Components
	TC-bit auger 150Ø	Nil					CH	CLAY, as previous.	M	VSt	completion of drilling. Note, no groundwater was observed during drilling.		
6					5.80 (16.40)		CH	CLAY, pale grey and orange brown, high plasticity (residual)	SM	H			
7					7.00 (15.20)		-	SILTSTONE, grey/dark grey, extremely to highly weathered, very low to low strength.	-	-			
8								From 8.0m, highly weathered.					Bentonite
													Sand Backfill
9								From 9.0m, possible minor sand inclusion into matrix (~10%)					
								From 9.8m, grading to slightly weathered to fresh, medium strength.			From 9.8m, increased resistance to drilling		
10													

See standard sheets for details of abbreviations & basis of descriptions

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Job No. 22-18015-03-02

BOREHOLE LOG SHEET

Client : Hydro Aluminium Kurri Kurri		**HOLE No. BH02A**	
Project : Supplementary Geotechnical Investigation			
Location : Kurri Kurri, NSW		**SHEET 3 OF 3**	
Position : 356900.6 E 6371351.2 N MGA94	**Surface RL:** 22.2m	**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout **Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd	**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 10/3/2016	**Date Completed :** 10/3/2016	**Logged by :** VW	**Date:** 15/04/2016

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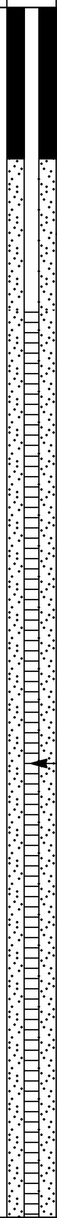
SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	BOREHOLE Log	Components
	TC-bit auger 150Ø	Nil						SILTSTONE, as previous.	-	-			Slotted Pipe
11													
								From 11.5m, medium to high strength.			From 11.5, further increased resistance to drilling Difficulty clearing cuttings out of hole		
12					12.00 (10.20)			End of borehole at 12 metres. Target Depth.					
13													
14													
15													

BOREHOLE LOG SHEET

Client : Hydro Aluminium Kurri Kurri		**HOLE No. BH03**
Project : Supplementary Geotechnical Investigation		
Location : Kurri Kurri, NSW		**SHEET 1 OF 1**
Position : 357013.1 E 6371563.8 N MGA94	**Surface RL:** 23.0m	**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout **Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd	**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 10/3/2016	**Date Completed :** 10/3/2016	**Logged by :** VW	**Date:** 15/04/2016

Note: * indicates signatures on original issue of log or last revision of log

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	BOREHOLE Log	Components
	TC-bit auger 200Ø	Nil	GNE				SC	Clayey SAND, pale grey, fine grained, low plasticity, trace fine, sub-rounded gravel , trace rootlets (topsoil).	D	-			Monument cover, 0.8m stick up; Bentonite
				B	0.30 (22.70)		CH	CLAY, grey/dark grey minor brown, high plasticity, trace fine, sub-angular to sub-rounded gravels (residual).	M	St			Sand Backfill
1					1.10 (21.90)		CH-CI	CLAY, pale grey mottled red, minor brown, medium to high plasticity (MC<=PL), trace fine, sub-angular, iron indurated gravels (residual).	SM	VSt			
2	TC-bit auger 150Ø						CH	From 1.9m, grading to pale grey minor red, moisture increasing, high plasticity (MC>PL)	M	St			Slotted Pipe
3							CH-CI	From 3.7m, pale grey mottled red and orange brown, medium to high plasticity (MC<=PL).	SM	VSt			
4					4.00 (19.00)			End of borehole at 4 metres. Target Depth.			Borehole dry on completion		
5													



See standard sheets for details of abbreviations & basis of descriptions

GHD GEOTECHNICS
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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 22-18015-03-02

BOREHOLE LOG SHEET

Client : Hydro Aluminium Kurri Kurri
Project : Supplementary Geotechnical Investigation
Location : Kurri Kurri, NSW

HOLE No. BH03A

Position : 357014.0 E 6371563.2 N MGA94		**Surface RL:** 23.0m		**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout	**Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd		**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 10/3/2016		**Date Completed :** 10/3/2016		**Logged by :** VW	**Date:** 15/04/2016

Note: * indicates signatures on original issue of log or last revision of log

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	BOREHOLE Log	Components
	TC-bit auger 150Ø	Nil					SC	Clayey SAND, pale grey, fine grained, low plasticity, trace fine, sub-rounded gravel , trace rootlets (topsoil).	D	-			Monument cover, 0.8m stick up
				SPT 2/4/8 N=12	0.30 (22.70)		CH	CLAY, grey minor orange brown mottling, high plasticity (MC>=PL), trace rootlets (residual).	M	St			
1				SPT 5/9/12 N=21	1.10 (21.90)		CI-CH	CLAY, pale grey mottled brown red and orange, medium to high plasticity (MC<=PL), trace fine, sub-angular, weakly cemented, iron indurated gravel, trace silt (residual).	SM	VSt			
2				D			CH	From 2.0m, grading to pale grey, minor red and orange, high plasticity (MC>PL), no gravel.	M	St	From 2.0m, increased moisture		
3				SPT 4/6/7 N=13									
				D									
4				SPT 9/15/22 N=37				From 4.0m, grading to pale grey mottled orange and red.	SM	VSt			Cuttings
			(4/4/16)		4.30 (18.70)		-	SILTSTONE, grey, very low to low strength, moderately to slightly weathered.	-	-	Siltstone easily broken with fingers, remoulds to low plasticity silt with clay. 4.83m, groundwater level recorded ~4		
5													

See standard sheets for details of abbreviations & basis of descriptions

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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 22-18015-03-02

BOREHOLE LOG SHEET

Client : Hydro Aluminium Kurri Kurri		**HOLE No. BH03A**	
Project : Supplementary Geotechnical Investigation			
Location : Kurri Kurri, NSW		**SHEET 2 OF 3**	
Position : 357014.0 E 6371563.2 N MGA94	**Surface RL:** 23.0m	**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout **Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd	**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 10/3/2016	**Date Completed :** 10/3/2016	**Logged by :** VW	**Date:** 15/04/2016

Note: * indicates signatures on original issue of log or last revision of log

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	BOREHOLE Log	Components
	TC-bit auger 150Ø	Nil						SILTSTONE, as previous. From 5.1m, increased brown staining, highly weathered to moderately weathered.	-	-	weeks following completion of drilling. Note, no groundwater was observed during drilling.		
				SPT 14/25 for 120mm N=ref									
6													
7								From 7.5m, grading to grey, minor brown staining.					
8											8.0m, water added down hole to aid with clearing of cuttings		Bentonite
													Sand Backfill
9								From 9.0m, grading to grey, moderately weathered to slightly weathered, low strength.					
10													

Client : Hydro Aluminium Kurri Kurri
Project : Supplementary Geotechnical Investigation
Location : Kurri Kurri, NSW

HOLE No. BH03A

Position : 357014.0 E 6371563.2 N MGA94	**Surface RL:** 23.0m	**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout **Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd	**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 10/3/2016	**Date Completed :** 10/3/2016	**Logged by :** VW	**Date:** 15/04/2016

Note: * indicates signatures on original issue of log or last revision of log

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	BOREHOLE Log	Components
	TC-bit auger 150Ø	Nil						SILTSTONE, as previous.	-	-			
								From 10.2m, medium strength.					Slotted Pipe
11													
12					12.00 (11.00)			End of borehole at 12 metres. Target Depth.					
13													
14													
15													

See standard sheets for details of abbreviations & basis of descriptions

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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 22-18015-03-02

BOREHOLE LOG SHEET

Client : Hydro Aluminium Kurri Kurri			**HOLE No. BH04**
Project : Supplementary Geotechnical Investigation			
Location : Kurri Kurri, NSW			**SHEET 1 OF 1**
Position : 357134.1 E 6371538.0 N MGA94	**Surface RL:** 22.1m	**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout **Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd	**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 11/3/2016	**Date Completed :** 11/3/2016	**Logged by :** VW	**Date:** 15/04/2016

Note: * indicates signatures on original issue of log or last revision of log

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	BOREHOLE Log	Components
	TC-bit auger 200Ø	Nil	GNE				CH	CLAY, pale red, minor pale grey, high plasticity (MC>=PL), with fine to medium grained sand, trace fine, angular to sub-angular gravel (residual). Between 0.2-0.3m, dark grey mottled orange and red.	M	St			Monument cover, 0.8m stick up; Bentonite
1				B	0.30 (21.80)		CI	Sandy CLAY, pale grey, mottled red and orange brown, medium plasticity (MC<=PL), fine grained sand, trace fine sub-rounded, iron indurated sandstone gravel, trace weakly cemented, iorn indurated bands (residual).	SM	VSt			
								From 1.2m, grading to pale grey, minor red and orange brown staining, medium to high plasticity (MC>=PL), no gravel.	M				
2	TC-bit auger 150Ø												Slotted Pipe
3													
					3.50 (18.60)			End of borehole at 3.5 metres. Target Depth.			Borehole dry on completion		
4													
5													

GEO_BOREHOLE 22180150302_HYDRO ALUMINIUM KURRI KURRI.GPJ GHD_GEO_TEMPLATE.GDT 2/5/16

Client : Hydro Aluminium Kurri Kurri
Project : Supplementary Geotechnical Investigation
Location : Kurri Kurri, NSW

HOLE No. BH04A

Position : 357131.9 E 6371538.5 N MGA94		**Surface RL:** 22.0m	**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout	**Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd	**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 11/3/2016		**Date Completed :** 11/3/2016	**Logged by :** VW	**Date:** 15/04/2016

Note: * indicates signatures on original issue of log or last revision of log

DRILLING: Drilling Method	Hole Support \ Casing	Water	Samples & Tests	MATERIAL: Depth / (RL) metres	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	BOREHOLE: Components
TC-bit auger 150Ø	Nil	GNE	D		CH	CLAY, pale red, minor pale grey, high plasticity (MC>=PL), with fine to medium grained sand, trace fine, angular to sub-angular gravel (residual). Between 0.2-0.3m, dark grey mottled orange and red.	M	St		Monument cover, 0.78m stick up
			SPT 3/7/10 N=17	0.30 (21.70)	CI	Sandy CLAY, pale grey, mottled red and orange brown, medium plasticity (MC<=PL), fine grained sand, trace fine, sub-rounded, iron indurated sandstone gravel, trace weakly cemented, iron indurated bands (residual).	SM	VSt		
			SPT 9/12/15 N=27			From 1.2m, grading to pale grey, minor red and orange brown staining, medium to high plasticity (MC>=PL), no gravel.	M			
			D							
			SPT 6/9/12 N=21							
			D	3.50 (18.50)	CI	CLAY, pale brown and grey, medium plasticity (MC>=PL), with fine grained sand (residual).	M	VSt		
			SPT 17/18/25 for 110mm HB N=ref	3.90 (18.10)	-	SILTSTONE, pale brown, minor red staining, extremly low to very low strength, extremely weathered, with sand in matrix.	-	-	3.9m, remoulds to medium plasticity clay.	Cuttings

SCALE (m): 1, 2, 3, 4, 5

Client : Hydro Aluminium Kurri Kurri			**HOLE No. BH04A**
Project : Supplementary Geotechnical Investigation			
Location : Kurri Kurri, NSW			**SHEET 2 OF 3**
Position : 357131.9 E 6371538.5 N MGA94	**Surface RL:** 22.0m	**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout **Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd	**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 11/3/2016	**Date Completed :** 11/3/2016	**Logged by :** VW	**Date:** 15/04/2016

Note: * indicates signatures on original issue of log or last revision of log

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	BOREHOLE Log	Components
	TC-bit auger 150Ø	Nil						SILTSTONE, as previous.	-	-			
6								From 6.0m, medium strength, no sand in matrix.			From 6.0m, increased resistance to drilling		
								From 6.5m, grading to grey and brown, highly to moderately weathered.					
7													
8								From 8.0, grading to grey, slightly weathered.					Bentonite
													Sand Backfill
9													
10													

BOREHOLE LOG SHEET

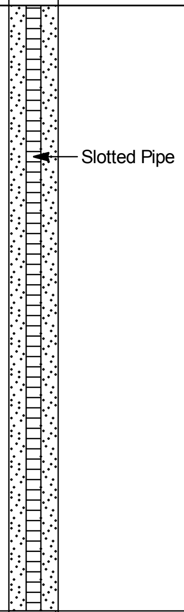
Client : Hydro Aluminium Kurri Kurri
Project : Supplementary Geotechnical Investigation
Location : Kurri Kurri, NSW

HOLE No. BH04A

Position : 357131.9 E 6371538.5 N MGA94	**Surface RL:** 22.0m	**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout **Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd	**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 11/3/2016	**Date Completed :** 11/3/2016	**Logged by :** VW	**Date:** 15/04/2016

Note: * indicates signatures on original issue of log or last revision of log

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations	BOREHOLE Log	Components
11	TC-bit auger 150Ø	Nil						SILTSTONE, as previous.	-	-			Slotted Pipe
12					12.00 (10.00)			End of borehole at 12 metres. Target Depth.			Borehole dry on completion		
13													
14													
15													



See standard sheets for details of abbreviations & basis of descriptions

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CONSULTING GEOTECHNICAL ENGINEERS AND GEOLOGISTS

Job No. 22-18015-03-02

BOREHOLE LOG SHEET

Client : Hydro Aluminium Kurri Kurri
Project : Supplementary Geotechnical Investigation
Location : Kurri Kurri, NSW

HOLE No. BH05

SHEET 1 OF 1

Position : 357034.9 E 6371462.5 N MGA94		**Surface RL:** 24.1m		**Angle from Horiz. :** 90°	**Processed :** VW
Rig Type : Scout	**Mounting:** Truck	**Contractor :** Total Drilling Pty Ltd		**Driller :** Ryan Whyte	**Checked :** SA
Date Started : 10/3/2016		**Date Completed :** 10/3/2016		**Logged by :** VW	**Date:** 15/04/2016

Note: * indicates signatures on original issue of log or last revision of log

DRILLING | **MATERIAL**

SCALE (m)	Drilling Method	Hole Support \ Casing	Water	Samples & Tests	Depth / (RL) metres	Graphic Log	USC Symbol	Description: SOIL TYPE, colour, structure, minor components (origin), and ROCK TYPE, colour, grain size, structure, weathering, strength	Moisture Condition	Consistency / Density Index	Comments/ Observations
	TC-bit auger 200Ø	Nil	GNE	D			CH	CLAY, brown with grey and red, high plasticity (MC>=PL) (residual).	M	St	
				SPT 4/7/9 N=16	0.40 (23.70)		CI	CLAY, pale grey mottled orange brown, medium plasticity (MC<=PL), with pockets of fine gained sand, trace silt (residual). From 0.8-2.0m, grading to pale grey mottled red and orange brown, with bands of weakly cemented iron induration.	SM	St	0.5-1.5m, BULK sample taken in addition to other tests
1				SPT 4/6/9 N=15				From 1.0m, moisture increasing.	SM-M		
2	TC-bit auger 150Ø			D							
				SPT 13/16/16 N=32				From 2.5m, bands of weakly cemented, sand rich, iron induration.			
3				D							
				D	3.70 (20.40)		-	SILTSTONE, brown/pale brown, mottled pale grey, extremely low to low strength, extremely weathered to highly weathered, with sand in matrix (~20%).			
4				SPT 12/25 for 120mm HB N=ref	4.27 (19.83)			End of borehole at 4.27 metres. Target Depth.			Borehole dry on completion
5											

See standard sheets for details of abbreviations & basis of descriptions

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Job No. **22-18015-03-02**

Appendix D – Laboratory report sheets

Sydney Laboratory
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California Bearing Ratio Test Report

Report No: CBR:SYD16-0099-01

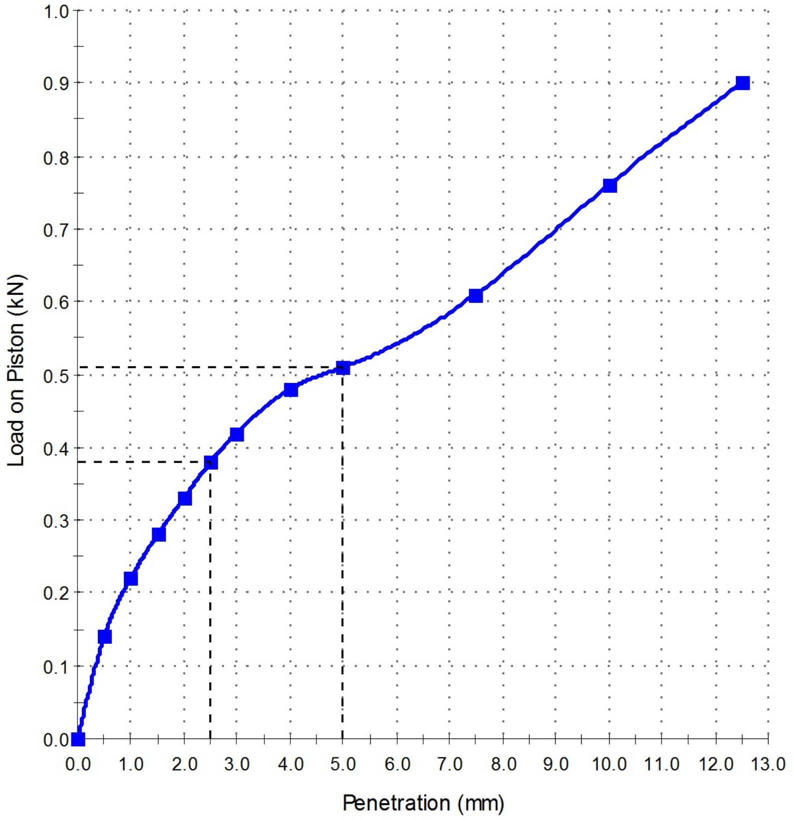
Client:
Hydro Aluminium Kurri Kurri
Supplementary Geotechnical Investigation
Kurri Kurri NSW

Project: 2218015

Sample Details

GHD Sample No:	SYD16-0099-01	Client Sample ID:	
Date Sampled:	11/03/2016	Sampled By:	Sampled by GHD
Location:		BH /TP No:	BH01
Date Tested:	8/04/2016	Depth (m):	0.5 - 1.5
Sample Description:	CLAY: red brown & grey some sand		

Load vs Penetration



Test Results

AS 1289.6.1.1

CBR At 2.5mm (%):	3.0
Maximum Dry Density (t/m³):	1.75
Optimum Moisture Content (%):	17.3
Dry Density before Soaking (t/m³):	1.75
Density Ratio before Soaking (%):	100
Moisture Content before Soaking (%):	17.1
Moisture Ratio before Soaking (%):	99
Dry Density after Soaking (t/m³):	1.70
Density Ratio after Soaking (%):	97
Swell (%):	3.0
Moisture Content of Top 30mm (%):	
Compactive Effort:	Standard
Surcharge Mass (kg):	4.50
Period of Soaking (Days):	4
Oversize Material (%):	0.0

AS 1289.2.1.1

Field Moisture Content (%):	16.4

Comments

Sydney Laboratory
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Aggregate/Soil Test Report

Report No: SYD1600484
Issue No: 1
This report replaces all previous issues of report no 'SYD1600484'.

Client:
Hydro Aluminium Kurri Kurri
Supplementary Geotechnical Investigation
Kurri Kurri NSW

Project: 2218015

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 8/04/2016

Sample Details

GHD Sample No	SYD16-0099-02
Date Sampled	11/03/2016
Sampled By	Sampled by GHD
BH / TP No.	BH01
Depth (m)	1.0 - 1.45
Soil Description	CLAY: red & grey mottled

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	11.5	
Date Tested		23/03/2016	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	13.0	
Mould Length (mm)		125	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	39	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	15	
Plasticity Index (%)	AS 1289.3.3.1	24	
Date Tested		1/04/2016	

Comments

N/A

Sydney Laboratory
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Aggregate/Soil Test Report

Report No: SYD1600485
Issue No: 1
This report replaces all previous issues of report no 'SYD1600485'.

Client:
Hydro Aluminium Kurri Kurri
Supplementary Geotechnical Investigation
Kurri Kurri NSW

Project: 2218015

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 8/04/2016

Sample Details

GHD Sample No	SYD16-0099-03
Date Sampled	11/03/2016
Sampled By	Sampled by GHD
BH / TP No.	BH01
Depth (m)	2.5 - 2.95
Soil Description	CLAY: red & grey

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	1	
Soil Description		CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		22	
Date Tested		31/03/2016	

Comments

N/A

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Aggregate/Soil Test Report

Report No: SYD1600494
Issue No: 1
This report replaces all previous issues of report no 'SYD1600494'.

Client:
Hydro Aluminium Kurri Kurri
Supplementary Geotechnical Investigation
Kurri Kurri NSW

Project: 2218015

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 8/04/2016

Sample Details

GHD Sample No	SYD16-0099-12
Date Sampled	11/03/2016
Sampled By	Sampled by GHD
BH / TP No.	BH02
Depth (m)	0.5 - 0.6
Soil Description	CLAY: dark brown

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	3	
Soil Description		CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		22	
Date Tested		31/03/2016	

Comments

N/A

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Aggregate/Soil Test Report

Report No: SYD1600486
Issue No: 1
This report replaces all previous issues of report no 'SYD1600486'.

Client:
Hydro Aluminium Kurri Kurri
Supplementary Geotechnical Investigation
Kurri Kurri NSW

Project: 2218015

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 8/04/2016

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Details

GHD Sample No	SYD16-0099-04
Date Sampled	11/03/2016
Sampled By	Sampled by GHD
BH / TP No.	BH02
Depth (m)	2.5 - 2.95
Soil Description	CLAY: grey & red mottled

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	6.8	
Date Tested		23/03/2016	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	15.0	
Mould Length (mm)		125	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	51	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	19	
Plasticity Index (%)	AS 1289.3.3.1	32	
Date Tested		1/04/2016	

Comments

N/A

Sydney Laboratory
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Tel: (02) 9462 4860
Fax:(02) 9462 4710

Aggregate/Soil Test Report

Report No: SYD1600487
Issue No: 1
This report replaces all previous issues of report no 'SYD1600487'.

Client:
Hydro Aluminium Kurri Kurri
Supplementary Geotechnical Investigation
Kurri Kurri NSW

Project: 2218015

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 8/04/2016

THIS DOCUMENT SHALL NOT BE REPRODUCED EXCEPT IN FULL

Sample Details

GHD Sample No	SYD16-0099-05
Date Sampled	11/03/2016
Sampled By	Sampled by GHD
BH / TP No.	BH02
Depth (m)	7.0 - 7.24
Soil Description	CLAY: dark grey

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	1	
Soil Description		CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		22	
Date Tested		31/03/2016	

Comments

N/A

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Aggregate/Soil Test Report

Report No: SYD1600488
Issue No: 1
This report replaces all previous issues of report no 'SYD1600488'.

Client:
Hydro Aluminium Kurri Kurri
Supplementary Geotechnical Investigation
Kurri Kurri NSW

Project: 2218015

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 8/04/2016

Sample Details

GHD Sample No	SYD16-0099-06
Date Sampled	11/03/2016
Sampled By	Sampled by GHD
BH / TP No.	BH03A
Depth (m)	2.5 - 2.95
Soil Description	CLAY: mottled red & grey

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	1	
Soil Description		CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		22	
Date Tested		31/03/2016	

Comments

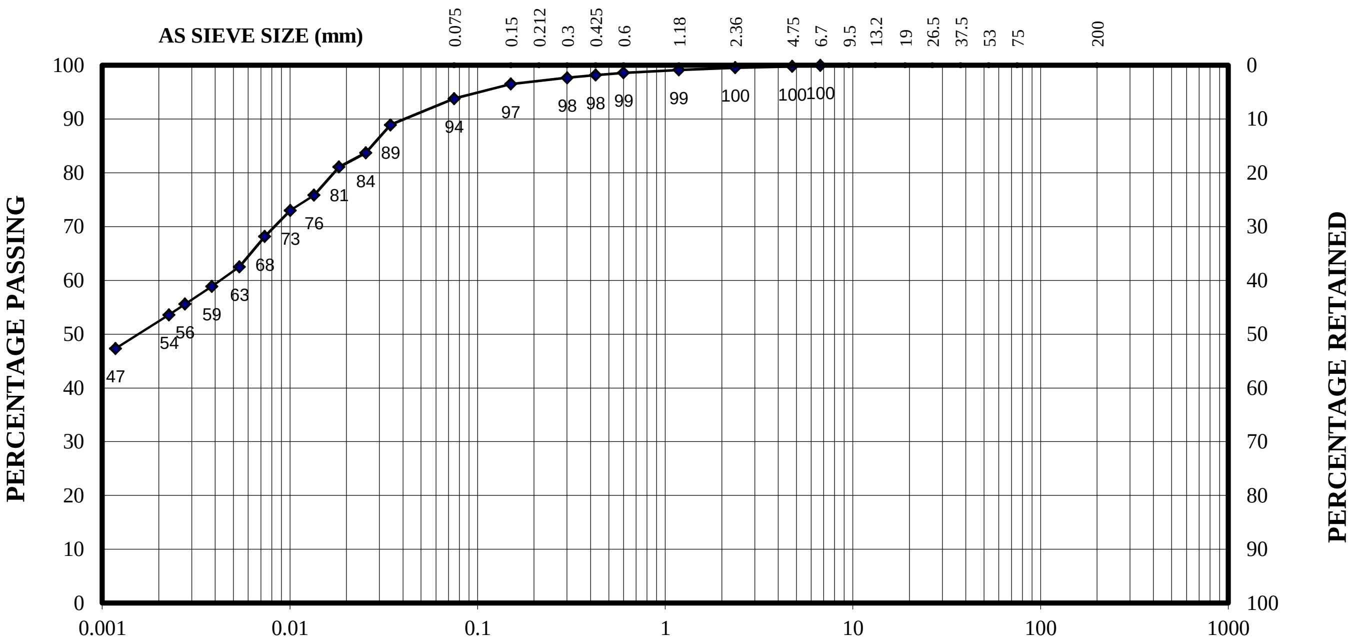
N/A

SOIL CLASSIFICATION REPORT

Trial Hole:	BH03A
Depth (m):	3.5 - 3.6
Sample No:	SYD16-0099-07

Client: Hydro Aluminium Kurri Kurri
Project: Geotechnical Investigation
Location: Kurri Kurri, NSW

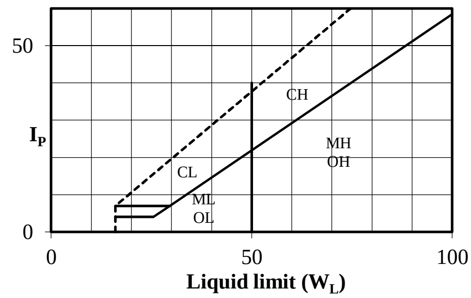
Client Sample No.: -
Sample History: Sampled by GHD



CLAY	SILT FRACTION			SAND FRACTION			GRAVEL FRACTION			COBBLES	BOULDERS
	Fine	Medium	Coarse	Fine	Medium	Coarse	Fine	Medium	Coarse		

0.002 0.006 0.02 0.075 0.2 0.6 2.36 6 20 63 200

PARTICLE SIZE (mm)



TEST METHODS
Particle size AS1289.3.6.3

OTHER TESTS
AS1289.3.5.1

GRADING
$C_u = D_{60} / D_{10} =$ not determinable
$C_c = D_{30}^2 / (D_{10} \times D_{60}) =$ not determinable

PARTICLE DENSITY 2.65 (measured)

PRE-TREATMENT HYDROMETER N/A

TEST CONDITION Washed sieve with dispersing agent

GROUP SYMBOL:

SOIL NAME: CLAY:red brown trace fine sand

INDEX PROPERTIES (%)
Liquid Limit = N/A Plastic Limit = N/A
Plasticity Index = N/A Linear Shrinkage % = Not determined

Atterberg Limits (History/preparation)

Liquid Limit (type of test)

Linear Shrinkage (mould size)

REMARKS:

Tested by:	AN
Date tested:	5.04.16
Checked by:	DB
Date checked:	8/04/2016

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Approved Signatory:

D. Brooke
8/04/2016

Accredited for compliance with ISO/IEC 17025
Laboratory Accreditation Number: 679

JOB No.	**22180150502**
REPORT No.	**SYD1600489**

Ref: Document F9.1.16 issue 1.2

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Aggregate/Soil Test Report

Report No: SYD1600490
Issue No: 1
This report replaces all previous issues of report no 'SYD1600490'.

Client:
Hydro Aluminium Kurri Kurri
Supplementary Geotechnical Investigation
Kurri Kurri NSW

Project: 2218015

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 8/04/2016

Sample Details

GHD Sample No	SYD16-0099-08
Date Sampled	11/03/2016
Sampled By	Sampled by GHD
BH / TP No.	BH03A
Depth (m)	5.5 - 5.62
Soil Description	CLAY: brown & yellow with sand

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	16.3	
Date Tested		23/03/2016	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	10.5	
Mould Length (mm)		125	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	44	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	19	
Plasticity Index (%)	AS 1289.3.3.1	25	
Date Tested		1/04/2016	

Comments

N/A

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California Bearing Ratio Test Report

Report No: CBR:SYD16-0099-09

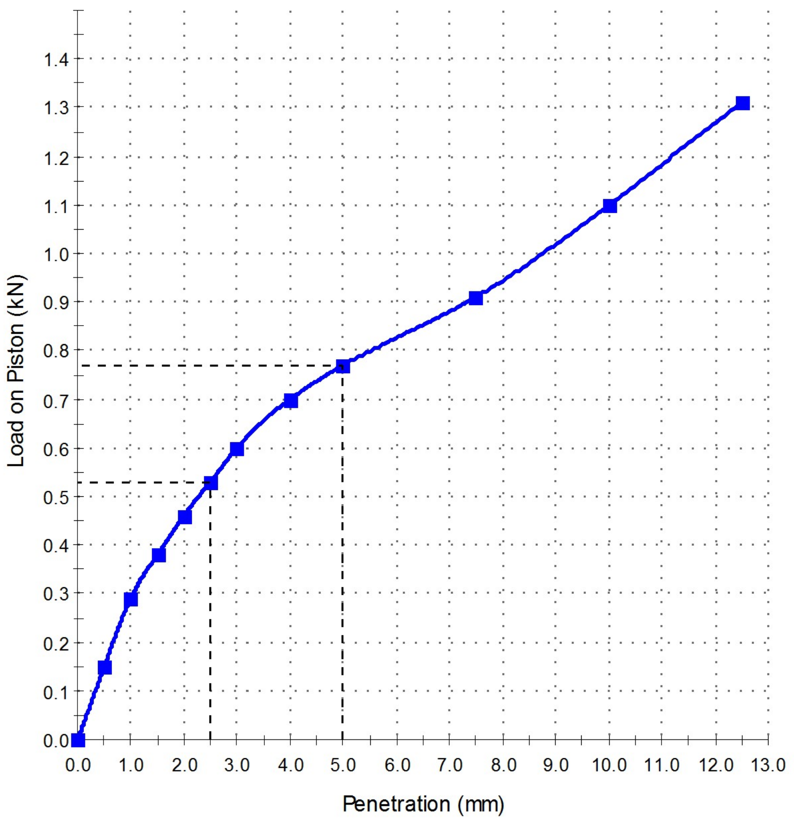
Client:
Hydro Aluminium Kurri Kurri
Supplementary Geotechnical Investigation
Kurri Kurri NSW

Project: 2218015

Sample Details

GHD Sample No:	SYD16-0099-09	Client Sample ID:	
Date Sampled:	11/03/2016	Sampled By:	Sampled by GHD
Location:		BH /TP No:	BH04
Date Tested:	8/04/2016	Depth (m):	0.3 - 1.5
Sample Description:	CLAY: mottled grey & red brown with sand		

Load vs Penetration



Test Results

AS 1289.6.1.1

CBR At 2.5mm (%):	4.0
Maximum Dry Density (t/m³):	1.72
Optimum Moisture Content (%):	18.2
Dry Density before Soaking (t/m³):	1.72
Density Ratio before Soaking (%):	100
Moisture Content before Soaking (%):	18.1
Moisture Ratio before Soaking (%):	99
Dry Density after Soaking (t/m³):	1.68
Density Ratio after Soaking (%):	98
Swell (%):	2.5
Moisture Content of Top 30mm (%):	
Compactive Effort:	Standard
Surcharge Mass (kg):	4.50
Period of Soaking (Days):	4
Oversize Material (%):	0.0

AS 1289.2.1.1

Field Moisture Content (%):	22.1

Comments

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Aggregate/Soil Test Report

Report No: SYD1600492
Issue No: 1
This report replaces all previous issues of report no 'SYD1600492'.

Client:
Hydro Aluminium Kurri Kurri
Supplementary Geotechnical Investigation
Kurri Kurri NSW

Project: 2218015

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 8/04/2016

Sample Details

GHD Sample No	SYD16-0099-10
Date Sampled	11/03/2016
Sampled By	Sampled by GHD
BH / TP No.	BH04A
Depth (m)	1.0 - 1.45
Soil Description	CLAY: mottled grey & red brown some sand

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	15.4	
Date Tested		23/03/2016	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	13.0	
Mould Length (mm)		125	
Crumbling		No	
Curling		Yes	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	39	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	17	
Plasticity Index (%)	AS 1289.3.3.1	22	
Date Tested		1/04/2016	

Comments

N/A

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Aggregate/Soil Test Report

Report No: SYD1600493
Issue No: 1
This report replaces all previous issues of report no 'SYD1600493'.

Client:
Hydro Aluminium Kurri Kurri
Supplementary Geotechnical Investigation
Kurri Kurri NSW

Project: 2218015

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 8/04/2016

Sample Details

GHD Sample No	SYD16-0099-11
Date Sampled	11/03/2016
Sampled By	Sampled by GHD
BH / TP No.	BH04A
Depth (m)	4.0 - 4.45
Soil Description	CLAY: red brown

Test Results

Description	Method	Result	Limits
Moisture Content (%)	AS 1289.2.1.1	13.5	
Date Tested		23/03/2016	
Sample History	AS 1289.1.1	Oven-dried	
Preparation	AS 1289.1.1	Dry Sieved	
Linear Shrinkage (%)	AS 1289.3.4.1	10.5	
Mould Length (mm)		125	
Crumbling		No	
Curling		No	
Cracking		No	
Liquid Limit (%)	AS 1289.3.1.1	39	
Method		Four Point	
Plastic Limit (%)	AS 1289.3.2.1	17	
Plasticity Index (%)	AS 1289.3.3.1	22	
Date Tested		1/04/2016	

Comments

N/A

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Aggregate/Soil Test Report

Report No: SYD1600495
Issue No: 1
This report replaces all previous issues of report no 'SYD1600495'.

Client:
Hydro Aluminium Kurri Kurri
Supplementary Geotechnical Investigation
Kurri Kurri NSW

Project: 2218015

Accredited for compliance with ISO / IEC 17025

NATA Accredited Laboratory Number: 679

Approved Signatory: D.P Brooke (Sydney Laboratory Manager)

Date of Issue: 8/04/2016

Sample Details

GHD Sample No	SYD16-0099-13
Date Sampled	11/03/2016
Sampled By	Sampled by GHD
BH / TP No.	BH05
Depth (m)	3.7 - 3.8
Soil Description	CLAY: red brown

Test Results

Description	Method	Result	Limits
Emerson Class Number	AS 1289.3.8.1	2	
Soil Description		CLAY	
Type of Water		Distilled	
Temperature of Water (°C)		22	
Date Tested		31/03/2016	

Comments

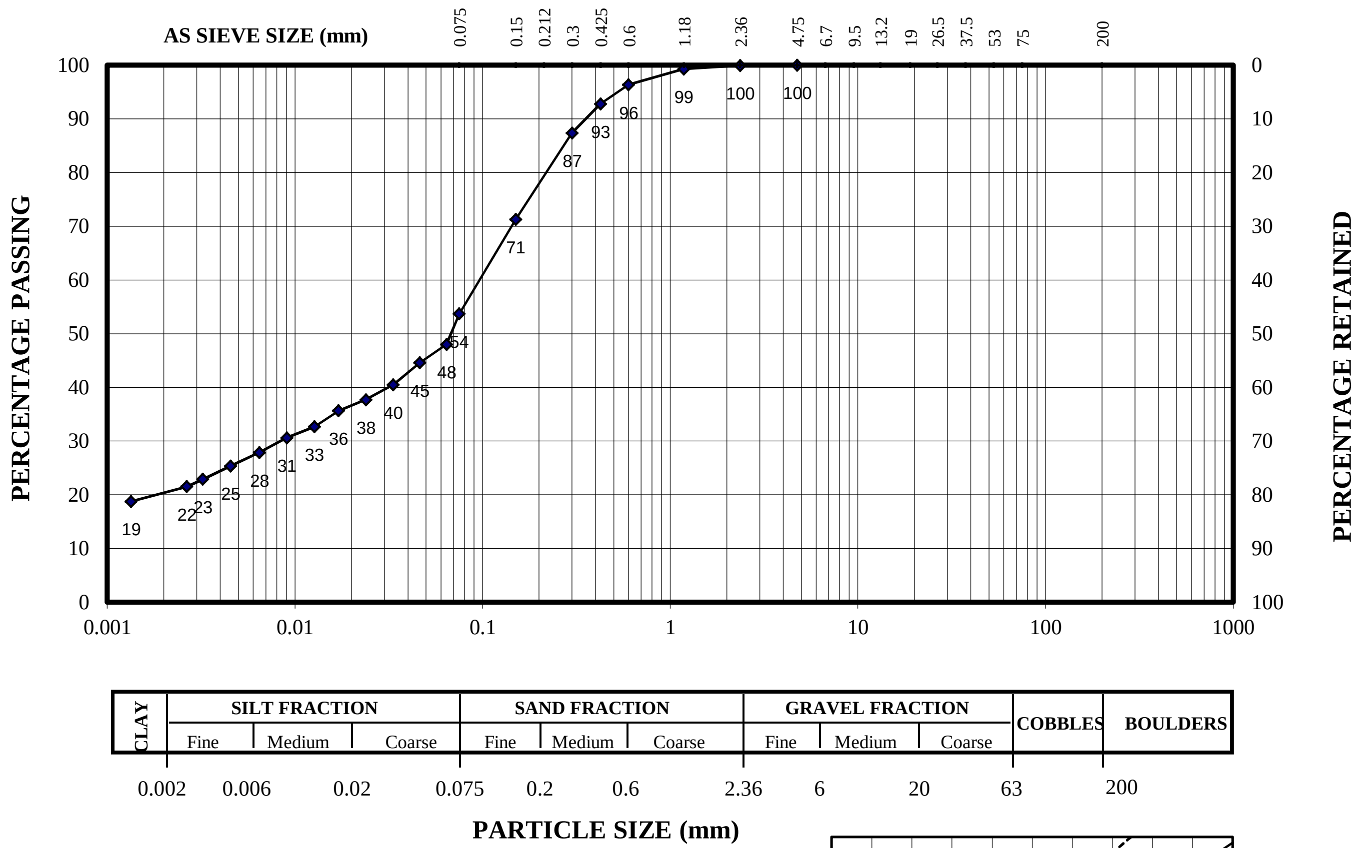
N/A

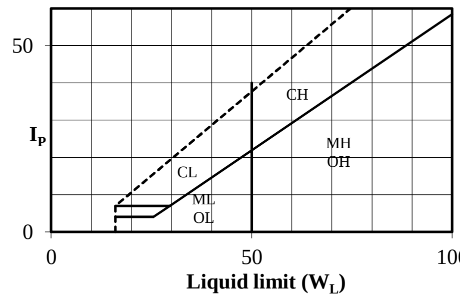
SOIL CLASSIFICATION REPORT

Trial Hole:	BH05
Depth (m):	4.0 - 4.12
Sample No:	SYD16-0099-14

Client: Hydro Aluminium Kurri Kurri
Project: Geotechnical Investigation
Location: Kurri Kurri, NSW

Client Sample No.: -
Sample History: Sampled by GHD





TEST METHODS
Particle size AS1289.3.6.3

OTHER TESTS
AS1289.3.5.1

GRADING
$C_u = D_{60} / D_{10} =$ not determinable
$C_c = D_{30}^2 / (D_{10} \times D_{60}) =$ not determinable

PARTICLE DENSITY 2.67 (measured)

PRE-TREATMENT HYDROMETER N/A

TEST CONDITION Washed sieve with dispersing agent

GROUP SYMBOL:

SOIL NAME: Sandy SILT / CLAY: Yellow brown

REMARKS:

INDEX PROPERTIES (%)
Liquid Limit = N/A Plastic Limit = N/A
Plasticity Index = N/A Linear Shrinkage % = Not determined

Atterberg Limits (History/preparation)

Liquid Limit (type of test)

Linear Shrinkage (mould size)

Tested by:	AN
Date tested:	4/05/2016
Checked by:	DB
Date checked:	8/04/2016

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Approved Signatory:

D. Brooke
8/04/2016

Accredited for compliance with ISO/IEC 17025
Laboratory Accreditation Number: 679

JOB No.	**22180150302**
REPORT No.	**SYD1600496**

Ref: Document F9.1.16 issue 1.2

GHD

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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	A Wynne Jones	S Amoroso	S. Amoroso	I Gregson		03/05/2016

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Memorandum

15 July 2016

To	David Barrett		
Copy to	Adrian Roberts		
From	Steve Amoroso	Tel	(02) 4350 4114
Subject-	HAKK Containment Cell Detailed Design - Preliminary Interpretation of Factual Geotechnical and Geophysical Data	Job no.	22/18015

1. Introduction

This memorandum provides requested preliminary interpretation of geotechnical and geophysical data associated with the containment cell to be constructed within the existing 'clay borrow pit' area located approximately 250 m west of the north eastern corner of the existing Hydro Aluminium Kurri Kurri (HAKK) facility.

It is understood that preliminary geotechnical interpretation, discussion and recommendations are required to address:

- Excavatability
- Excavated clay permeability
- Excavated clay dispersivity and reactivity

This memo should be read in conjunction with GHD report No 2218015-1976 titled 'Hydro Aluminium Kurri Kurri, Containment Cell Detailed Design and Associated Services, Supplementary Geotechnical Investigation Factual Report', Rev 0, dated May 2015; and GBG Australia draft report GBGA1933 titled 'Geophysical Investigation to Determine Rock Depth, Hydro Aluminium Plant, Kurri Kurri, NSW'.

Reference is also made to the Environ Australia report Ref AS120389 titled 'Preliminary Geotechnical Investigation, Proposed Containment Cell Site, Clay Borrow Pit', dated 16 February 2015.

The limitations discussed in Section 1.2 of the GHD report are also directly applicable to the interpretation, discussion and recommendations provided in this memorandum.

2. Summary of factual investigation findings

2.1 Geotechnical data

The additional subsurface investigations identified a typical profile of residual clay strata overlying weathered siltstone bedrock. Limited topsoil and fill materials were also encountered at the site. The residual clays were typically stiff to very stiff and comprised an upper layer of red-brown and orange brown medium to high plasticity clay overlying pale grey predominantly medium to high plasticity clay. Siltstone and sandstone bedrock (belonging to the early Permian aged Rutherford Formation) was generally extremely weathered to highly weathered and very low to low strength within the depth of the investigation.

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Laboratory testing of the site soils show them to be generally dry of the plastic limit, of medium to high plasticity and highly dispersive.

Bedrock was encountered at depths ranging from 3.7 m to 7 m. Approximate reduced levels at the top of the bedrock strata suggest that the rock surface typically dips to the north and south from a local high point near the centre of the site (in the vicinity of BH5). Further assessment of the approximate depths to rock across the site, if critical to the cell design, could be undertaken by means of additional boreholes and/or geophysical survey (e.g. seismic refraction survey).

Groundwater was not encountered during the drilling and well installation. Subsequent measurements in the installed wells on 4 April 2016 identified groundwater levels at between 3.4 m and 4.9 m below the existing surface (approximate RL 18.2 m to RL 12.7 m AHD).

2.2 Geophysical data

Seismic refraction survey was undertaken along five (5) linear traverses (refer attached extract of Figure GBGA19233-01). The report provides seismic profiles via pseudo colour contours of seismic p-wave velocities with depth along the traverse lines.

The report references four ranges of seismic velocity commensurate with the anticipated subsurface conditions as presented in Table 2-1.

Table 2-1 Typical seismic velocities corresponding to interpreted strata

Seismic velocity range (m/sec)	Interpreted strata
500 to 700	Clay and sand layers (overburden)
700 to 1100	Extremely weathered bedrock
1100 to 1950	Highly to slightly weathered bedrock
1950 to 3000	“unweathered” rock

3. Discussion and recommendations

3.1 Excavatability

Topsoil, fill and residuals clay strata, which were encountered to depths ranging from 3.7 to 7.0 m beneath the existing surface in the five GHD boreholes (corresponding to approximately RL 15.2 to 20.4 m AHD) are expected to be readily excavated using conventional earthmoving equipment (such as tracked excavators). These depths generally correlated well with the seismic velocity range nominated in the geophysical investigation report for these soils of 500 to 700 m/s.

The upper limit of ‘hard digging’ is expected to correspond to a seismic velocity of about 1000 m/s within the extremely weathered bedrock. Beyond this seismic velocity limit and up to a seismic velocity limit of about 2000 m/s the rock strata are expected to be readily rippable[1]. Beyond a seismic velocity limit of 2000 m/s the excavatability of the strata is expected to become marginally rippable to non-rippable.

The depths corresponding to the 1000 m/s and 2000 m/s seismic limits were tabulated with corresponding plan coordinates at various intervals along each seismic traverse and then imported into the ‘12D’ design model to assess the excavatability of the subsurface strata within the proposed design excavation.

The results of this modelling are presented in the following figure and attached cross sections (Attachment 3). These results suggest that most of the proposed excavation can be undertake using large excavators (20 tonne plus)/bull dozers and that conventional ripping is likely to be required towards the base of the excavation in the extremely to highly weathered rock strata (typically where seismic velocities exceed 1000 m/s but are less than 2000 m/s). The ‘green’ surface in the figure below represents the 1000 m/s seismic velocity level, while the ‘red’ surface represents the 2000 m/s seismic velocity level. It can be seen from the figure that the 1000 m/s surface intersects the proposed base of excavation (‘brown’), but rock strata with seismic velocities in excess of 2000 m/s (as identified by the geotechnical investigation) are shown to lie below the maximum depth/lowest base RL of the proposed excavation.

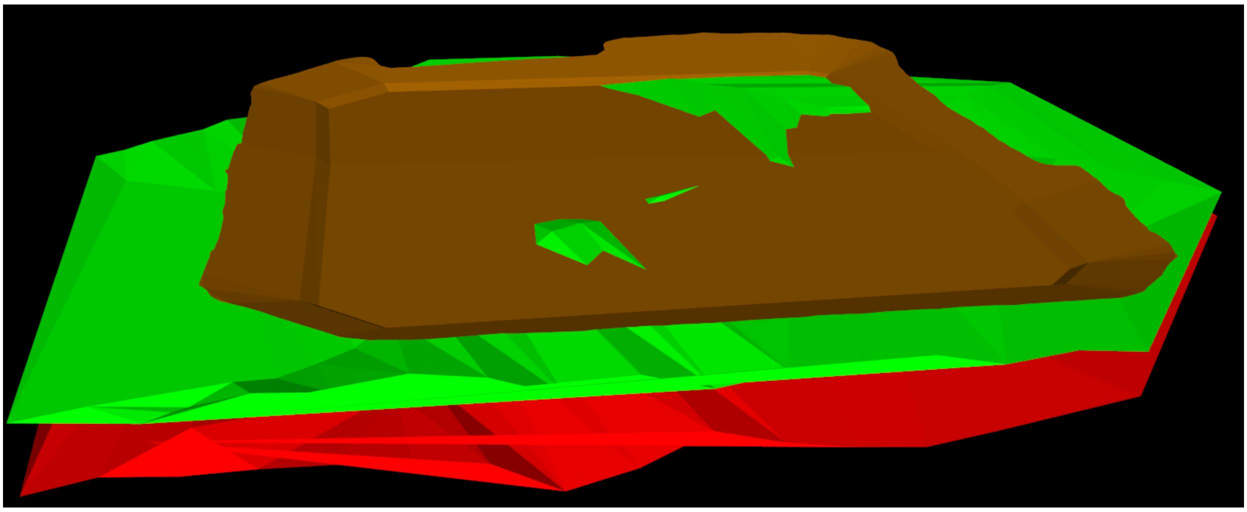


Figure 3-1 3D representation of 1000 m/s and 2000 m/s seismic velocity limits within the proposed containment cell excavation model

[1] Caterpillar Performance Handbook (2000) Version 39 Page 1-68 & 69)

3.2 Excavated clay permeability

Constant head permeability tests were undertaken by Environ Australian as part of the 2015 preliminary geotechnical investigation for the clay borrow pit area. Testing of the residual clays was undertaken both in potable water (4 tests) and in supplied leachate (3 tests), with the following results:

- Permeabilities in potable water were reported between 5 x 10^{-10} m/sec and 4 x 10^{-11} m/s
- Permeabilities in leachate were reported between 3 x 10^{-11} m/sec and 5 x 10^{-12} m/s

The slightly lower permeabilities in the leachate tests results are excepted to be due to electrolyte (salt) interaction/exchange with the clay minerals, as salts within the leachate permeated through the clay. However, both sets of results are considered to be very low (i.e. practically impermeable).

The reported permeabilities are generally at the lower (i.e. less permeable) end of the range typically associated with homogenous clays unaffected by weathering. Note that in-situ clay soils are unlikely to be ‘homogenous’ and in-situ permeabilities will vary based on clay structure and ‘history’ – e.g. cracks and or sand filled fissures may be present as a result of previous shrink-swell reactive movements.

3.3 Excavated clay dispersivity and reactivity

3.3.1 Clay erosion and dispersion

All natural soils have the potential to erode and normal construction measures such as sediment fencing and re-vegetation should be implemented to limit and manage sediment run off and erosion.

Erosion is often exacerbated by the presence of dispersive soils. Dispersion is the potential for the clay soil to break down in contact with water and form a cloudy colloidal suspension. This process typically results from the presence of exchangeable sodium between clay platelets. When a dispersive (or sodic) soil comes into contact with non-saline water, water molecules are drawn in-between the clay platelets causing the clay to swell to such an extent that individual clay platelets are separated from the aggregate. In slightly saline water, or water with a moderate electrolyte (salt) concentration, sodic soils swell, but generally don’t disperse, since the presence of salt within the soil water reduces the osmotic gradient between the outside and inside of clay platelets.

Several Emerson Class No. dispersion tests have been undertaken for the site soils. The Emerson Class No. reflects the propensity of a soil to disperse (in distilled water), as follow:

- Emerson Class 1 or 2 soil are generally considered highly dispersive
- Emerson Class 3 soil are generally considered moderately to slightly dispersive
- Emerson Class 4 soil are non-dispersive due to the presence of carbonate or gypsum in the soil
- Emerson Class 5 or 6 are generally considered non dispersive

Summaries of the results of dispersion testing from the available previous reports relating to clay borrow pit soils are provided in the following table:

Table 3-1 Summary of Emerson Class No. test results

Investigation	Samples tested	Test Results*	Corresponding dispersion potential
GHD 2016	5	3 x Class 1 1 x Class 2 1 x Class 3	Highly dispersive
RCA Aust 2013	4	All Class 5	Non-dispersive
Dames & Moore 1992	3	All Class 6	Non-dispersive
Coffey 1986	4	All Class 2	Highly dispersive

* All reported tests were in distilled water

The previous data shows somewhat variable results, with two sets of tests suggesting highly dispersive behaviour and two sets of tests suggesting non-dispersive behaviour.

Without the benefit of further confirmatory testing, we suggest that all clay soils within the clay borrow pit area be considered as dispersive.

Particular precautions are generally suggested to reduce erosion potential of dispersive soils in embankments, foundations or cut batters. These may include the mixing of gypsum or lime at 3 to 4% by dry mass through the top 200 to 400 mm of the exposed layer of soil prior to moisture conditioning and compaction. Such stabilisation increases the electrolyte concentration in the soil solution as well as displacing sodium with calcium in the clay structure.

If treatment is not undertaken, the consequences of additional erosion and requirement for increased maintenance must be understood and accepted.

The dispersivity of these soil if/when exposed to leachate is expected to be significantly less than when exposed to non-saline surface water, as the electrolytes within the leachate will interact with the clay structure to reduce the potential for dispersion. Note that we are not currently aware of the electrolytic content of the site leachate.

3.3.2 Clay reactivity

The Atterberg Limits test results from the GHD and previous investigation for the clay borrow pit area are plotted on a plasticity chart below.

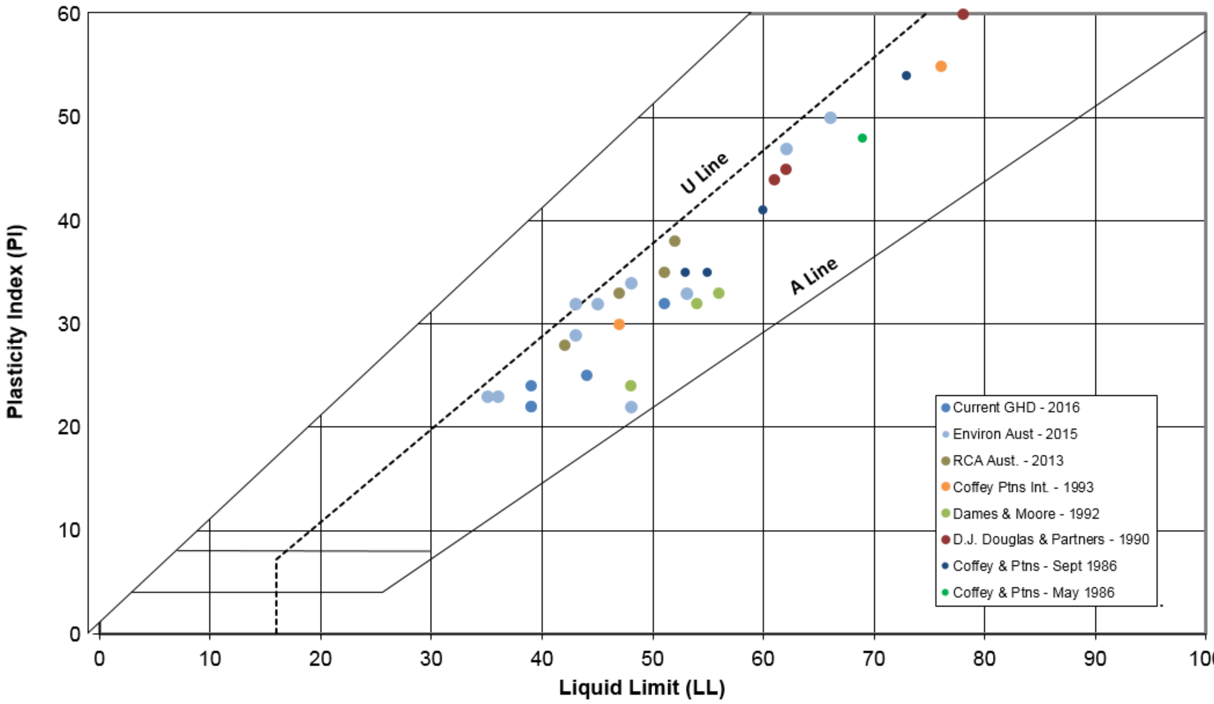


Figure 3-2 Plasticity Chart

The results suggest that the tested clay and weathered siltstone materials lie within the medium (35%<LL<50%) plasticity or high (LL>50%) plasticity ranges.

Reactive soils exhibit shrink-swell behaviour due to moisture content change, which is more prevalent in the upper soil profile and areas with more extreme variations in dry and wet conditions. Maintaining uniform soil moisture content helps to reduce these deformations and the associated free surface movement issues.

Whilst linear shrinkage or shrink swell index testing has not been undertaken, the relatively high liquid limit values (especially those over 70%) suggests that at least some of the site clays could be considered to be highly reactive.

Where buried within a liner system, these soil are not expected to be subjected to significant soil moisture variation and thus should not be problematic. However, consideration should be given to the time of year construction is undertaken; particularly if these soils are likely to be exposed for long periods. If allowed to dry and shrink during construction, the magnitude of initial swell or heave as the soil increases in moisture content will be greater, resulting in additional movement.

Consideration could be given to lime stabilisation of near surface reactive clay soil to reduce the risk of shrink-swell related free surface movements.

The reactivity of these soil if/when exposed to leachate is expected to be significantly less than when exposed to non-saline surface water, as the electrolytes within the leachate will interact with the clay mineral structure which typically influences the reactive (swelling) behaviour.

Soils should be compacted as near as possible to the Standard optimum moisture content (OMC) to reduce the potential for significant variation in moisture as the materials achieve their equilibrium moisture content.

Also note that the high plasticity (and potential reactivity) of the clays will impact upon trafficability, 'workability' and compactability of the clays during construction. Once saturated by exposure to wet conditions, these soil could prove very difficult to dry back and effectively become unworkable.

4. Groundwater and dewatering

Groundwater levels recorded during and immediately after the GHD supplementary geotechnical investigations recorded variable depths to groundwater, corresponding to groundwater levels at RL 16.1 to RL 18.2 m AHD in three of the four 'shallow' wells (with the fourth shallow well noted as being dry at the time). Further monitoring of the installed groundwater wells is recommended to establish the groundwater regime across the site and assess possible interactions with the proposed excavation.

Based on the design cell floor levels, it is considered likely that that the proposed excavation will intersect perched (i.e. within the clay strata) groundwater and possibly the static groundwater (within the underlying rock strata). Given that the intersected clay and weathered rock strata are expected to have relatively low permeabilities, groundwater inflows into the proposed excavations are expected to be controllable using 'sump and pump' de-watering techniques. Further assessment of soil and rock permeabilities could be undertaken using in-situ testing within the GHD installed wells (i.e. 'slug testing') or through laboratory testing of remoulded samples collected during the supplementary geotechnical investigations.

Further advice should be sought from GHD hydrogeologists to assess hydrogeological conditions, dewatering requirements and other groundwater related challenges to the design.

Regards

Steve Amoroso
Principal Geotechnical Engineer

Attachments:

1. Figure 1 - Geotechnical test location plan (extract from Supplementary Geotechnical Investigation Factual Report)
2. Figure GBGA1933-01 – Seismic Refraction Line Locations (extract for Geophysical Investigation report)
3. Preliminary Design Model plan and three sections showing 1000 m/s and 2000 m/s seismic velocity boundaries (3 pages)

Paper Size A4

0 10 20 40 60 80

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- Site boundary
- Cadastre
- Current investigation borehole test locations

Previous test locations (approximate locations)

- Borehole (2012)
- Test pit (2012)
- Borehole (2014)
- Test pit (2014)

GHD

Hydro Aluminium Kurri Kurri Ltd
Containment Cell Design
Supplementary Geotechnical Investigation

Job Number	22-18015
Revision	0
Date	28 Apr 2016

Geotechnical test location plan

Figure 1

G:\22\18015\GIS\Maps\Deliverables\Geotech\2218015_G001_BoreholeLocations_0.mxd

Level 3, GHD Tower, 24 Honeysuckle Drive, Newcastle NSW 2300 **T** 61 2 4979 9999 **F** 61 2 4979 9988 **E** ntlmail@ghd.com **W** www.ghd.com.au

Data source: HAKK: Imagery, 2015. Environ: Existing monitoring locations, 2015. Commonwealth of Australia (Geoscience Australia): 250K Topographic Data Series 3, 2006. Created by: tmorton, fmackay

SEISMIC REFRACTION LINE LOCATIONS
HYDRO ALUMINIUM PLANT, KURRI KURRI, NEW SOUTH WALES

LEGEND

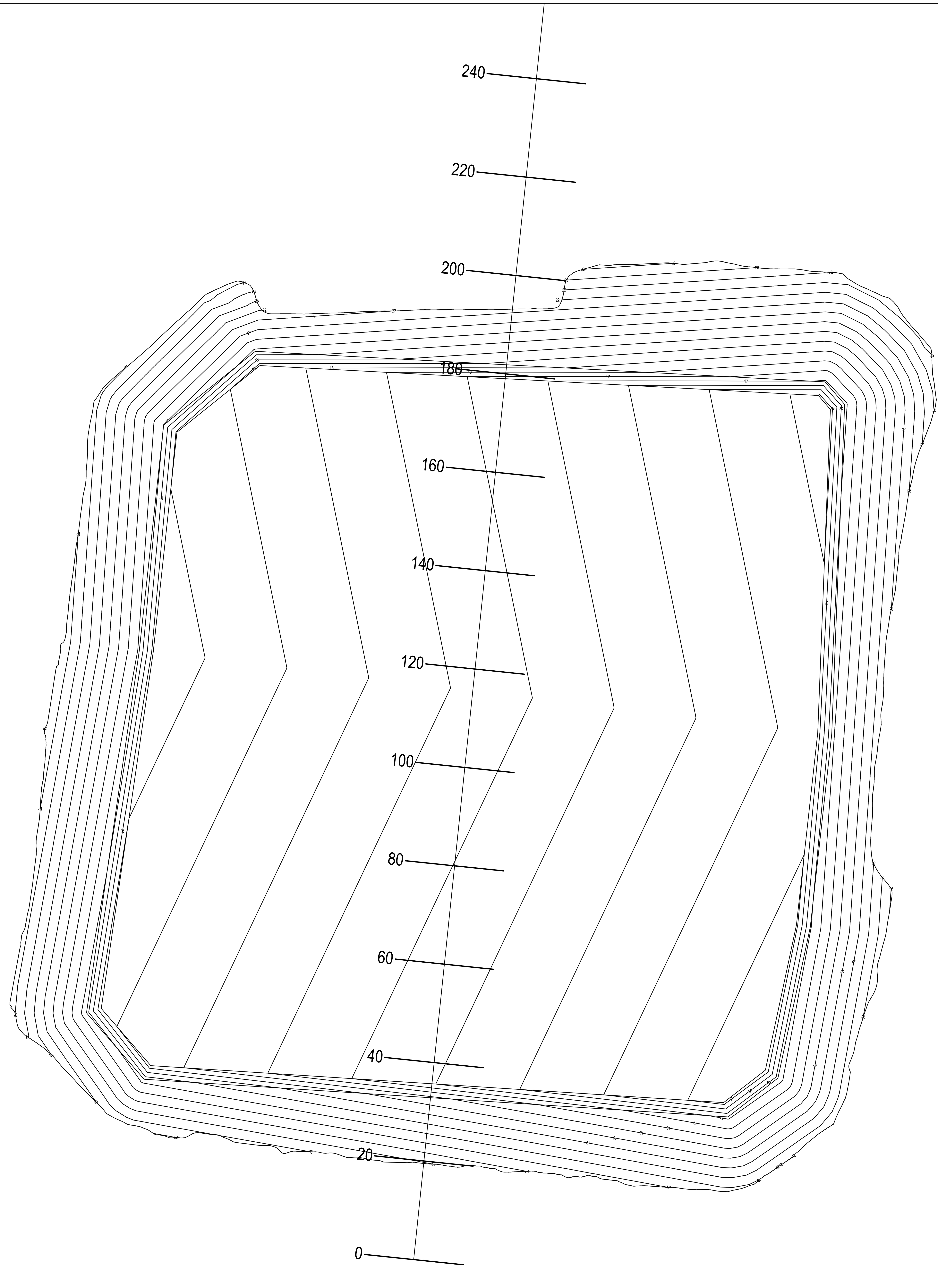
Seismic Line Location

Borehole Location

DRAFT

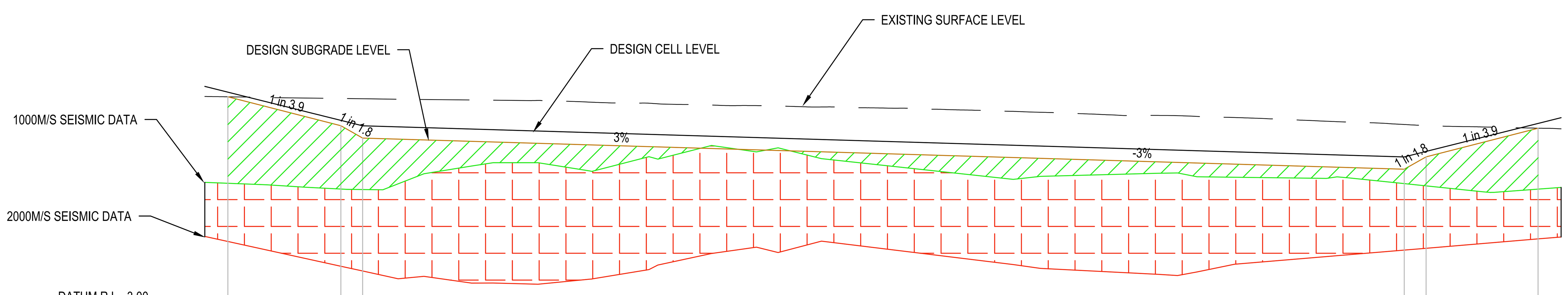
ABN 77 009 550 869
ADVANCED SUBSURFACE INVESTIGATIONS
18 Fennell Street, NORTH PARRAMATTA NSW 2151, Australia
Telephone: (02) 9890 2122 Facsimile: (02) 9890 2922

GHD	DATE: 23rd MAY 2016 / PAPER SIZE: A3
GEOPHYSICAL INVESTIGATION TO DETERMINE BEDROCK DEPTH HYDRO ALUMINIUM PLANT, KURRI KURRI, NSW	SCALE: / DRAWN: T.B
	DRAWING NUMBER: GBGA1933-01



PLAN

12d Model
Horizontal Scale 1:500
Wed 13 Jul 2016 - 11:21AM



DATUM R.L. -3.00

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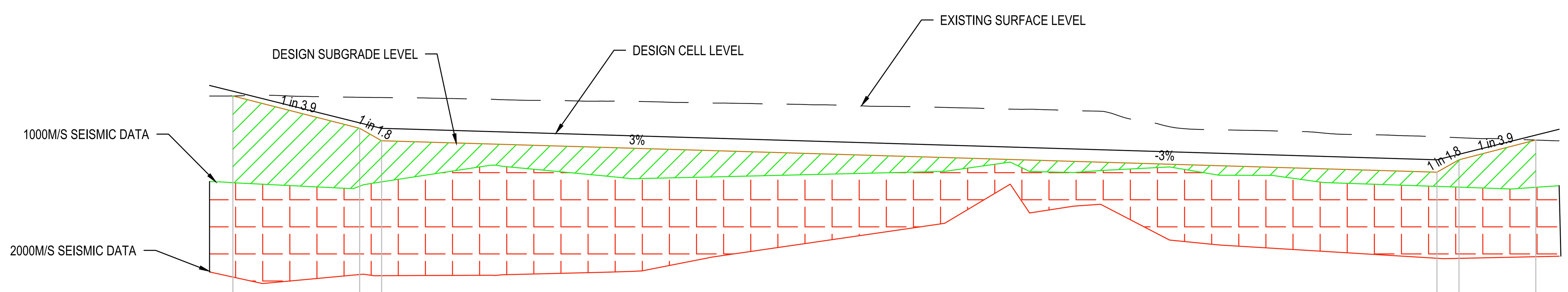
2000M/S SIESMIC DATA	5.33	2.1	1.48	4.21	4.45	5.66
1000M/S SEISMIC DATA	12.91	12.16	12.09	12.86	12.57	12.14
DESIGN CELL LEVEL	24.78	21.1	20.39	16.34	17.05	20.7
DEPTH TO SUBGRADE CUT - / FILL +	0	-3.55	-5.12	-5.82	-4.07	0
EXISTING SURFACE LEVEL	24.16	23.94	23.91	20.56	20.42	20.08
OFFSET FROM CENTRELINE	-84.99	-70.25	-67.41	68.36	71.21	85.8

CH 60



DATUM R.L. -3.00

DESIGN SUBGRADE LEVEL	24.937	20.763	19.161	15.108	16.708	19.249
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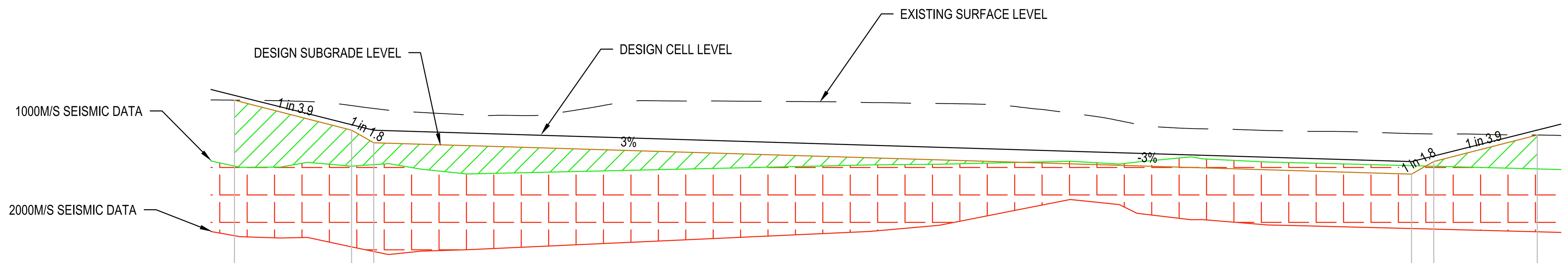
1000M/S SEISMIC DATA	13.75	13.3	13.85	13.27	13.17	13.15
DESIGN CELL LEVEL	25.55	21.47	20.76	16.71	17.42	19.89
DEPTH TO SUBGRADE CUT - / FILL +	0	-3.99	-5.57	-4.56	-2.84	0
EXISTING SURFACE LEVEL	24.94	24.76	24.73	19.67	19.55	19.25
OFFSET FROM CENTRELINE	-84.92	-68.59	-65.76	70.18	73.01	82.91

CH 100

CROSS SECTIONS

12d Model
Horizontal Scale 1:500
Vertical Scale 1:500
Wed 13 Jul 2016 - 11:21AM



DATUM R.L. 1.00

DESIGN SUBGRADE LEVEL	24.33	20.513	18.903	14.913	16.52	19.891
2000M/S SIESMIC DATA	7.08	5.66	5.07	7.99	7.92	7.58
1000M/S SEISMIC DATA	15.94	15.93	16.12	15.99	15.92	15.58
DESIGN CELL LEVEL	24.94	21.21	20.5	16.51	17.22	20.52
DEPTH TO SUBGRADE CUT - / FILL +	0	-3.13	-4.37	-5.16	-3.51	0
EXISTING SURFACE LEVEL	24.33	23.65	23.27	20.07	20.03	19.89
OFFSET FROM CENTRELINE	-82.66	-67.74	-64.91	67.32	70.16	83.35

CH 160

CROSS SECTIONS

12d Model
Horizontal Scale 1:500
Vertical Scale 1:500
Wed 13 Jul 2016 - 11:21AM

Appendix E Liner Degradation Assessment

ExcelPlas Independent Materials Testing

Accelerated Degradation Testing of HDPE Liners in Mixed Smelter Waste Leachate from the Capped Waste Stockpile

Prepared for: David Barrett <Dave.Barrett@ghd.com>

Prepared by: Dr. John Scheirs (www.excelplas.com)

ExcelPlas Job #: 5644

Date: 8th January 2016 (V. 2.1)

GLOSSARY

ASTM – American Society for Testing and Materials

CWS – Capped Waste Stockpile

HAS – Hindered Amine Stabilizers

HPA – Hindered Phenolic Antioxidants

HP-OIT – High Pressure Oxidative Induction Time

MSW – Mixed Smelter Waste

OIT – Oxidative Induction Time which is a measure a the level of antioxidants/stabilizers in a polymer

S-OIT – Standard Oxidative Induction Time

SPL – Spent Pot Liner

VOC – Volatile Organic Compounds

Contents

Executive Summary

Three different High-Density Polyethylene (HDPE) liners were incubated in Mixed Smelter Waste leachate from the Capped Waste Stockpile (CWS) with a view to estimating their service lifetimes.

HDPE geomembranes contain proprietary blends of antioxidants and stabilizers to retard and inhibit oxidative degradation of the polymer. The service life of HDPE geomembranes is therefore controlled by the slow loss of these antioxidants and stabilizers.

The loss of antioxidants and stabilizers from the HDPE membranes with progressive incubation in Mixed Smelter Waste leachate from the Capped Waste Stockpile at three different temperatures (55, 75 and 95 deg.C) was determined by S-OIT and HP-OIT measurements respectively.

Large decreases were observed in S-OIT values at 95 deg.C over the 6 months incubation (up to almost 80% loss) for all three geomembranes reflecting loss of the phenolic antioxidants (i.e. short-term thermal protection). This is consistent with the fact that these molecularly smaller antioxidant molecules are most easily extracted from the HDPE matrix combined with the fact that they are mostly ester-based and hence susceptible to alkali-catalyzed hydrolysis (i.e. destruction at high pH).

In contrast, there has been no statistically significant reduction in the HP-OIT results over the 6 month incubation program. This is testimony to the outstanding long-term thermal stability of these fortified high-performance HDPE liners. The hindered amine stabilizers which are reflected in the HP-OIT response are known to be bulky molecules with steric hindrance that are difficult to extract from the polymer into solution and they are also basic in nature hence can tolerate high pH environments such as the Mixed Smelter Waste leachate.

The total lifetime estimates based on the HP-OIT data for all three liners were in the range **181-223 years** thus indicating they will all comfortably meet the expected 100 yr design life.

It should be noted that it is difficult to generate lifetime data based on these HP-OIT results as the Arrhenius lifetime extrapolation technique requires clear/measurable decreases in HP-OIT values with increasing test temperature and with increasing test time. As can be seen from the HP-OIT retention curves there has been no clear or constant decrease over the 6 months of testing. This is because these liner samples are very stable. Nevertheless based on the HP-OIT results to date it is apparent that these HDPE liners will all achieve in excess of a 100 year design life.

Further extended immersion testing would be required for what we estimate is at least 1 year to more accurately determine life expectancies using the HP-OIT retention values.

1. Objective

The main objective of this study is to assess the durability and performance of different High-Density Polyethylene (HDPE) liners in Mixed Smelter Waste leachate from the Capped Waste Stockpile (CWS) with a view to estimating their service lifetimes.

The study will provide information on aging of the liners from antioxidant depletion times, stabilizer depletion times, induction times and mechanical property deterioration and other critical parameters that may impact on the design life.

2. Introduction

HDPE geomembranes contain proprietary blends of antioxidants and stabilisers to retard and inhibit oxidative degradation of the polymer. The service life of HDPE geomembranes is therefore controlled by the slow loss of these antioxidants and stabilisers.

Different HDPE geomembrane manufacturers use different blends, ratios and levels of antioxidants and stabilisers. The antioxidants are based on different hindered phenolic antioxidants and thioesters while the stabilisers are based on hindered phosphites and hindered amines.

HDPE Geomembranes typically contain the following four anti-ageing additives:

- **Hindered phenolic antioxidant** [processing, welding and medium –term heat stability]
- **Hindered phosphite antioxidant** [processing stability]
- **Hindered amine stabilizer LMW** (low molecular weight HALS) [heat and UV stability]
- **Hindered amine stabilizer HMW** (high molecular weight HALS) [heat and UV stability]

Figure 1 displays the Active Temperature Range for Additives in HDPE

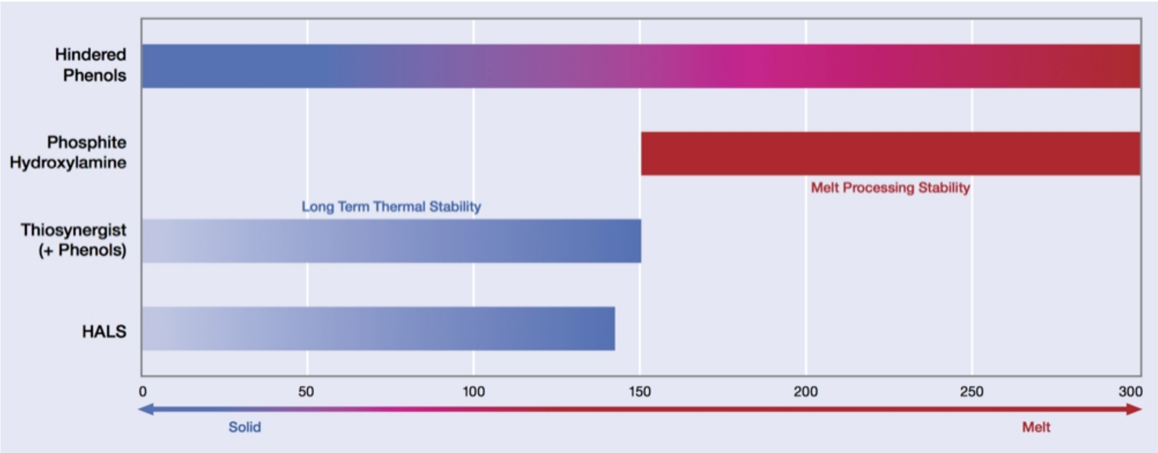


Figure 1 - Active temperature range for additives in HDPE

Figure 2 displays the Mechanisms of Additive Loss from HDPE

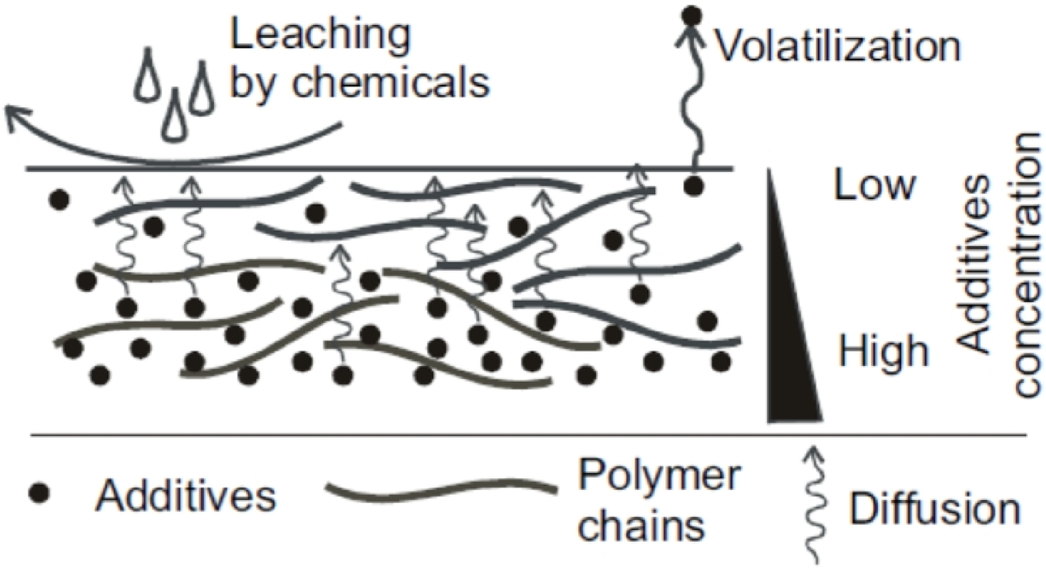


Figure 2 - Additive loss from HDPE

Figure 3 shows the Additive Depletion Pathways in HDPE Liners

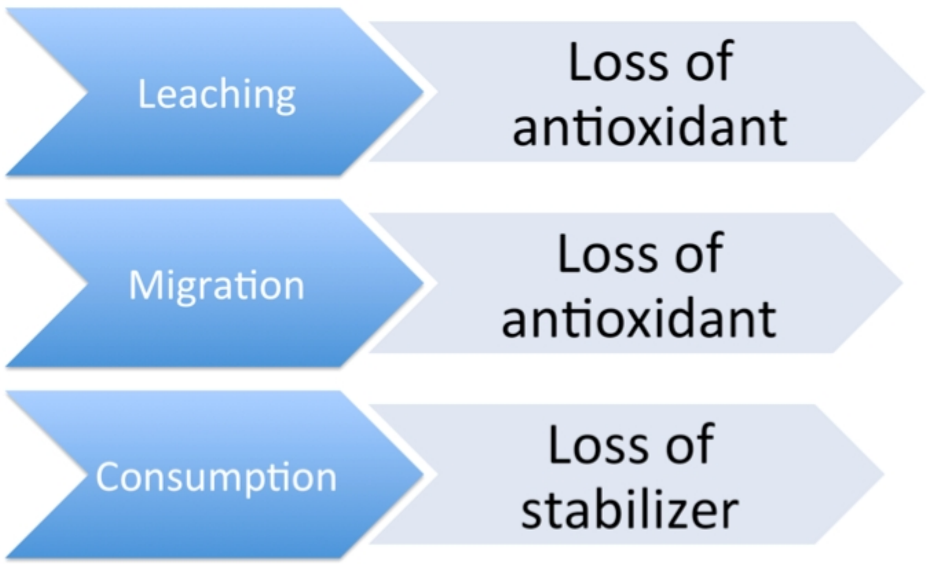


Figure 3 - Additive depletion pathways in HDPE liners

3. Liner materials tested

The three candidate HDPE liners that were evaluated are:

- [redacted] 2 mm High Performance HDPE (DDS[1]) roll#904
- [redacted] 2 mm BPEM compliant HDPE (HDS[2]) roll#922
- [redacted] 2 mm Premium HD Series (PHD) roll#596

The HDPE liner materials tested are displayed in Table 1.

Table 1- HDPE materials tested

Sample Name	[redacted] DDS-200AM-BBB-W-OO	[redacted] HDS-200VM-BBB-W-OV	[redacted] 480-9095 (5005596)
SAMPLE NUMBER (Excelplas)	1	2	3
MATERIAL TYPE	HDPE	HDPE	HDPE
GRADE NAME			
MANUFACTURER	[redacted]	[redacted]	[redacted]
ROLL NUMBER?	806585904	806585922	3-48596
SAMPLE THICKNESS (mm)	2	2	2
WHITE/BLACK?	black	black	black
DID YOU RECEIVE MQA DATA (YES/NO)?	Yes	Yes	Yes
OTHER	Product Code: DDS-200AM-BBB-W-OO	Product Code: HDS-200VM-BBB-W-OV	Product Code: 480-9095 (5005596)

The roll data for [redacted] 904 Liner can be found in Table 2

Table 2 - [redacted] 904 roll data

[redacted]

MANUFACTURER QUALITY CERTIFICATE
HDPE GEOMEMBRANE

Date Issued: 05-Mar-16

Properties	Test Method	Frequency	Result
High Pressure Oxidative Induction Time (min) 806585904 (DDS-200AM-BBB-W-00) Roll no # 806583479 (Tested date : 14/8/2015)	ASTM D5885	1/90,000 kg	1711
Oven Aging- via High Pressure Oxidative Induction Time - Initial HP- OIT (min) - After exposed HP-OIT (min) - % retained after 90 days	ASTM D5721 ASTM D5885	1/formulation	1480 1295 88
UV Resistance via High Pressure Oxidative Induction Time - Initial HP- OIT (min) - After exposed HP-OIT (min) - % retained after 1600 hrs	ASTM D7238 ASTM D5885	1/formulation	1480 1350 91

[1] DDS relates to smooth HDPE High Performance
[2] HDS relates to smooth HDPE standard.

The roll data for [redacted] 922 Liner is displayed in Table 3

Table 3 - [redacted] 922 roll data

[redacted]

MANUFACTURER QUALITY CERTIFICATE
HDPE GEOMEMBRANE

Date Issued: 05-Mar-16

Properties	Test Method	Frequency	Result
High Pressure Oxidative Induction Time (min)	ASTM D5885	1/90,000 kg	
806585922 (HDS-200VM-BBB-W-0V)			1650
Roll no # 806581864 (Tested date : 17/6/2015)			
Oven Aging- via std. Oxidative Induction Time [1]	ASTM D5721	1/formulation	
- Initial std OIT (min)	ASTM D3895		220
- After exposed std OIT (min)			185
- % retained after 90 days			84
Oven Aging- via High Pressure Oxidative Induction Time [1]	ASTM D5721	1/formulation	
- Initial HP- OIT (min)	ASTM D5885		1228
- After exposed HP-OIT (min)			1128
- % retained after 90 days			93
UV Resistance via High Pressure Oxidative Induction Time [1]	ASTM D7238	1/formulation	
- Initial HP- OIT (min)	ASTM D5885		1228
- After exposed HP-OIT (min)			1012
- % retained after 1600 hrs			82

The roll data for [redacted] Liner sample is displayed in Table 4.

Table 4 - [redacted] roll data

[redacted]

QUALITY CONTROL REPORT
Roll Certification

[redacted]

ROLL IDENTIFICATION

Roll Number : 3-48596
Packing Slip Number : 607665
Product Code : 5005596
HDPE 2.00 mm Black Smooth
Production Date 18/03/2016

Length (± 1%) :	105.0 meters
Width :	8.00 meters
Sheet Area :	840 sq. meters
Weight :	1,664 kilograms

RESIN INFORMATION

Resine Lot Numb BGK445944
Resine Type : HDPE / K306
Resine Supplier : Chevron-Singapore

Property	Test Method	Results
Density (g/cc)	ASTM D 1505	0.937
Melt Index (g/10 min.	ASTM D 1238 (190/2.16)	0.1
ESCR (hrs)	ASTM D 5397	>1000
OIT (min.)	ASTM D 3895	279
HP-OIT (min.)	ASTM D 5885	1,106

Physical Property		Test Method	Test Frequency	Technical Data Metric	Test Results Metric
Thickness (mm)	Average	ASTM D-5199	1/1 ro	2.00	2.03
	Minimum			1.80	1.97
Asperity (mm)	Average (out / in)	N/A	N/A		/

4. Immersion media used

Analysis of Leachate from the Capped Waste Stockpile (CWS) was undertaken to characterize the chemical nature of the liquor.

Table 5 contains the analysis report, which shows that the Leachate from the Capped Waste Stockpile (CWS) is quite alkaline with a pH of 10.6.

Table 5 - Analysis report

Work Order : EM1606030
Client : ExcelPlas Pty Ltd
Project : 5644

Analytical Results

Sub-Matrix: LIQUOR
(Matrix: WATER)

			Client sample ID	Hydro Untreated SPL Liquor
			Client sampling date / time	[25-May-2016]
Compound	CAS Number	LOR	Unit	EM1606030-001
				Result
EA005P: pH by PC Titrator				
pH Value	----	0.01	pH Unit	10.6
ED037P: Alkalinity by PC Titrator				
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	24200
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	4950
Total Alkalinity as CaCO3	----	1	mg/L	29100
EG020T: Total Metals by ICP-MS				
Aluminium	7429-90-5	0.01	mg/L	833
Arsenic	7440-38-2	0.001	mg/L	0.490
Cadmium	7440-43-9	0.0001	mg/L	<0.0010
Chromium	7440-47-3	0.001	mg/L	1.52
Copper	7440-50-8	0.001	mg/L	0.089
Nickel	7440-02-0	0.001	mg/L	0.990
Lead	7439-92-1	0.001	mg/L	0.462
Zinc	7440-66-6	0.005	mg/L	0.580
EG035T: Total Recoverable Mercury by FIMS				
Mercury	7439-97-6	0.0001	mg/L	<0.0001
EK026SF: Total CN by Segmented Flow Analyser				
Total Cyanide	57-12-5	0.004	mg/L	227
EK040P: Fluoride by PC Titrator				
Fluoride	16984-48-8	0.1	mg/L	1910

The volatile organic compounds (VOC) in the Leachate from the Capped Waste Stockpile (CWS) was determined using Headspace Gas Chromatography/Mass Spectroscopy and the results are displayed in Table 6.

Table 6 - Volatile organic compounds identified in leachate

Table 1: VOCs identified in headspace of the sample "Hydro Untreated SPL Liquor" analysis using DHS-TDU-CIS-GC-MS

RT	Area Pct	Library/ID	CAS
3.6432	35.6588	Acetone	000067-64-1
4.5027	19.4043	Silanol, trimethyl-	001066-40-6
5.1044	8.602	2-Butanone	000078-93-3
6.1073	0.9785	2-Butanone, 3-methyl-	000563-80-4
6.2147	1.1642	Benzene	000071-43-2
6.5156	0.9218	2-Pentanone	000107-87-9
7.3393	1.5021	Methyl Isobutyl Ketone	000108-10-1
7.8551	11.2742	Toluene	000108-88-3
8.0341	1.2138	2-Hexanone	000591-78-6
8.1129	1.8064	3-Pentanone, 2,4-dimethyl-	000565-80-0
9.345	1.3625	3-Heptanone	000106-35-4
11.0211	1.6577	1-Hexanol, 2-ethyl-	000104-76-7
11.9953	0.8531	Nonanal	000124-19-6
13.0769	1.4186	Decanal	000112-31-2

5. Experimental methods

The immersion and incubation of the HDPE samples in the Mixed Smelter Waste leachate from the Capped Waste Stockpile (CWS) was conducted at three temperatures (55, 75 and 95 deg.C) in stainless steel incubators in accordance with test method **ASTM D5747 - 2013** 'Standard Practice for Tests to Evaluate the Chemical Resistance of Geomembranes to Liquids'.

Oxidation induction time (OIT) measurements were conducted on the liner samples to determine residual additive levels. Both types of OIT tests were performed namely standard OIT (S-OIT) at 200 deg.C (as per **ASTM D3895**) and HP-OIT at 150 deg.C (as per **ASTM D5885**). The S-OIT value reflects the retained antioxidant levels while the HP-OIT value reflects the retained stabilizer content in the liner samples. See Figure 4 showing OIT concept below.

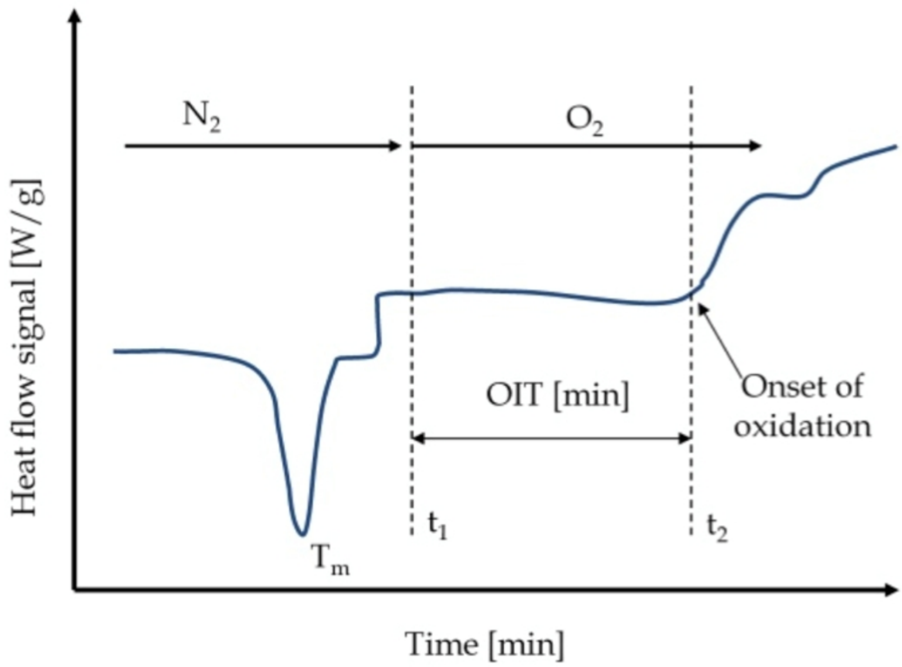


Figure 4 - OIT concept

S-OIT can only detect antioxidants that are effective at 200 deg.C such as hindered phenolic and hindered phosphites which are used to inhibit oxidation of the geomembrane during the extrusion processing of the liner, during welding of the liner and also during the GMB service life when it is exposed to elevated temperatures.

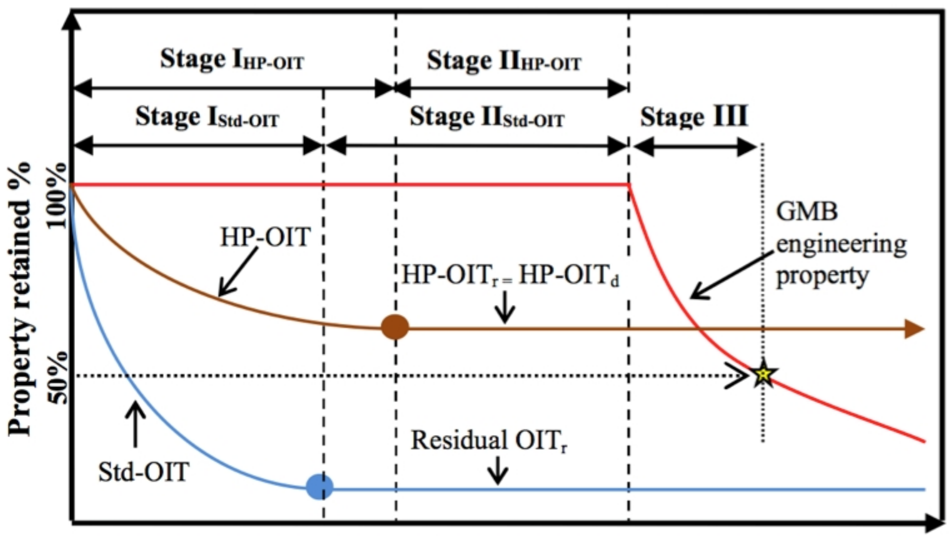
However, stabilizers such as hindered amines stabilizers (HAS) and thiosynergists are not active at these temperatures (i.e. around 200 deg.C) and therefore cannot be detected by the Standard OIT test. For this reason, the HP-OIT test run at 150 deg.C is used to detect these stabilizers which control the long-term stability to the geomembrane (Ref. Scheirs, reference 1, pp. 73, 286, 301, 332).

Key Stages of HDPE Ageing

Lifetime predictions for HDPE geomembranes are based on extrapolating the three conceptual stages of ageing:

- **Stage A** – when the HDPE is protected from mechanical degradation by antioxidants and stabilisers
- **Stage B** – the induction time after the antioxidants and stabilisers have been depleted (when OIT and HP-OIT are greatly reduced to residual values) but there is no significant measurable decrease in mechanical properties
- **Stage C** – is the time taken from the onset of a reduction in mechanical properties to when the properties reach 50% of their original design value (i.e. failure point).

Figure 5 shows the Effect of S-OIT and HP-OIT Levels on Geomembrane Failure Time



From **Ewais et al. 2014a**

Figure 5 - The effects of S-OIT and HP-OIT on failure time

Limiting OIT Values

The S-OIT and HP-OIT methods therefore give complimentary information regarding the antioxidant and stabilizer systems in the liners.

The tensile properties of the liner are not expected to diminish until the S-OIT and HP-OIT reach their limiting residual values which is typically 1 min and 50 mins respectively.

Figure 6 shows the experimental equipment used for this study.


Figure 6 - Experimental apparatus used in study

Figure 7 shows the Incubation Rigs Used to Hold the Liner Specimens in the Leachate During Incubation.

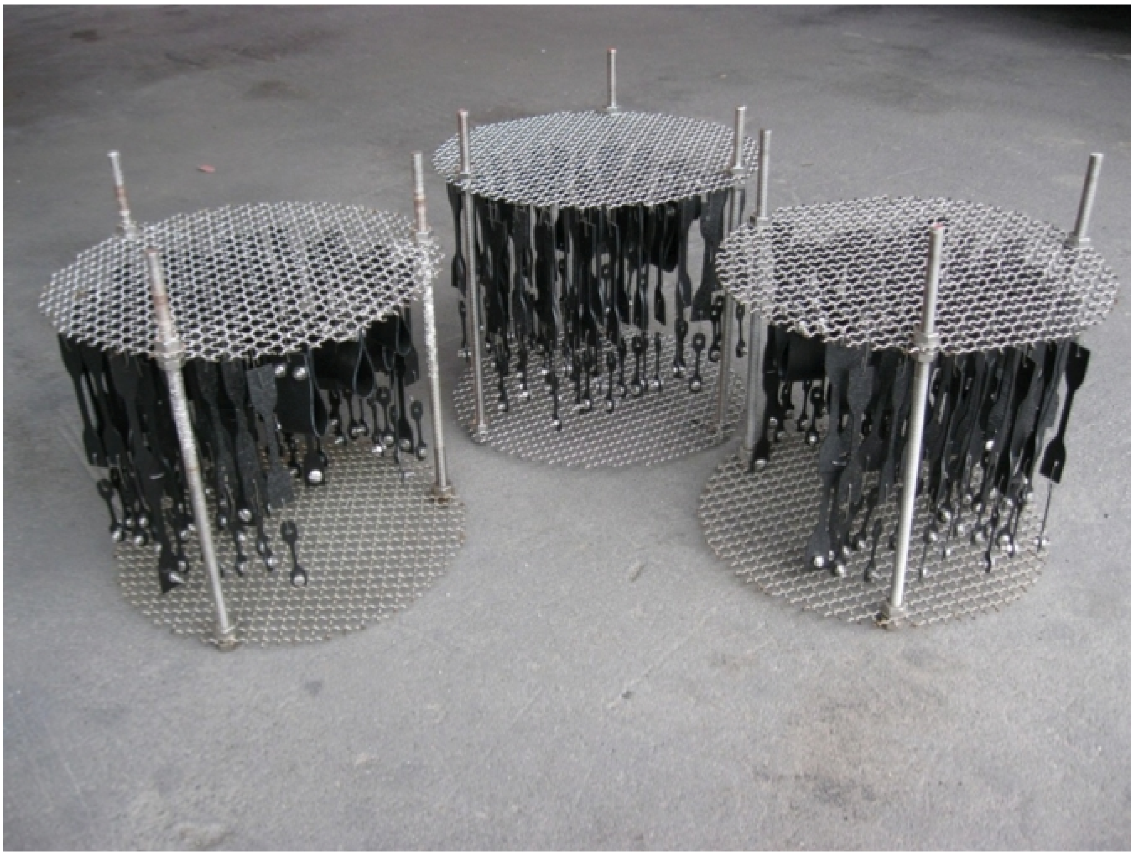


Figure 7 - Incubation rigs

Figure 8 shows the Samples After 6 Months Incubation at 55 deg.C.

Figure 8 - Samples post 6 months incubation

Note samples are individually suspended and weighted to prevent them sticking to each other or floating hence allowing full and intimate contact with the immersion medium.

During incubation of samples at 95 deg.C it was noted that salt crystals were nucleating on the HDPE samples forming a whitish bloom. Elemental testing by x-ray analysis found that this bloom was comprised of porous layers of sodium-iron aluminum silicates (see report at **Annexure A1**).

6. Initial S-OIT and HP-OIT values before immersion and ageing

Table 7 contains the initial S-OIT Values of the Candidate HDPE Liners

Table 7 - S-OIT values

Geomembrane ID	***Initial S-OIT (as measured by manufacturer for lot)***	***Initial S-OIT (as measured by ExcelPlas before immersion)***
[redacted] 904	195 mins	190 mins
[redacted] 922	220 mins	190 mins
[redacted]	279 mins	295 mins

The above HDPE liners are all exceptionally well stabilized with respect to ***short-term thermal stability*** as their initial S-OIT values are all close to or in excess of 200 mins. Note the generic global industry specification (i.e. GRI GM-13) requires that the S-OIT of HDPE liners be > 100 mins. Thus the above liners clearly well exceed this industry minimum norm by ~100%. It is known however that the hindered phenolic antioxidants (HPA) that give the S-OIT signal contain ester bridges in their molecules that are sensitive to high pH environments. So there may be rapid destruction of the HPA additives and a concomitant rapid decreases in the S-OIT values with immersion and incubation.

Table 8 of Initial HP-OIT Values of the Candidate HDPE Liners

Table 8 - Initial HP-OIT values

Geomembrane ID	***Initial HP-OIT (as measured by manufacturer for lot)***	***Initial HP-OIT (as measured by ExcelPlas before immersion)***
[redacted] 904	1480 mins	1647 mins
[redacted] 922	1228 mins	1684 mins
[redacted]	1106 mins	1081 mins

The above HDPE liners are all exceptionally well stabilized with respect to ***long-term thermal stability*** as their initial HP-OIT values are all in excess of 1000 mins. Note the generic global industry specification (i.e. GRI GM-13) requires that the HP-OIT of HDPE liners be > 400 mins. Thus the above liners clearly well exceed this industry minimum norm by at least 150%.

7. Retained OIT results

S-OIT results

Figure 9 shows the S-OIT Results for Sample 1 [redacted] DDS-200AM After 6 Months Incubation.

Figure 9 - [redacted] DDS 200AM Sample 1 S-OIT Results

Figure 10 shows the S-OIT Results for Sample 1 [redacted] HDS-200VM After 6 Months Incubation.

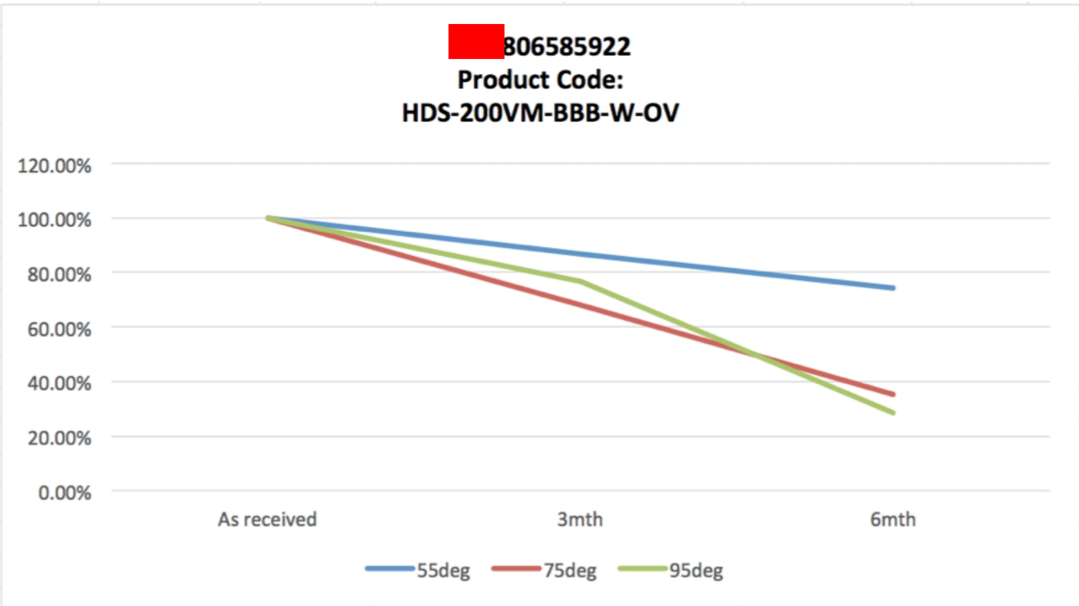


Figure 10 - [redacted] HDS 200VM Sample 1 S-OIT results

Figure 11 shows the S-OIT Results for Sample 3 [redacted] 480-9095 After 6 Months Incubation.

Figure 11 - [redacted] 480-9095 Sample 3 S-OIT results

HP-OIT results

Figure 12 shows the HP-OIT Results for Sample 1 [redacted] DDS-200AM After 6 Months Incubation.

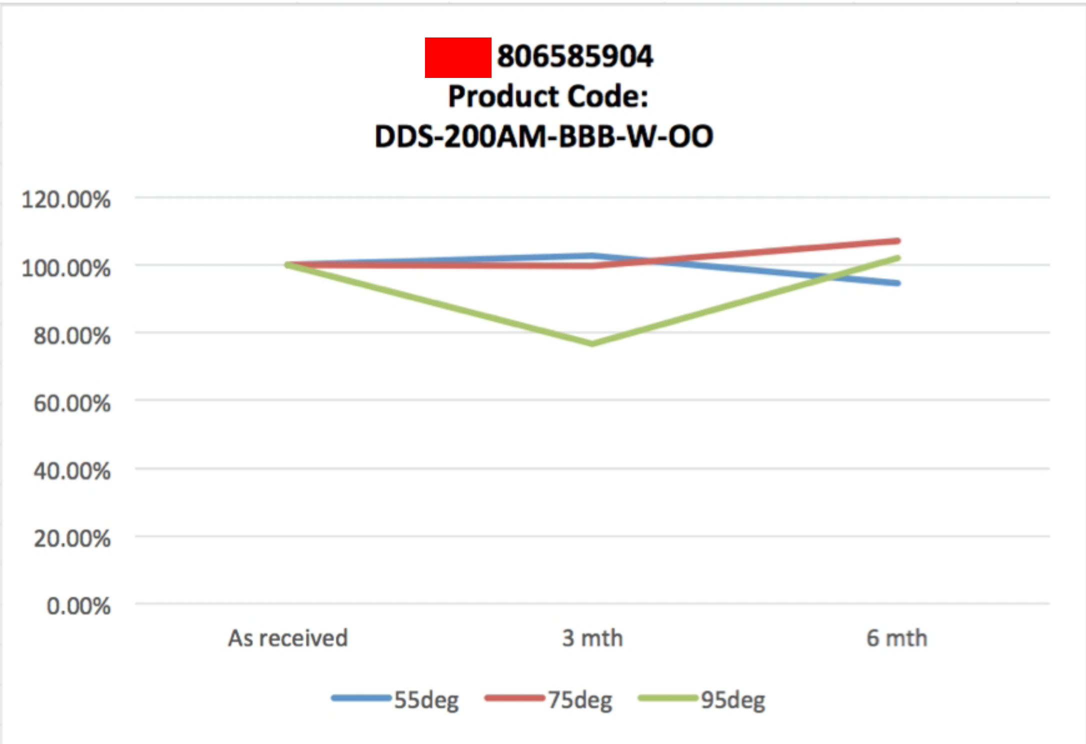


Figure 12 - [redacted] DDS 200AM Sample 1 HP-OIT results

Figure 13 shows the HP-OIT Results for Sample 2 [redacted] HDS-200VM After 6 Months Incubation.

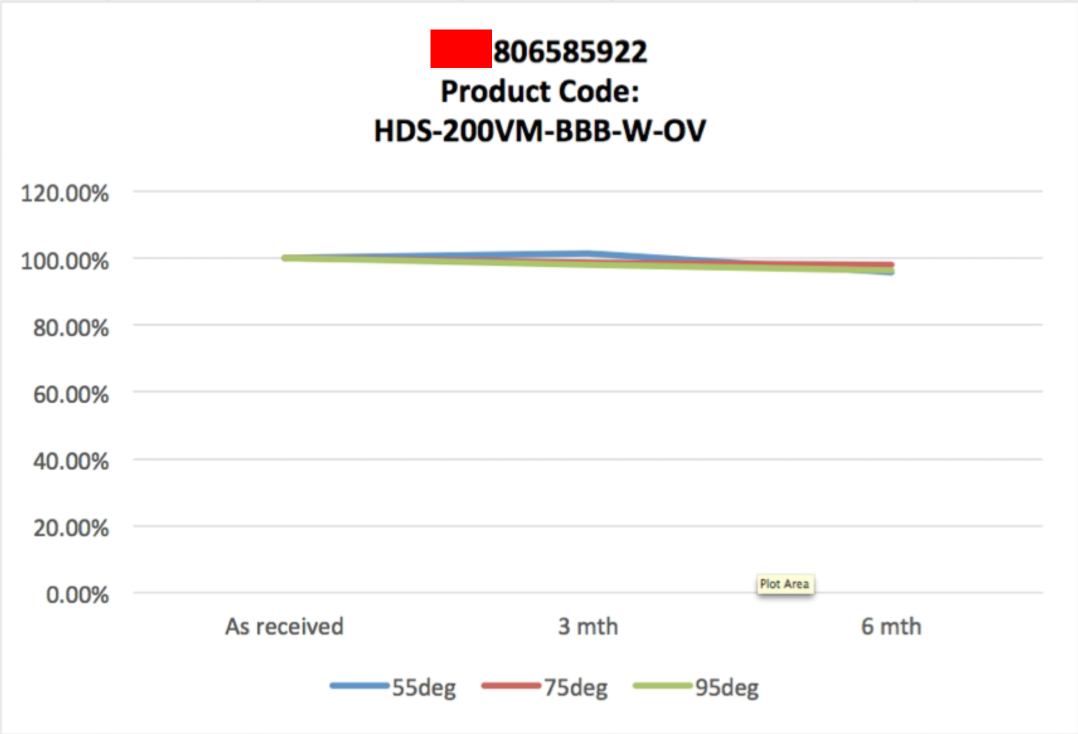


Figure 13 - [redacted] HDS 200VM Sample 2 HP-OIT results

Figure 14 shows the HP-OIT Results for Sample 3 [redacted] 480-9095 After 6 Months Incubation.

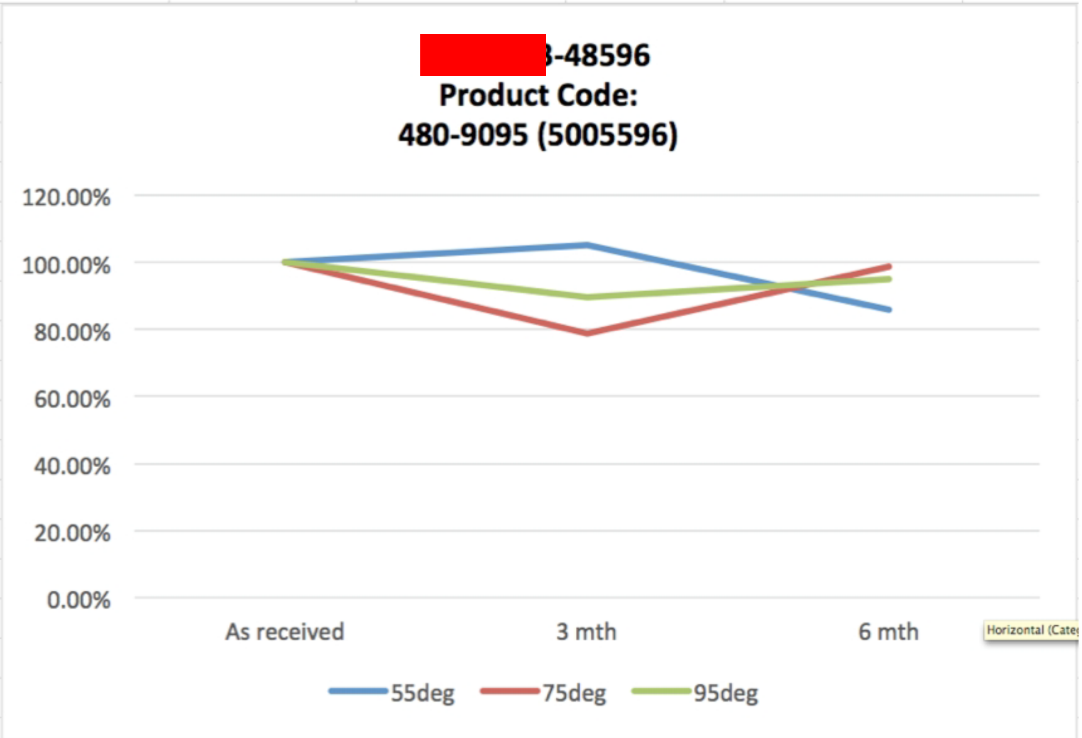


Figure 14 - [redacted] 480-9095 Sample 3 SP-OIT results

No significant change in the HP-OIT of any of the samples was recorded after 6 months immersion which is testimony to the outstanding long-term thermal stability of these liners.

8. Discussion

There have been large decreases observed (up to almost 80% loss) in S-OIT values at 95 deg.C over the 6 months incubation for all three geomembranes reflecting loss of the phenolic antioxidants (i.e. short-term thermal protection). This is consistent with the fact that these molecularly smaller antioxidant molecules are most easily extracted from the HDPE matrix combined with the fact that they are mostly ester-based and hence susceptible to alkali-catalyzed hydrolysis (i.e destruction at high pH).

In contrast, there has been no statistically significant reduction in the HP-OIT results over the 6 month incubation program. This is testimony to the outstanding long-term thermal stability of these fortified high performance liners. The hindered amine stabilizers which the HP-OIT scans record are known to be bulky molecules with steric hindrance that are difficult to extract into solution and they are also basic in nature hence can tolerate high pH environments.

Accordingly it is difficult to generate lifetime data based on the HP-OIT results as the Arrhenius lifetime extrapolation technique requires clear/measurable decreases in HP-OIT values. As can be seen from the HP-OIT retention curves there has been no clear or constant decrease over the 6 months. Nevertheless based on the HP-OIT results to date it is clear that the liners will all achieve in excess of a 100 year design life. Further extended immersion testing would be required for what we estimate is at least 1 year to determine more accurate life expectancies using the HP-OIT retention values.

9. Lifetime extrapolations

The lifetime extrapolations were determined using the Arrhenius method as outlined in ISO 2578 as shown in Figure 15.

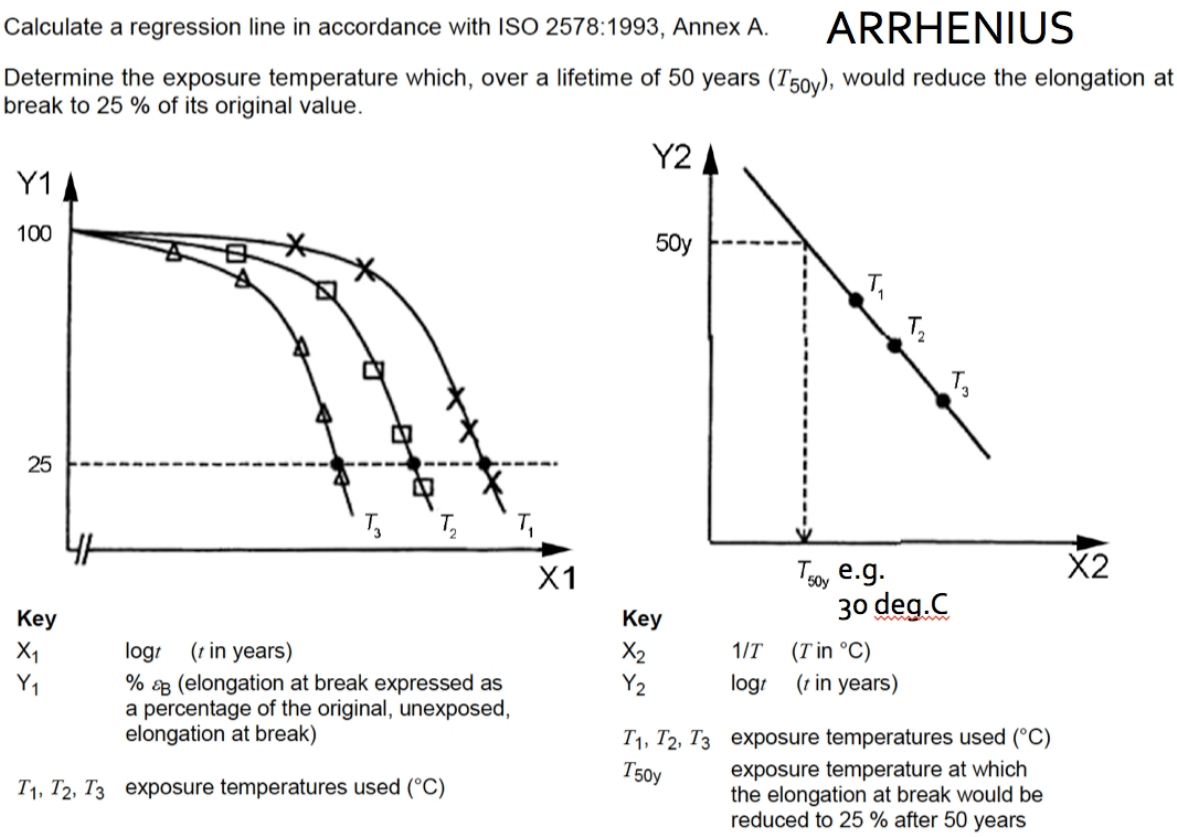


Figure 15 - Arrhenius method

The Arrhenius relationship is the most common lifetime-stress relationship utilized in accelerated lifetime testing of polymers. It has been widely used when the stimulus or acceleration variable (or stress) is thermal (i.e., temperature). It is derived from the Arrhenius reaction rate equation proposed by the Swedish physical chemist Svandte Arrhenius in 1887.

Note the above example using % elongation at break data at three different temperatures to generate the Arrhenius plot whereas HP-OIT data was used in this report.

904 S-OIT Extrapolations

Oxidative Induction Time (OIT)

RESULTS INPUT TABLE

Temperature [°C]	Exposure Time [days] 0	90	180
55	190	169	145
75	190	133	65
95	190	136	44

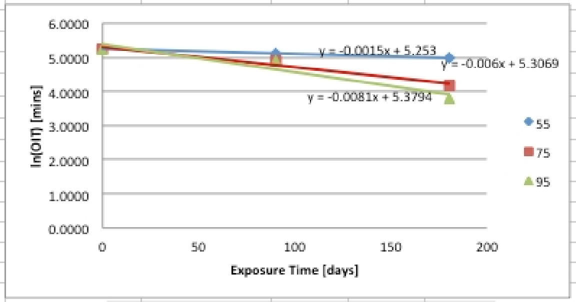
CALCULATIONS

ln(OIT)			OIT Depletion Rate [min/day]	ln(OIT Depletion Rate) [min/day]	1/T [°K]	ln(S) [min/day]	S [min/day]
5.2470	5.13	4.98	-0.0015	-6.502290171	0.003047	-7.926226245	0.000361147
5.2470	4.89	4.17	-0.0060	-5.11599581	0.002872		
5.2470	4.91	3.78	-0.0081	-4.815891217	0.002716		

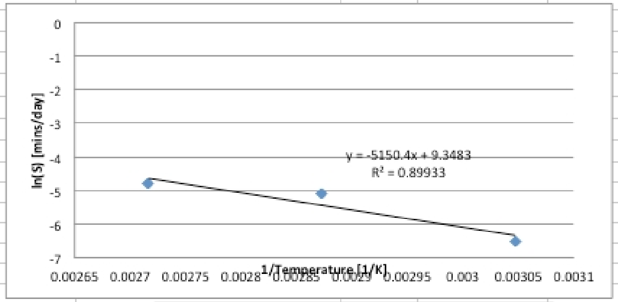
DESIGN PARAMETER INPUTS

Site Temperature [°C]	OIT End Life [min]	Slope	Intercept
25	1.0	-5150.4	9.35

Design Life (days) =	14529
Design Life (years) =	40



Graph 1 - For Estimation of Depletion Rates



Graph 2 - Arrhenius Graph

904 HP-OIT Extrapolations

High Pressure Oxidative Induction Time (HP-OIT)

RESULTS INPUT TABLE

Temperature [°C]	Exposure Time [days] 0	90	180
55	1647	1600	1558
75	1647	1590	1520
95	1647	1590	1500

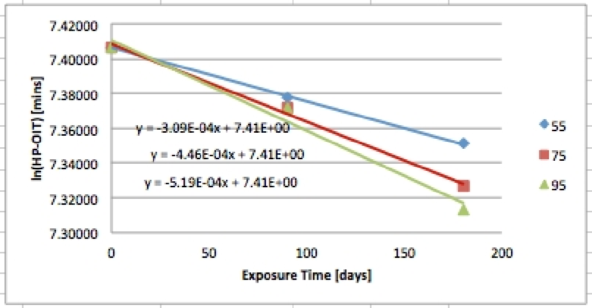
CALCULATIONS

ln(OIT)			OIT Depletion Rate [min/day]	ln(OIT Depletion Rate) [min/day]	1/T [°K]	ln(S) [min/day]	S [min/day]
7.40671	7.38	7.35	-0.0003	-8.082169281	0.003047	-8.536548516	0.00019617
7.40671	7.37	7.33	-0.0004	-7.715191606	0.002872		
7.40671	7.37	7.31	-0.0005	-7.563606675	0.002716		

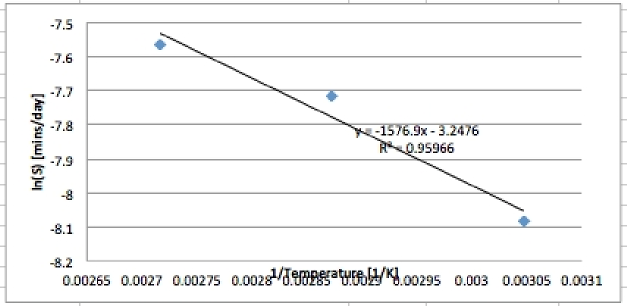
DESIGN PARAMETER INPUTS

Site Temperature [°C]	OIT End Life [min]	Slope	Intercept
25	50	-1576.9	-3.25

Design Life (days) =	17815
Design Life (years) =	49



Graph 1 - For Estimation of Depletion Rates



Graph 2 - Arrhenius Graph

922 S-OIT Extrapolations

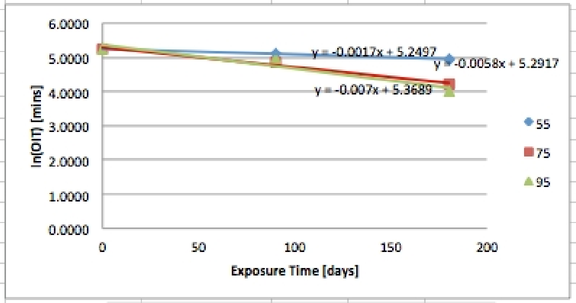
Oxidative Induction Time (OIT)

RESULTS INPUT TABLE				
	Exposure Time [days]			
Temperature [°C]	0	90	180	
55	190	165	141	
75	190	129	67	
95	190	146	54	

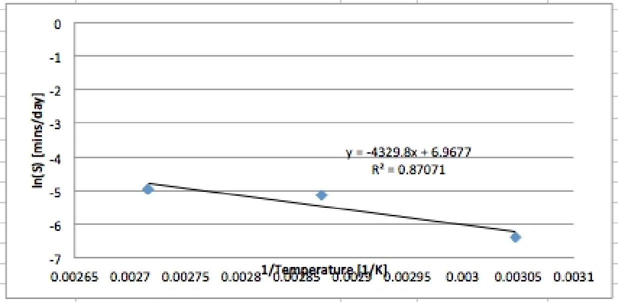
DESIGN PARAMETER INPUTS			
Site Temperature [°C]	OIT End Life [min]	Slope	Intercept
25	1.0	-4329.8	6.97

Design Life (days) =	10018
Design Life (years) =	27

CALCULATIONS								
ln(OIT)				OIT Depletion Rate [min/day]	ln(OIT Depletion Rate) [min/day]	1/T [°K]	ln(S) [min/day]	S [min/day]
5.2470	5.11	4.95		-0.0017	-6.377127028	0.003047	-7.554520359	0.000523737
5.2470	4.86	4.20		-0.0058	-5.149897361	0.002872		
5.2470	4.98	3.99		-0.0070	-4.96184513	0.002716		



Graph 1 - For Estimation of Depletion Rates



Graph 2 - Arrhenius Graph

922 HP-OIT Extrapolations

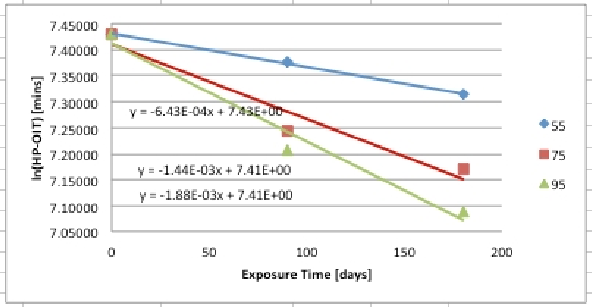
High Pressure Oxidative Induction Time (HP-OIT)

RESULTS INPUT TABLE				
	Exposure Time [days]			
Temperature [°C]	0	90	180	
55	1684	1600	1500	
75	1684	1400	1300	
95	1684	1350	1200	

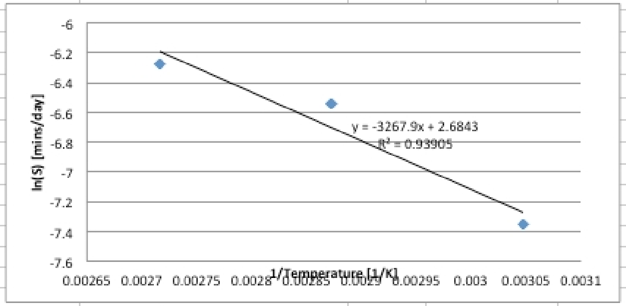
DESIGN PARAMETER INPUTS			
Site Temperature [°C]	OIT End Life [min]	Slope	Intercept
25	50	-3267.9	2.68

Design Life (days) =	13820
Design Life (years) =	38

CALCULATIONS								
ln(OIT)				OIT Depletion Rate [min/day]	ln(OIT Depletion Rate) [min/day]	1/T [°K]	ln(S) [min/day]	S [min/day]
7.42893	7.38	7.31		-0.0006	-7.349365834	0.003047	-8.276290307	0.00025448
7.42893	7.24	7.17		-0.0014	-6.543112165	0.002872		
7.42893	7.21	7.09		-0.0019	-6.276483502	0.002716		



Graph 1 - For Estimation of Depletion Rates



Graph 2 - Arrhenius Graph

S-OIT Extrapolations

Oxidative Induction Time (OIT)

RESULTS INPUT TABLE

Temperature [°C]	Exposure Time [days] 0	90	180
55	295	275	257
75	295	203	116
95	295	209	84

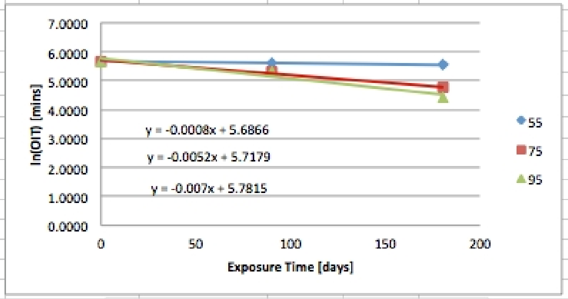
CALCULATIONS

ln(OIT)			OIT Depletion Rate [min/day]	ln(OIT Depletion Rate) [min/day]	1/T [°K]	ln(S) [min/day]	S [min/day]
5.6870	5.62	5.55	-0.0008	-7.13089883	0.003047	-8.938228241	0.000131273
5.6870	5.31	4.75	-0.0052	-5.259096653	0.002872		
5.6870	5.34	4.43	-0.0070	-4.96184513	0.002716		

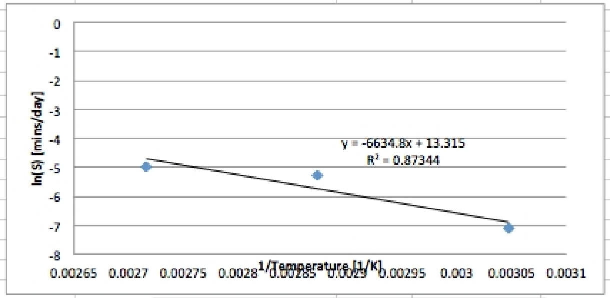
DESIGN PARAMETER INPUTS

Site Temperature [°C]	OIT End Life [min]	Slope	Intercept
25	1.0	-6634.8	13.32

Design Life (days) =	43322
Design Life (years) =	119



Graph 1 - For Estimation of Depletion Rates



Graph 2 - Arrhenius Graph

HP-OIT Extrapolations

High Pressure Oxidative Induction Time (HP-OIT)

RESULTS INPUT TABLE

Temperature [°C]	Exposure Time [days] 0	90	180	
55	1081	1020	948	
75	1081	870	800	
95	1081	850	750	

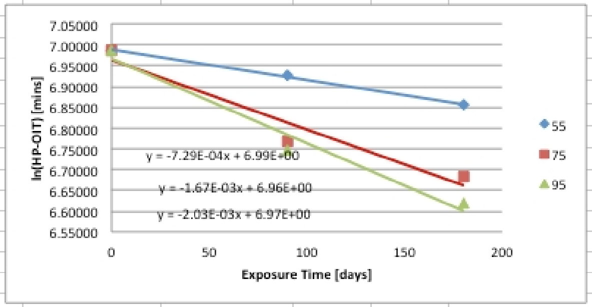
CALCULATIONS

ln(OIT)				OIT Depletion Rate [min/day]	ln(OIT Depletion Rate) [min/day]	1/T [°K]	ln(S) [min/day]	S [min/day]
6.98564	6.93	6.85		-0.0007	-7.223836826	0.003047		
6.98564	6.77	6.68		-0.0017	-6.394931653	0.002872	-8.09236158	0.00030587
6.98564	6.75	6.62		-0.0020	-6.199719486	0.002716		

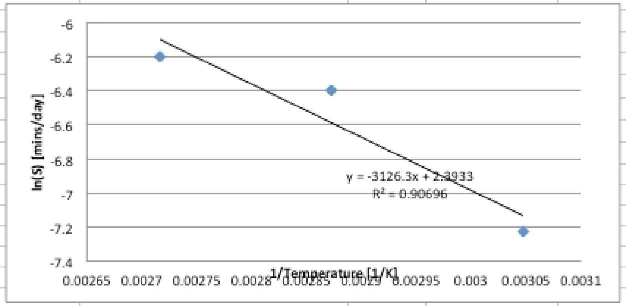
DESIGN PARAMETER INPUTS

Site Temperature [°C]	OIT End Life [min]	Slope	Intercept
25	50	-3126.3	2.39

Design Life (days) =	10049
Design Life (years) =	28



Graph 1 - For Estimation of Depletion Rates



Graph 2 - Arrhenius Graph

Stage B and Stage C Lifetimes (from Koerner)

Stage B and Stage C Lifetimes (Table 2 from Koerner see **Annexure A2**) are shown below. Since the proprietary antioxidants and stabilizers in HDPE are depleted at the end of Stage A, the number of years for Stage B and C can be used from this literature data as it applies to a generic unstabilized HDPE with the proprietary additives.

Table 2 - Lifetime prediction of HDPE (nonexposed) at various field temperatures

In Service Temperature (°C)	Stage "A" (years)			Stage "B" (years)	Stage "C" (years)	Total Prediction* (years)
	Standard OIT	High Press. OIT	Average OIT			
20	200	215	208	30	208	446
25	135	144	140	25	100	265
30	95	98	97	20	49	166
35	65	67	66	15	25	106
40	45	47	46	10	13	69

*Total = Stage A (average) + Stage B + Stage C

Example of Estimate Lifetime Calculation

The estimated total lifetime of the liners can be calculated suing the following method:

- Total Lifetime = Stage A + Stage B + Stage C
- HDPE GMB Stage A = X years (from Arrhenuis extrapolation) x 2 (for single sided immersion)
- Stage B lifetime (from Koerner) = 25 years at 25 deg.C
- Stage C lifetime (from Koerner) = 100 years at 25 deg.C
- Total estimate lifetime at 25 deg.C = 2X +125 years

Table of Estimated Lifetimes

The total estimated lifetimes for the HDPE liners at 25 deg.C based on the HP-OIT results are summarized in Table 9.

Table 9 –Lifetime estimate of HDPE liners

Sample ID	***Stage A Extrapolated Lifetime (double sided immersion)***	***Stage A Extrapolated Lifetime (single sided immersion)***	***Stage B + C Lifetime (from Koerner)***	***Total Estimated Lifetime***
[redacted] 904	49 yrs	98	125 yrs	223 yrs
[redacted] 922	38 yrs	76	125 yrs	201 yrs
[redacted] 596	28 yrs	56	125 yrs	181 yrs

10. Conclusions

Three different High-Density Polyethylene (HDPE) liners were incubated in Mixed Smelter Waste leachate from the Capped Waste Stockpile (CWS) with a view to estimating their service lifetimes.

HDPE geomembranes contain proprietary blends of antioxidants and stabilizers to retard and inhibit oxidative degradation of the polymer. The service life of HDPE geomembranes is therefore controlled by the slow loss of these antioxidants and stabilizers.

The loss of antioxidants and stabilizers from the HDPE membranes with progressive incubation in Mixed Smelter Waste leachate from the Capped Waste Stockpile at three different temperatures (55, 75 and 95 deg.C) was determined by S-OIT and HP-OIT measurements respectively.

Large decreases were observed in S-OIT values at 95 deg.C over the 6 months incubation (up to almost 80% loss) for all three geomembranes reflecting loss of the phenolic antioxidants (i.e. short-term thermal protection). This is consistent with the fact that these molecularly smaller antioxidant molecules are most easily extracted from the HDPE matrix combined with the fact that they are mostly ester-based and hence susceptible to alkali-catalyzed hydrolysis (i.e. destruction at high pH).

In contrast, there has been no statistically significant reduction in the HP-OIT results over the 6 month incubation program. This is testimony to the outstanding long-term thermal stability of these fortified high-performance HDPE liners. The hindered amine stabilizers which are reflected in the HP-OIT response are known to be bulky molecules with steric hindrance that are difficult to extract from the polymer into solution and they are also basic in nature hence can tolerate high pH environments such as the Mixed Smelter Waste leachate.

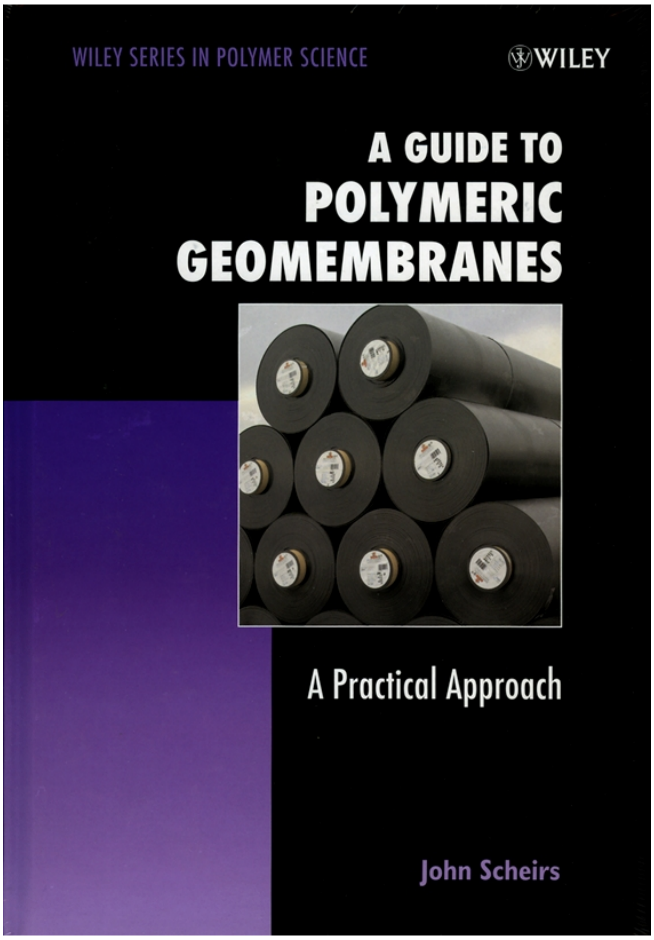
The total lifetime estimates based on the HP-OIT data for all three liners were in the range **181-223 years** thus indicating they will all comfortably meet the expected 100 yr design life.

It should be noted that it is difficult to generate lifetime data based on these HP-OIT results as the Arrhenius lifetime extrapolation technique requires clear/measurable decreases in HP-OIT values with increasing test temperature and with increasing test time. As can be seen from the HP-OIT retention curves there has been no clear or constant decrease over the 6 months of testing. Nevertheless based on the HP-OIT results to date it is apparent that these HDPE liners will all achieve in excess of a 100 year design life.

Further extended immersion testing would be required for what we estimate is at least 1 year to more accurately determine life expectancies using the HP-OIT retention values.

11. References

'A Guide to Polymeric Geomembranes: A Practical Approach', by John Scheirs. ISBN: 978-0-470-51920-2. 596 pages. October 2009.



GRI White Paper #6 - on - Geomembrane Lifetime Prediction: Unexposed and Exposed Conditions by Robert M. Koerner, Y. Grace Hsuan and George R. Koerner, Geosynthetic Institute, 475 Kedron Avenue, Folsom, PA 19033 USA (see **Annexure A2**).

Signature

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Appendix F Design Basis Report

Hydro Aluminium Kurri Kurri Pty Ltd

Containment Cell Design

Design Basis for Containment Cell

September 2016

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Figure index

Appendices

1. Introduction

This document is to be considered a living document and may be updated as additional information is acquired. This document is to form the basis of the final design report at the completion of the detailed design.

1.1 General

GHD Pty Ltd (GHD) has been engaged by Hydro Aluminium Kurri Kurri Pty Ltd (herein referred to as 'Hydro') to prepare a detailed engineering design report and supporting documentation for a proposed Containment Cell for the HAKK Demolition and Remediation Project (the Project). GHD's Scope of Services covers the detailed design, constructability review, quality specifications, project cost estimate, schedule and other related requirements. The future Containment Cell will be an engineered facility for the purpose of immobilising and managing various waste streams generated by the Capped Waste Stockpile and the demolition and remediation of the Smelter.

This memorandum presents the basis for which the proposed Containment Cell will be designed. As provided in GHD's 18 May 2015 *Proposal for HAKK Demolition and Remediation project*, an agreement on the conditions defined in this design basis memo is required, to proceed with the preparation of the design report. The purpose of this memo is to seek agreement from stakeholders on the applicable details on which the design for the proposed Containment Cell shall be undertaken, specifically in regards to regulatory requirements, project risks (and proposed mitigating actions), and design assumptions.

1.2 Purpose of this report

The purpose of this report is to further clarify the scope of work and provide clarity and definition to the standards, functional requirements and performance criterion required to meet the project requirements including assumptions to be used in the development of the proposed Containment Cell design and associated leachate management system.

1.3 Reliance

The following data has been relied upon in the preparation of this memorandum:

- D&M (1992 Part 2 of 3), Waste Storage Environmental Impact Statement
- Douglas & Partners (1990), Investigation Report – Toxicity Testing
- GHD Pty Ltd (2016), Supplementary Geotechnical Investigation Factual Report
- Hydro Aluminium Kurri Kurri Pty Ltd, CWS - Leachate and gas monitoring.xlsx
- Hydro Aluminium Kurri Kurri Pty Ltd, Leachate Analysis_KMcN.xlsx
- Hydro Aluminium Kurri Kurri Pty Ltd, Volume estimaes_D1-1_160502.xlsx
- Hunter Water Corporation (1999), Major Trade Waste Permit
- Hunter Water Corporation (2013), Trade Wastewater Agreement
- NSW Environment Protection Authority (2016), Environmental Guidelines: Solid Waste Landfills
- NSW Environment Protection Authority, Environmental Protection Licence - NSW Licence number 1548

- Ramboll Environ (2015), Characteristics of the Capped Waste Stockpile
- Ramboll Environ (2016), Draft Capped Waste Stockpile Assessment
- Ramboll Environ (2015), Environmental Impact Statement – Former Hydro Aluminium Kurri Kurri Smelter Demolition and Remediation
- Ramboll Environ (2014), Former Hydro Aluminium Kurri Kurri Smelter – Preliminary Environmental Assessment
- Ramboll Environ (2015), Preliminary Geotechnical Investigation – Proposed Containment Cell Site – Clay Borrow Pit.

1.4 Limitations

This report: has been prepared by GHD for Hydro Aluminium Kurri Kurri Pty Ltd and may only be used and relied on by Hydro Aluminium Kurri Kurri Pty Ltd for the purpose agreed between GHD and the Hydro Aluminium Kurri Kurri Pty Ltd as set out in this report.

GHD otherwise disclaims responsibility to any person other than Hydro Aluminium Kurri Kurri Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this report on the basis of information provided by Hydro Aluminium Kurri Kurri Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Site characteristics

The design has been prepared considering the following site characteristics. Additional site characterisation may be undertaken as the detailed design develops and will incorporated into the final design report as appropriate.

2.1 Site location

Hydro Aluminium Kurri Kurri Pty Ltd (herein referred to as “Hydro”) operates the former Hydro Aluminium Kurri Kurri Aluminium Smelter (herein referred to as the “site”) which is located on Hart Road, Loxford, N.S.W. The site covers approximately 80 ha, surrounded by approximately 1,940 ha of Hydro owned buffer zone land (herein referred to as “Hydro land”).

The large areas in Hydro land that are not used by the site consist of flora in the northwest and south, rural in the northeast, and leased rural residential in the southeast. Hydro land also consists of The Kurri Kurri Speedway and the Kurri Kurri Junior Motorcycle Club, which are located 200 m from site.

Hydro land is located within the Cessnock City Council and Maitland City Council local government areas, and is approximately situated three kilometres north of the Kurri Kurri central business district (CBD), 10 km south of the Maitland CBD and 33 km to the northwest of the Newcastle CBD.

The land uses surrounding the site include industrial, residential, rural and rural residential areas. The industrial areas consist of small to medium businesses in the north of Kurri Kurri to the south of the site. The residential areas are located in south Kurri Kurri, Weston and Heddon Greta south of site and in Gillieston heights and Cliftleigh to the northeast and east of site. Rural and rural residential areas reside to the north, east and west of site. Two educational institutions, the Kurri Kurri TAFE and the Kurri Kurri High School are located approximately 1.5 km and 1.9 km to the southeast of the site respectively.

A private rail line known as the South Maitland Railway travels through the eastern portion of Hydro Land.

2.2 Site access

The site is accessed via Hard Road in Loxford, which is reached via the Hunter Expressway in the south-western edge of Hydro Land. The Hunter Expressway is a large freeway within the Lower Hunter Region that connects to the Pacific Motorway and Newcastle Link Road in the south and New England Highway in the north.

Another main road of access is John Renshaw Drive, which joins the Hunter Expressway towards the south of site. John Renshaw Drive leads towards the Port of Newcastle and nearby industrial areas.

2.3 History and future use

The site operated as an aluminium smelter from 1969 until September 2012, and shut down formally in May 2014. Hydro has since been assessing the future use of the site, particularly ensuring that a combination of employment, residential and rural conservation areas are included within Hydro land. Hydro aims to remain aligned with the NSW Government *NSW State Plan 2021*, which encourages positive economic, employment and environmental activity.

2.4 Climate

A meteorological tower has been operating at the site from 1996 in order to provide information concerning the climate of the area. Information was collected from 10 m and 30 m above ground level (AGL) These measurements were analysed from January 2010 recordings to December 2014.

2.4.1 Temperature

Temperature records from 1968 to date were acquired from the Bureau of Meteorology (BoM) Automatic Weather Station (AWS) 061242 located at Cessnock Airport approximately 12 km west of site. The data showed that the average monthly temperatures for the area are from 4°C to 17°C and the average maximum monthly temperature ranges from 17°C to 30°C. The highest temperatures occur during the months of November and February, while the lowest temperatures occur during June and August.

2.4.2 Rainfall

Rainfall data was acquired from both BoM at AWS 061242 and the meteorological tower at the site. The data was analogous and showed that the area receives average yearly precipitation of 730 mm, with an average range of 460 mm to 1040 mm. The majority of the rainfall occurred between November and March and the area received a yearly average of 112 days of rain.

2.4.3 Evaporation

Information from the BoM AWS 061242 informed that the site experienced an annual evaporation mean of 1350 mm. The majority of this occurred during the summer months.

2.4.4 Wind

Wind records from the meteorological tower on site were taken at 10 m AGL and at 30 m AGL. The records informed that wind speeds were higher at 30 metres AGL and calm winds of 0.5 m/s occurred more frequently at 10 m AGL. Largest wind speeds travelled from west to north at both levels.

The 10 m AGL readings informed that the main yearly wind flow was south-easterly with some southwest and northwest components. The yearly mean speed is 1.5 m/s.

The 30 m AGL readings informed that the main yearly wind was a more balanced circulation from east to southwest. The yearly mean speed is 2.7 m/s.

2.5 Topography and hydrology

2.5.1 Topography

The terrain in this area is predominantly flat sloping mildly from south to north and west to east.

The future Containment Cell is proposed for location in the western portion of the site, in the vicinity of the Clay Borrow Pit at an elevation of 25 m AHD, which increases in elevation towards the west.

The site is surrounded by low hills, consisting of residential housing, in the west and low lying swampy land in the north and east. Fill was added to raise the low lying areas to approximately 16 m AHD to create a balanced foundation for the creation of the Smelter.

2.5.2 Hydrology

The site is located within the Hunter catchment. The Hunter catchment flows to the north of the site in a south-easterly direction and ultimately enters the Pacific Ocean in Newcastle south east of the site.

The site is further surrounded by Swamp Creek to the south and east and Black Waterholes Creek to the north west of site. Both creeks belong to the Wentworth Swamps. Swamp Creek is located approximately 180 m to the east of the southeast corner of site. Swamp Creek and Black Waterholes Creek flow in a northerly direction, ultimately connecting to Hunter River.

An unnamed tributary to Black Waterholes Creek is found 45 m west of site, and approximately 170 m east of the proposed Containment Cell location.

2.5.3 Flooding

The site is located above the 1% Annual Exceedance Probability (AEP) flood level.

2.6 Geology and soils

2.6.1 Regional geology

The site is located within the Sydney Basin. The Sydney Basin begins at Newcastle in the north and ends in Batemans Bay in the south. The length of the basin extends to Lithgow in the west.

The basin consists primarily of sedimentary rock known as Permian and Triassic rocks. These involve closely horizontal layers of sandstones and shales with a number of igneous dykes. Minor folding and faulting of the rocks allowed the Great Dividing Range to develop in the west. Beneath the sedimentary rocks lies the Lachlan Fold belt consisting of older basement rock. Below the Lachlan Ford Belt lie the Greta Coal Measures and Newcastle Coal Measures, and then the Dalwood Group situated in a marine environment.

2.6.2 Local geology

The Sydney Basin Geological Sheet informs that the site is located within an area of siltstone, marl and minor sandstone from the Permian aged Rutherford Formation (Dalwood Group) in the Sydney Basin.

2.6.3 Soils

The soils surrounding the site consist of quaternary sediment, to the east, and complex interbedded fluvial and marine sands and estuarine muds to the west. The former sediment comes from Swamp Creek and the latter from Wentworth Swamps and the Hunter River, having been deposited during period of sea level rise and fall. There are no known occurrences of acid sulfate soils at the site.

A geotechnical investigation by GHD at the site showed the general subsurface profile of an upper layer of residual clay soil, overlying weathered siltstone bedrock. At some locations the residual clay was overlain by fill or topsoil material.

The following extract is taken from Supplementary Geotechnical Investigation Factual Report (GHD Pty Ltd 2016):

The more pertinent aspects of general occurrences of these strata are summarised as follows

***Topsoil -** comprising sandy clay with some roots, encountered in boreholes BH01 and BH03 only and extending to depths of 0.15 m and 0.3 m respectively.*

***Fill -** identified in BH02 only to a depth of 0.4 m, comprising clayey sand.*

Residual Clay - *comprising an upper layer of red-brown and orange brown medium to high plasticity clay, encountered from the surface or underlying the fill or topsoil strata to depths ranging from 0.4 m to 2.4 m; underlain by pale grey medium to high plasticity clay layer.*

Bedrock - *encountered underlying the predominantly medium plasticity residual clay layer, at depths ranging from 3.7 m to 7 m and comprising extremely to highly weathered, very low to low strength siltstone. A 1.5 m thick bed of extremely to completely weathered, very low to low strength sandstone layer was encountered above the siltstone bedrock in BH01.*

The following extract is taken from Preliminary Geotechnical Investigation – Proposed Containment Cell Site – Clay Borrow Pit (Ramboll Environ, 2015):

The following generalised soil profile was encountered across the clay borrow pit (CPB) site (as observed within the bore holes and test pits):

A veneer of topsoil and/or slopewash/colluvial soils comprising silty sands/sandy silts with some gravel (and in one case, clayey sand fill), was encountered, overlying a profile of weathered in-place siltstone/shale/sandstone as residual, sandy silty clays, and gravelly clays becoming extremely weathered rock. The clays had low to medium plasticity, with occasional higher plasticity and were generally very stiff to hard.

In general, the rock comprised massively-bedded sandstones, or more thinly bedded siltstones, down to laminated shales. The rock profiles exposed in the cored sections were generally tight, with few defects visible.

2.7 Hydrogeology

Groundwater ranges between 1 m and 5 m below ground surface (bgs) in the estuarine sands in the eastern portion of the site. At the Clay Borrow Pit, the groundwater occurs within the residual clay at 8 m to 9 m bgs. The shallow groundwater travels north and northeast towards the Wentworth Swamps.

Testing showed fluoride leachate, from the smelting works, within the groundwater. Fluoride was found at concentrations ranging from 0.22 mg/L to 43 mg/L.

Leachate from the Capped Waste Stockpile has also affected the shallow groundwater (0.3 m to 2.5 m bgs). The leachate plume is 350 m in lengths and travels approximately 350 m northeast of the eastern corner of the Capped Waste Stockpile. The depth of the leachate is limited by the low permeability of the high plasticity clays situated beneath the coarse-grained sands. Increased concentrations of fluoride, cyanide and sodium exist within the leachate plume at pH>9. The water affected is identified as an unsuitable water source due to its impermanent nature, having insufficient yield, and being within unconsolidated estuarine deposits.

Actions to decrease the effect of the waste stockpile on groundwater included the capping of the stockpile in 1995 and the introduction of two interception trenches to capture and direct leachate to ultimately discharge to the North Dam. Ongoing monitoring showed that the capping and the trenches improved groundwater quality significantly.

Fate and transport modelling was conducted on the leachate plume to predict its effect on the nearby Swamp Creek. The modelling was a conservative representation of worst-case scenario and concluded that fluoride would reach the creek at concentration of 5 mg/L. The modelling however considered the plume as an infinite source, which is not a representation of the leachate mitigation once the stockpile is moved and leachate is treated.

2.8 Air emissions

Potential air emission sources in the area include vehicle emissions from the nearby rail lines and Hunter Expressway, and coal mining emissions from the Bloomfield Open Cut, Donaldson

Open Cut, Abel Underground and Tasman Underground mines. The mines are situated approximately 7 to 12 kilometres east to southeast of site.

2.9 Flora and fauna

Ten threatened fauna species, six listed migratory fauna species and two threatened flora species have been identified within Hydro land. None have been identified within the proposed location of the Containment Cell.

2.10 Existing services and infrastructure

2.10.1 Electricity

The electricity infrastructure on site includes overhead power lines situated in the north, west, southwest and northwest portions of the site.

2.10.2 Water supply

The water supply for the site is sourced from the Hunter Water Corporation. The works within the site will rely on this source as long as is feasible. Additional sourced are planned to support the works, including water from the North Dam, which is presently used for irrigation purposes.

2.10.3 Infrastructure

The site consists of electricity, telecommunications, water, sewer and gas services infrastructure, most of which is terminated. Hydro has created a program that focuses on the disconnection of these services, ensuring the security of works, decreasing negative environmental impacts, and enhancing efficiency.

2.11 Indigenous heritage

An Aboriginal Cultural Heritage Assessment conducted with the support of Aboriginal stakeholders revealed an Aboriginal stone artefact and potential archaeological deposit in the northern section of the site. If required, Hydro proposes to relocate the artefact in consultation with Aboriginal stakeholders. The area of Aboriginal importance is to be avoided during ongoing works, and any stockpiles within the area will need to be placed on a geo-matting surface. No areas of indigenous importance were identified within the proposed location of the Containment Cell.

3. Design Basis

3.1 General

The following sections address the regulatory requirements that relate to the project.

3.2 Environmental Planning Instruments

The Project has been identified as a State Significant Development. Schedule 1 of the S&RD SEPP, accompanying the ‘waste and resource management facility’, further identifies the development as:

- *“(5) Development for the purpose of hazardous waste facilities that transfer, store or dispose of solid or liquid waste classified in the Australian Dangerous Goods Code or medical, cytotoxic or quarantine waste that handles more than 1,000 tonnes per year of waste.”*

The Australian Dangerous Goods Code (‘Australian Code for the Transport of Dangerous Goods by Road & Rail’, Seventh Edition prepared by the National Transport Commission, 2011) recognises ‘Aluminium smelting by product’ to be currently located within the Capped Waste Stockpile, which will be relocated to the proposed Containment Cell. ‘Aluminium smelting by product’ is identified to include *‘aluminium dross, aluminium skimmings, spent cathodes, spent pot lining, and aluminium salt slags.’*

The demolition and remediation of the current site infrastructure is also contained within the requirements of a State Significant Development (Clause 8(2)), due to consisting of material which will be disposed of within the proposed Containment Cell.

3.2.1 Cessnock Local Environmental Plan 2011

During the operation of the Smelter, the site was categorised as ‘RU2 Rural Landscape’ under Cessnock Local Environmental Plan 2011(the LEP). The primary objective of RU2 Rural Landscape is for the protection of rural land and activities, and is not aligned with the previous manufacturing processes of the Smelter. The operation of the site was permitted under existing use rights under the EP&A Act.

Development of a waste disposal facility can be approved with consent within the RU2 Rural Landscape zone. The operations of the proposed Containment Cell do not align with the objectives of the RU2 Rural Landscape zone, however they are consistent with the previously approved industrial activities under existing use rights and developments consents granted under the EP&A Act.

Hydro has applied to change the current zone of Hydro land to IN1 General Industrial for the Smelter Site and IN3 Heavy Industrial for the proposed Containment Cell under the Cessnock City Council. A Gateway Determination by the NSW Department of Planning and Environment (DPE) has been received by Hydro. The primary objective of the IN1 General Industrial Zone is for the protection and encouragement of sustainable industrial development, and the primary objective of the IN3 Heavy Industrial zone is for the provision of appropriate area for industries that require separation from other land uses.

The proposed Containment Cell will be within the IN3 Heavy Industrial zone and the demolition and remediation of the site will be within the IN1 General Industrial zone and the IN3 Heavy Industrial zone.

3.3 Other Environmental Planning Instruments

Under the State Environmental Planning Policy No 33—Hazardous and Offensive Development (SEPP 33), a preliminary hazard analysis has been prepared for approval. A preliminary hazard analysis is required for developments with potential for hazardous work and materials.

3.3.1 Protection of the Environment Operations Act 1997

Under the Protection of the Environment Operations Act 1997 (POEO Act), Hydro is required to acquire an Environmental Protection Licence (EPL) to allow for works, which are labelled scheduled activities in Schedule 1 of the POEO Act to proceed.

The site is regulated by the EPL 1548, which allows Hydro to store hazardous, restricted solid, liquid, clinical and related waste materials, asbestos, and other wastes.

The application of the proposed Containment Cell may require scheduled activities which are not included in the EPL 1548. An update to Hydro's EPL is currently being negotiated with the EPA to update the scheduled activities. These scheduled activities may include the removal of the Capped Waste Stockpile, the remediation of affected soils, and the storage of chemicals within the proposed Containment Cell.

3.3.2 Protection of the Environment Operations (Waste) Regulation 2014

Under Clause 98 of the Protection of the Environment Operations (Waste) Regulation 2014 (POEO Regulation), an immobilised contaminants approval is required from the EPA for the reclassification of waste to allow its displacement in the proposed Containment Cell. This allows the EPA to place other restrictions on the waste according to its chemical properties.

Hydro is submitting an application for an immobilised contaminants approval.

3.3.3 Environmentally Hazardous Chemical Act 1985

The EPA issues a Chemical Control Order for hazardous chemical wastes, which have been identified as per the Environmentally Hazardous Chemical Act 1985 (EHC Act). A Chemical Control Order has been delivered for the management of aluminium smelter waste, which contains fluoride and/or cyanide.

The Chemical Control Order requires a number of actions to be undertaken by Hydro. These include:

- The control and security of wastes on site, including the prohibition of the spreading of leachate, the security of a holding facility, and the prohibition of unauthorised access
- Aluminium smelter waste that does not contain leachable fluoride or leachable cyanide and is in accordance with the POEO Act can be disposed
- Waste can be displaced for the reduction of leachable fluoride and leachable cyanide levels if EPA approval is given
- Waste can be sent for processing for the purpose of researching environmental acceptable methods of fluoride and/or cyanide leachate reduction and for the reduction of fluoride and/or cyanide leaching.

License Number 05, under the EHC Act, is currently applied to the aluminium smelter waste at the site. This includes relocation to an approved receiving facility. The spent pot lining and all other waste materials located within the Capped Waste Stockpile is to be contained within the proposed Containment Cell, categorised as approved aluminium smelter waste. The proposed Containment Cell will address the immobilisation of the leachable fluoride and cyanide.

3.4 Site constraints

It is proposed to locate the future Containment Cell in an area that minimises vegetation clearance, at a suitable height above the highest recovered groundwater level, and above acceptable strata where alluvial soils are avoided.

The following extract is taken from Environmental Impact Statement – Former Hydro Aluminium Kurri Kurri Smelter Demolition and Remediation (Ramboll Environ, 2015):

In a location:

Above the 1% Annual Exceedence Probability (AEP) flood level.

- *More than 100 metres from a watercourse*
- *More than 500 metres from the nearest residence, within 500 metres of the Smelter and on the northern side of the Hunter Expressway*
- *A minimum of 20 metres from power line easements.*

3.5 Site opportunities

- An area exists adjacent to the creek to allow for a laydown area and stockpiling
- The slope of the site allows for natural grades to ponds
- Material (both excavated and recovered) may be used in the design.

3.6 Site access and internal traffic requirements

The following extract is taken from, Former Hydro Aluminium Kurri Kurri Smelter – Preliminary Environmental Assessment (Ramboll Environ, 2014):

The Project site would continue to be accessed via Hart Road. Vehicles would use the following routes:

- *Vehicles travelling to the south would travel on the Hunter Expressway via the Hart Road exit*
- *Vehicles travelling to Maitland and surrounds would travel on the Hunter Expressway via the Hart Road interchange before exiting at the Main Road interchange and continuing on Main Road/Cessnock Road*
- *Vehicles travelling to the northwest would use the same route to the Main Road interchange, before using it as a roundabout and continuing northwest on the Hunter Expressway*
- *Vehicles transporting municipal waste to the Cessnock Waste and Reuse Centre would travel along Sawyers Gully Road and then Old Maitland Road.*

As such Project vehicles would avoid residential areas. Project vehicles would include personal vehicles of Works personnel, trucks for the delivery and removal of construction machinery and works compound components, removal of recyclable and reusable materials, transport of municipal wastes and delivery of materials.

Access and haul roads would be built within the Project site to connect the Smelter with the Containment Cell and ancillary facilities. These roads would be constructed of suitable materials sourced from within the Hydro land, generated during demolition activities or potentially transported from licensed facilities.

At the completion of the Works, the access road to the Containment Cell would be graded to be used for the operational phase. An access track would be maintained around the perimeter of the Containment Cell.

3.7 Amenities requirements

The proposed Containment Cell has a proposed height, which will enable its visibility. Hence, the flora, which will be used on the cap of the proposed Containment Cell should complement the existing nearby native vegetation. A vegetation cover will also aid in offsetting the carbon footprint and reducing long-term maintenance.

4. Preliminary design

4.1 General

This section details the preliminary cell design which will form the basis for the detailed design.

4.2 Design approach

The overarching design approach is to provide for meeting the minimum standards for design, construction, operation, monitoring and rehabilitation requirements for conventional landfill facilities that accept general waste and/or some regulated waste for co-disposal, and addressed risk areas associated with the disposal of waste, utilising industrial waste guidelines available for facilities in Victoria and New South Wales.

4.3 Waste volumes

An analysis of the waste data provided by Hydro:

- Hydro Aluminium Kurri Kurri Pty Ltd, Volume estimates_D1-1_160502.xls
- Ramboll Environ (2016), Draft Capped Waste Stockpile Assessment.

The review included:

- Reviewing an updating the assumed waste densities where relevant
- Addition of an additional contingency volume of 10%
- Review and updating the CWS volume based on survey information
- 2 m depth of contaminated soil beneath the CWS based on the bore logs included Ramboll Environ assessment.

Based on the review, GHD will allow for a required landfill airspace of 345,000 m^3 (rounding up to the nearest 1,000 m^3) and an in place density in the cell of 1.6 t/m^3 (refer Table 1).

Table 1 Waste Volumes

Waste type	m^3	tonnes
Capped Waste Stockpile	183,491	326,816
Process Wastes	26,330	27,050
Smelter Contaminated Soils	34,328	58,492
Hydro Land Contaminated Soils:		
Dickson Road Landfill	14,150	21,225
Former Municipal Landfill	8,400	16,800
Asbestos Contaminated Soils	6,700	13,400
Stockpiled Hydro Land Soils	6,622	12,611
Kline Street Wastes and Soils	3,074	6,149
Non-Recyclable Demolition and Smelter Wastes		

Waste type	m^3	tonnes
Non-Leachable/Non-Hazardous	21,000	14,000
Leachable/Hazardous	9,000	6,000
TOTAL	**313,096**	**502,543**
Contingency	**10%**	**50,254**
TOTAL (incl. contingency)	**345,000**	**553,000**

4.4 Excavation

The base of the cell would be graded towards a single low point with minimum grade of 1% and cross fall of 3% to allow adequate leachate drainage. Within the excavation surface, additional excavation for formation of groundwater, leak detection and leachate trenches and sumps would be included.

The preliminary design has allowed for 4 sumps. The detailed design will confirm the location and number of sumps required.

The sidewalls will be shaped to 1(V) in 4(H) to allow placement of the soil confining protection layer and minimise stress on the basal lining system.

4.5 Perimeter bunds

A bund will be included around the perimeter of the landfill. The bund will form part of the surface for the sidewall liner and will be formed from compacted on-site materials.

It will be shaped with a 3 m wide crest and to 1(V) in 4(H) within the landfill and 1(V) in 2(H) on the outside face. The height of the bund will be typically 1.5 m however may vary around the cell based on the existing site grade

The toe of the perimeter bund will be shaped to promote drainage of surface water around the landfill to the proposed surface water ponds.

4.6 Cell liner

Table 2 outlines the concept design for the cell liner system.

The following aspects will be considered as part of the detailed design:

- The basal liner and sidewall liner materials will be connected near the toe of the slope
- The geosynthetic materials of the sidewall liner at the top of the slope will be placed within a trench and the trench backfilled to provide anchorage to the materials. Calculations will be undertaken to ensure the trench is appropriately sized
- Calculations will be undertaken to review the stability of the sidewall soil confinement/protection layer
- The material to be used for the secondary lining system will be either compacted clay or bituminous geomembrane.

Table 2 Concept cell liner system (from top to bottom)

Layer description	Basal liner	Sidewall liner
Confinement/protection layer	No system proposed	Sacrificial geomembrane (typ. 1 mm PE geomembrane) Soil confinement/protection layer (typ. 300 mm soil layer)
	Due to the omission of a drainage aggregate layer on the sidewall, an additional confinement/protection layer has been included to confine the GCL layer and to protect the primary barrier system. Should a cost effective source of aggregate be found or sufficient suitable recycled aggregate be sourced from site the confining protection layer could be replaced with a drainage layer however a sacrificial GMB would still be required to protect the required separation geotextile from degradation and prevent surface water flow into the leachate collection system where possible.	
Leachate collection system	Non-woven separation geotextile 300 mm drainage aggregate	Geonet drainage geocomposite, consisting a geonet core for drainage and non-woven separation geotextile both sides to prevent clogging.
	For the basal liner profile, a separation geotextile has been included to minimise potential clogging of the drainage layer via the landfilled waste and associated leachate. This is in line with relevant regulatory guidance and standard practice. For, the sidewall liner profile, a geonet drainage geocomposite has been included.	
Primary barrier system	Non-woven protection geotextile (typ. 1000 g/m^2) 2 mm HDPE geomembrane Geosynthetic clay liner (GCL)	
	As this is the primary barrier system, a composite geomembrane/GCL layer is included to provide a more robust composite barrier system and achieve a lower infiltration rate. This is in line with relevant regulatory guidance and industry best practice. The 2 mm geomembrane thickness has been chosen based on a balance between durability and ease of welding. Leachate compatibility testing is currently underway to ensure the service life of the geomembrane is suitable.	
Leak location system	Geonet drainage geocomposite, consisting a geonet core for drainage and non-woven separation geotextile both sides.	
	Should a cost effective source of sand be found or sufficient suitable recycled aggregate be sourced from site the leak location layer drainage geocomposite could be replaced with a sand or aggregate drainage layer.	

Layer description	Basal liner	Sidewall liner
Secondary barrier system	Compacted clay or bituminous geomembrane -	
	Compacted clay is in line with relevant regulatory guidance however a bituminous geomembrane is as resistant to installation damage, allows for traffic above to install the primary liner system and consumes less airspace.	
Groundwater collection system	Geonet drainage geocomposite consisting a geonet core for drainage and non-woven separation geotextile both sides or aggregate filled trenches.	

4.7 Final landform

The final cap will be placed over the waste surface which will be shaped to provide a minimum fall of 5% towards the perimeter.

The batters will generally be graded at 1(V) in 5(H), with the edge of the cap shaped at 1(V) in 4(H) to interface into the surrounding ground surface.

4.8 Final cap

Table 3 outlines the concept design for the final cap system.

The following aspects will be considered as part of the detailed design:

- The cap materials will be connected to the sidewall liner at the toe
- Calculations will be undertaken to review the stability of the cap materials.

Table 3 Concept final cap system (from top to bottom)

Layer description	Proposed cap	
Topsoil/revegetation layer	• Revegetation (grass) • Topsoil (0.15 m) • Subsoil (1.85 m)	The thickness of the topsoil layer will be adjusted to suit the revegetation species chosen and the availability of material.
Subsurface/infiltration drainage layer	• Drainage aggregate/Bio protection layer (0.3 m)	Where possible this material will be sourced from recycled material onsite and augmented with polypipe as required.
Sealing layer	• Protection geotextile • 1.5 mm LLDPE Geomembrane • 0.6 m clay liner of 1×10^{-9} m/s permeability	A GCL may be included in lieu of the clay liner material pending the material balance of the available clay material in the excavation
Gas drainage layer	Configuration to be confirmed based on outcomes of gas design basis.	
Seal bearing layer	• Seal bearing layer • Separation geotextile, if required	Separation geotextile may be required depending on seal bearing material and final layer of waste.

4.9 Landfill layout

The current concept consists of a roughly square-shaped landfill cell with the east and west cell boundaries parallel to the power easement.

The cell cuts into the tree line in all four corners. The existing surface contours have been estimated in these areas.

Table 4 Concept design – key aspects

Feature	Quantity	Notes
Bulk excavation to form subgrade	110,000 m^3	Does not include general stripping and any over-excavation required to form suitable surface.
Bulk filling to form subgrade	19,000 m^3	Includes formation of perimeter bunds
Subgrade footprint area	210 m x 200 m	Approximately, including perimeter bunds
Sidewall lining area	22,000 m^2	Batters only. Does not include overlaps or anchorage
Basal lining area	20,000 m^2	
Total waste void achieved	355,000 m^3	Top of liner to bottom of cap. The height would be lowered/adjusted to for allow for the finalised waste volume but the design allows for either a growth or reduction in waste volumes. It is noted that some volume would be lost to access roads, internal bunds and adjustments for offsets.
Final cap level	13 m	Above existing ground level
Final cap footprint area	220 m x 235 m	The concept design final cap does not go outside of the provided red boundary line. At the south east corner, it is quite close (3 m) and >10 m in other three corners. This can be adjusted to allow room for roads and drainage but we need additional info of the ground levels in these areas.
Total cap volume	100,000 m^3	Assumes 2 m thick cap system

4.10 Staging

Staging will be developed during detailed design. The number and sizing of stages will be developed to allow safe filling and minimise leachate generation.

4.11 Stormwater

Surface water collection and diversion drains will be sized/designed to operate both during and post construction.

A sediment basin will be located to the east of the landfill cell. Pending detailed design interim ponds may be required.

4.12 Leachate generation and disposal

To inform the leachate collection, storage and disposal measures for the proposed Containment Cell, GHD developed a preliminary leachate generation model to estimate the leachate generated across the life of the cell. The model considered leachate generation via infiltration of rainfall into the landfilled waste. Infiltration rates were developed with consideration to conservative infiltration rates identified in the NSW EPA's *Environmental Guidelines: Solid Waste Landfills* (2016), including 100% infiltration for active areas with daily covering, and 50% infiltration for intermediate covering and 10% infiltration for the interim capping. As the proposed final capping for the Containment Cell consists of a composite sealing layer, a more appropriate infiltration rate of 1% was adopted for the final capping.

Leachate generation was considered for both the mean (50% AEP) rainfall year and wet (10% AEP) rainfall year, with consideration to the proposed staging for the Containment Cell. The staging and associated results are described in Table 5, and assumes:

- Interim capping occurs progressively
- All final capping is done simultaneously at the completion of filling.

Table 5 Preliminary staging and results

Stage	Description	Leachate generation – 50% AEP rainfall year (kL/year)	Leachate generation – 10% AEP rainfall year (kL/year)
1	Filling occurring in sub-cell 1 below ground, all other sub-cells separated from sub-cell 1	10,000	13,000
2	Filling occurring in sub-cell 2 below ground, sub-cell 1 intermediate covered, sub-cell 3 separated from sub-cells 1 and 2	12,000	16,000
3	Filling occurring in sub-cell 3 below ground, sub-cell 2 intermediate covered, sub-cell 1 interim capped	13,000	17,000
4	All cells interim capped	4,000	5,000
5	All cells final capped	400	500

Pipework would extend from the leachate riser a leachate pond to allow disposal. The leachate pond would require a lining system.

4.13 Gas generation and disposal

The basis for design for the gas management system including gas production and disposal will be developed in a separate report.

4.14 Access infrastructure

Access roads would be included around the perimeter of the landfill and into the cell via a ramp(s) for access of plant and trucks into the active waste cell. The location of the ramp(s) would be such that it can provide access for the longest possible period.

The gradient of the ramp would be suitable for truck access, under consideration of vehicle traction under full load. Under consideration of the direction of approaching or departing trucks, a sufficiently large truck turning would be allowed for.

4.15 Key Risks

Key preliminary project risk events pertinent to design/construction/operation of the cells relate to:

- Liner leakage
- Liner damage
- Liner deterioration
- Groundwater pollution
- Surface water pollution
- Rainfall (flooding within cells).

The above risks will be mitigated during the detailed design of the liner type profile and the application of the operational and maintenance procedures being developed.

5. Leachate Management Design Basis

5.1 Scope of leachate management

The Environmental Impact Statement - Former Hydro Aluminium Kurri Kurri Smelter Demolition and Remediation (Ramboll Environ, 2015) describes a requirement for a significant quantity of contaminated groundwater to be treated.

At the leachate design basis workshop (23/5/16) Fiona Robinson (Ramboll Environ) advised that it has been demonstrated and presented to the regulator that the leachate affected groundwater plume extending out from the Capped Waste Stockpile (CWS) is not currently causing environmental harm.

The removal of waste and remediation of the CWS will subsequently result in an improvement in groundwater quality over time. Therefore, it is no longer considered necessary to extract and treat the contaminated groundwater plume extending out from the CWS.

During excavation of waste from the CWS, a layer of contaminated natural ground under the waste material will also be removed. During this activity it is expected that there will be some contaminated groundwater ingress into the excavation.

The leachate system is therefore required to manage the following water sources:

- Leachate from the CWS:
  - stormwater that falls on the CWS and becomes contaminated during excavation
  - residual leachate in the waste material and contaminated groundwater that enters the CWS excavation during the extraction of waste material and the underlying contaminated natural ground
- Leachate from the containment cell:
  - stormwater that falls within waste containing sub-cells in the containment cell and becomes contaminated during the placement of waste
  - residual leachate generated from the containment cell following capping of the sub-cells

The leachate management system to which this design basis applies does not allow for:

- treatment of the existing contaminated groundwater plume extending out from the CWS, site stormwater other than that falling in the CWS or containment cell generating leachate, or existing water stored in on-site dams
- treatment of any leachate associated with off-site stockpiles e.g. the three smaller landfill sites contributing waste material to the containment cell.

5.2 Reliance

The following documents provided to GHD by Hydro have been relied upon in developing the leachate management design basis:

- Ramboll Environ (2015), Environmental Impact Statement – Former Hydro Aluminium Kurri Kurri Smelter Demolition and Remediation
- D&M (1992 Part 2 of 3), Waste Storage Environmental Impact Statement
- Douglas & Partners (1990), Investigation Report – Toxicity Testing
- Hydro Aluminium Kurri Kurri Pty Ltd, CWS - Leachate and gas monitoring.xlsx
- Hydro Aluminium Kurri Kurri Pty Ltd, Leachate Analysis_KMcN.xlsx

- Ramboll Environ (2015), Characteristics of the Capped Waste Stockpile
- NSW Environment Protection Authority, Environmental Protection Licence - NSW Licence number 1548
- Hunter Water Corporation (1999), Major Trade Waste Permit
- Hunter Water Corporation (2013), Trade Wastewater Agreement
- Ramboll Environ (2016), Draft Capped Waste Stockpile Assessment
- Pulver Cooper & Blackley (2016), Stormwater Management Report - Flood Modelling Review.

5.3 Design approach

Rather than progressing straight to design of a treatment system for the leachate, an options study is being conducted to identify and assess a range of options for management of the leachate. Given the relatively variable quantities of leachate to be managed over the project life, more practical and cost effective management option(s) other than on-site permanent treatment may be available such as:

- Outsource the leachate treatment to a third party
- Haulage offsite to an existing municipal wastewater treatment plant (WWTP)
- Pre-treatment and discharge to sewer under a trade waste agreement
- Pre-treatment to produce a water quality suitable for current irrigation practices
- Pre-treatment and use for dust suppression
- Reduce leachate volume
  - Evaporation ponds
  - Enhanced evaporation techniques

Once the preferred option(s) are agreed, the implementation strategy will be determined and the required design and/or specification will be completed.

5.4 Leachate Quality

The collected groundwater quality data in the vicinity of the CWS is significantly more extensive than leachate quality data.

An active interception trench was constructed downstream of the CWS in 2014 to intercept and pump out affected groundwater. Groundwater wells in the vicinity of the CWS interception trench, provide an indication of relative levels of contamination from the leachate, although the contaminant concentrations may be more dilute than those in the CWS.

Additional sampling was conducted from new wells in the CWS in November and December 2015 to provide more representative leachate water quality data.

5.4.1 Capped waste stockpile material composition

The Characteristics of the Capped Waste Stockpile (2015) report noted the following regarding the composition of the CWS.

> *The following materials are understood to be contained within the Capped Waste Stockpile:*
>
> - *Spent pot lining*

- *Carbon Plant shot blast refuse, including grit and dust*
- *Carbon Plant dust collector product*
- *Collar mix (coke, pitch) spillage*
- *Carbon Plant floor sweepings*
- *Packing coke oversize*
- *Contaminated bath*
- *Rotary breaker oversize*
- *Pot lining mix (hot ramming paste)*
- *Rodding mix (coke, graphite, pitch and anthracene oil)*
- *Stud joining mix*
- *Pitch spills/pencil pitch*
- *Aluminium swarf*
- *Scrap aluminium billets*
- *Anode cover material*
- *Butt from spent anodes*
- *Ahead of schedule anodes*
- *Dross*
- *Pot bottom aluminium*
- *Consumable gaskets, insulation material (synthetic mineral fibre, asbestos)*
- *General rubbish, including plastic, wood and steel.*

With the exception of spent pot lining, the majority of these materials are associated with the Carbon Plant, which produced carbon anodes from liquid pitch and petroleum coke. The main chemicals of concern for these materials are Polycyclic Aromatic Hydrocarbons (PAHs). PAHs associated with pitch, coke and anodes have a low solubility in water and are unlikely to generate leachable concentrations.

In addition to the material in the existing CWS, other materials e.g. contaminated soils, smelter wastes, asbestos and glass and demolition wastes, will be stored in the proposed Containment Cell which may impact on the quality of the leachate generated. However, leachate quality will be dominated by the CWS material.

5.4.2 Historical leachate pond water quality

Table 6 summarises a range of water quality data from the previous leachate pond (also refered to as cathode pile dam – see “Collected Leachate” in Figure 1 below, extracted from Figure 4.3 in Waste Storage EIS (D&M, 1992 Part 2 of 3)). Part of this summary table was sourced from the Waste Storage EIS (D&M, 1992 Part 2 of 3). This information was supplemented with additional analytes from the original sourced data used in the Waste Storage EIS and additional sample (Investigation Report - Toxicity Testing - Douglas & Partners 1990) not included in the EIS.

Table 6 Historical leachate pond water quality

	Coffey & Partners (1987)	Patterson & Britton (1990)	D J Douglas (1990)	Houseman (Nov 1990)	Douglas & Partners (1990)
pH (pH units)	10.6	10.5		10.9	10.8
Total Alkalinity as $CaCO_3$ (mg/L)	22,300			17,100	48,400
Electrical Conductivity (uS/cm)		51,600		40,600	
Sodium (mg/L)	4,800	16,400-17,100	15,300	15,800	11 [(1)]
Potassium (mg/L)	75	140-168	102	102	88
Calcium (mg/L)	30	<2	<0.8		3
Magnesium (mg/L)	2	0.2	2		2
Iron (mg/L)	20	73-79			36
Aluminium (mg/L)	<1				
Silicon (as Si) (mg/L)	25				
Chloride (mg/L)	700		810	460	
Fluoride (mg/L)	1,100	3,300	3,420	4,200	2,500
Sulphide (mg/L)		present			126
Sulphate (mg/L)	4,000		6,740	3,990	
Cyanide (mg/L)	70	130-200	133	148	158
Carbonate as CO3 (mg/L)				10,540	
Arsenic (mg/L)		0.7			1
Bismuth (mg/L)		0.15			<0.1
Cadmium (mg/L)		<0.01			<0.05
Cobalt (mg/L)		0.27			0.2
Chromium (mg/L)		<0.05			0.1
Copper (mg/L)		0.6			1.05
Manganese (mg/L)		<0.1			<0.05
Molybdenum (mg/L)		1.5			1.25
Nickel (mg/L)		2.1			1.35
Lead (mg/L)		<0.1			0.3
Antimony (mg/L)		<0.2			<0.1
Tin (mg/L)		<0.1			<0.1
Uranium (mg/L)		3			<0.1
Vanadium (mg/L)		7.4			4.8
Tungsten (mg/L)		0.4			<0.2
Zinc (mg/L)		<0.1			0.35

[1] This value is likely to be in g/L rather than in mg/L as reported in Investigation Report - Toxicity Testing - Douglas & Partners, 1990.

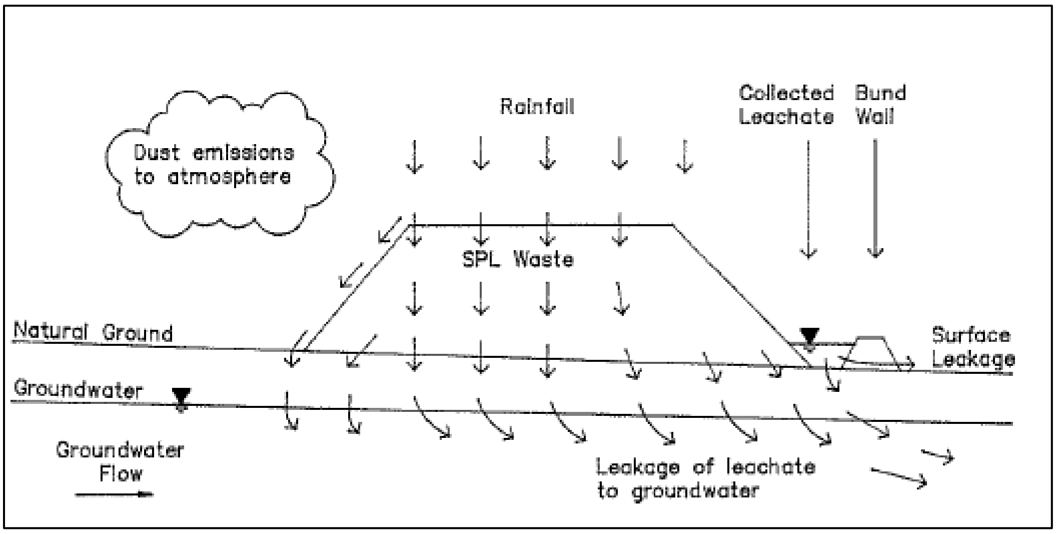

Figure 1 Leachate pond schematic (prior to capping)

5.4.3 Active interception trench

As the purpose of the active interception trench is to capture shallow groundwater which has been contaminated by the capped stockpile, samples from this trench will define the composition of the leachate impacted groundwater rather than the leachate itself. While these samples will show indicatively what contaminants are entering the groundwater and their relative concentrations, these samples may represent contaminant concentrations at lower levels than they will be present in leachate not diluted by groundwater.

Similarly, groundwater wells in the vicinity of the CWS provide an indication of relative levels of contamination from the leachate but the contaminant concentrations are likely to be more diluted than those in the undiluted leachate.

Table 7 summaries data from samples of leachate impacted groundwater taken from the active interception trench pump outlet from 7/05/2014 to 18/09/2015 (CWS - Leachate and gas monitoring.xlsx).

Table 7 Leachate active interception trench water quality (pump outlet)

Parameter	Soluble Fluoride mg/L	pH
Min	289	9.1
Max	794	9.9
Average	628	9.6
Median	641	9.6

Note: Statistics based on 182 samples

Table 8 summaries data from samples of leachate impacted groundwater taken near the vegetation impact areas from 27/02/2013 to 4/09/2015 (Leachate Analysis_KMcN.xlsx).

Table 8 Leachate interception trench water quality (bores)

Parameter	Leachate 1 - Start of vegetation impact area, immediately below interception trench		Leachate 2 - Intersection of road and bottom of vegetation impact area 1	
	pH	Soluble Fluoride mg/L	pH	Soluble Fluoride mg/L
Count	9	9	10	10
Min	8.3	15.4	7.8	15.1
Max	9.6	372.0	9.3	162.0
Average	9.1	255.2	8.5	74.4
Median	9.0	303.0	8.5	60.1

Table 9 presents a more comprehensive analyte suite for two samples from the active interception trench taken in June 2015 (Characteristics of the Capped Waste Stockpile – 2015).

Table 9 Interception trench water quality

Chemical	LT01 (3/6/2015) mg/L	LT02 (4/6/15) mg/L
pH (pH units)	9.7	9.7
Electrical Conductivity (uS/cm)	15,000	16,000
Aluminium	46	42
Iron	33	31
Fluoride	480	490
Total Cyanide	79	85
Mercury	<0.00005	<0.00005
Calcium	7	<5
Potassium	18	13
Sodium	5,600	5,600
Magnesium	3.6	2.4
Hydroxide Alkalinity as CaCO3	<5	<5
Bicarbonate Alkalinity as CaCO3	3,300	3,500
Carbonate Alkalinity as CaCO3	4,600	4,700
Total Alkalinity as CaCO3	7,900	8,200
Sulphate	1,900	2,000
Chloride	160	150
TRH C6-C10	<0.01	<0.01
TRH C10-40	<0.1	<0.1
BTEX	<0.002	<0.002
Benzo(a)pyrene	<0.001	<0.001
Total PAHs	<0.002	<0.002
PCBs	<0.002	<0.002

5.4.4 Additional leachate sampling

Prior to the recent core drilling and well installation, the only analyses of leachate available appears to be from the old leachate collection pond around 1990. The results from sampling in this pond may also have been influenced by varying volumes of stormwater runoff and evaporation in the pond.

To supplement historical water quality data from the leachate pond and leachate affected groundwater from the intercept trench, GHD recommended additional sampling be conducted from new wells in the Capped Waste Stockpile to provide more representative leachate water quality data.

Ramboll Environ arranged for wells to be drilled in a number of locations in the CWS to enable leachate sampling to be undertaken. Two rounds of sampling were conducted due to limited sample volume availability and on both occasions, samples were extracted by Ramboll Environ and GHD prepared the samples for laboratory analysis.

At the time of sampling, only two of the six new wells generated sufficient leachate to sample for full laboratory analysis:

- MW202 which was sampled from the level of the waste
- MW206 which was sampled from below the waste in the natural ground level.

Sufficient water was present in two other wells to provide limited water quality information:

- MW203 which was sampled from below the waste in the natural ground level
- MW204 which was sampled from below the waste in the natural ground level.

Although the recent samples from the CWS may have been influenced by groundwater intrusion (potentially diluted), the results are expected to be more representative of anticipated leachate quality than historical groundwater figures.

When the material in the existing capped stockpile is exposed to atmosphere during its transfer to the new Containment Cell, the change from anaerobic to aerobic conditions (redox potential) may result in changes to liquid and solids chemistry and may impact the leachate characteristics. No existing information on the change in solids/leachate chemistry due to oxygen exposure has been identified.

The leachate testing conducted to date is likely to have identified the key contaminants likely to appear in the leachate. However, there is a risk that the leachate generated may have higher concentrations than the current sampling data indicates, as discussed above.

The relevant well locations are shown in Figure 2 (an extract from Figure 2 in the Draft Capped Waste Stockpile Assessment (Ramboll Environ, 2016)).

Figure 2 Capped waste stockpile sampling wells (per Ramboll Environ)

On 11 November 2015, sufficient sample was extracted from MW206 to satisfy the required analyses but only a portion of the analyses were able to be conducted on the limited sample from MW202. A second round of sampling on 9 December 2015 yielded sufficient additional sample from MW202 to complete the required analyses. Some additional analytes were tested for both MW202 and MW206 during the second round of sampling by another laboratory.

In parallel with analysis of GHD's samples from 11 November, Ramboll Environ had some analyses conducted on several samples which are also included in this section.

A summary of the leachate testing results is provided in Table 10. The consolidated full analysis results spreadsheet and supporting laboratory reports for GHD's samples are included in Appendix A. The laboratory reports supporting Ramboll Environ's results in Table 10 are included in the Draft Capped Waste Stockpile Assessment (Ramboll Environ, 2016).

It is possible that leachate may contain asbestos fibres from material stored in the CWS. Risks associated with handling and disposal of the asbestos contaminated leachate and associated solids residues will need to be managed.

Table 10 Capped waste stockpile leachate water quality

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Sample date		11/11/15	11/11/15	9/12/15	9/12/15	11/11/15	11/11/15	11/11/15	11/11/15	9/12/15
Laboratory/Source		ALS	Environ	ALS	Eurofins	Environ	Environ	ALS	Environ	Eurofins
Parameter	Unit									
pH - field	pH Unit		9.08	9.14		9.16	10.28		10.68	10.97
Electrical Conductivity - field	µS/cm		26,800	38,344		17,500	36,800		42,600	49,204
Total Dissolved Solids (Calc.)	mg/L				32,000			44,800		
Suspended Solids (SS)	mg/L				240			375		
Hydroxide Alkalinity as $CaCO_3$	mg/L		<1		< 10			<1	<1	
Carbonate Alkalinity as $CaCO_3$	mg/L		26,700		6,700			26,200	24,700	
Bicarbonate Alkalinity as $CaCO_3$	mg/L		727		20,000			1,210	242	
Total Alkalinity as $CaCO_3$	mg/L		27,400		27,000			27,400	25,000	
Silicon as SiO_2	mg/L				< 200			47.5		
Chloride	mg/L		568		870			564	522	
Calcium (Dissolved)	mg/L				5			2		
Magnesium (Dissolved)	mg/L				41			<1		
Sodium (Dissolved)	mg/L		8,300		12,000			20,100	16,700	
Aluminium (Dissolved)	mg/L		0.2	0.26			0.79	7.76	2.41	
Aluminium (Total)	mg/L			9.02				7.01		

Sample ID		MW202 (Waste Level)	MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)
Arsenic (Dissolved) Arsenic (Total)	mg/L	0.251 0.249			0.509 0.428
Barium (Dissolved) Barium (Total)	mg/L	0.239 0.293			0.034 0.043
Chromium (Dissolved) Chromium (Total)	mg/L	0.144 0.15			0.06 0.057
Cobalt (Dissolved) Cobalt (Total)	mg/L	0.34 0.375			0.238 0.263
Copper (Dissolved) Copper (Total)	mg/L	0.023 0.032			<0.010 <0.010
Manganese (Dissolved) Manganese (Total)	mg/L	0.54 0.581			0.02 0.021
Molybdenum (Dissolved) Molybdenum (Total)	mg/L	1.26 1.41			1.14 1.46
Nickel (Dissolved) Nickel (Total)	mg/L	0.288 0.314			0.115 0.146
Strontium (Dissolved) Strontium (Total)	mg/L	0.199 0.227			0.038 0.042
Vanadium (Dissolved) Vanadium (Total)	mg/L	1.76 1.92			0.25 0.39
Zinc (Dissolved) Zinc (Total)	mg/L	0.075 0.129			<0.050 <0.052
Boron (Dissolved) Boron (Total)	mg/L	<0.10 <0.10			3.51 3.87
Iron (Dissolved) Iron (Total)	mg/L	14.6 19.4			30.3 44.3
Bromine (Dissolved)	mg/L	6.8			4.7

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Bromine (Total)				6.08				4.19		
Iodine (Dissolved) Iodine (Total)	mg/L			9.1 7.49				2.9 2.56		
Lead (Total)	mg/L			0.016				<0.010		
Lithium (Total)	mg/L			0.015				<0.010		
Arsenious Acid, As (III)	µg/L	<0.5						<0.5		
Arsenic Acid, As (V)	µg/L	72						310		
Mercury (Dissolved) Mercury (Total)	mg/L		<0.0001	<0.0001 0.0122				<0.0001 <0.0001	<0.0001	
Cyanide (Total) Cyanide (WAD) Cyanide (Free)	mg/L		7.81 <0.040		21 0.047	 <0.040	227 <0.040	205 <0.400	223 <0.040	
Fluoride	mg/L		1,880		250	0.2	1,380	1,700	1,640	
Ammonia as N	mg/L				48			529		
Total Nitrogen as N	mg/L				75			594		
Total Phosphorus as P	mg/L				5.2			8.6		
Reactive Phosphorus as P	mg/L				< 0.05			3.91		
Sulfate as SO_4	mg/L		1,250		2,040			7,660	9,000	
Total Organic Carbon	mg/L	2,570			310			1,890		
Oil & Grease	mg/L	13						6		
Chemical Oxygen Demand	mg/L				2,900			1,700		
Benzene (MAH) Benzene (BTEXN)	µg/L	42 44			29			<5 <5		
Toluene (MAH) Toluene (BTEXN)	µg/L	11 10			<20 -			5 <5		

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
2-Propanone (Acetone)	µg/L	<50			<20			340		
Chloroform	µg/L	19			<20			8		
Sum of PAHs	µg/L	<2	2.4					79	122	
Carbazole	µg/L	<2						4		
TPH C10 - C36 Fraction	µg/L	510	120					510	840	
TRH >C10 - C40 Fraction	µg/L	540	600					550	870	
Sum of BTEX	µg/L	54	29					<5	10	
Naphthalene (PAH) Naphthalene (BTEXN)	µg/L	<2 5	1.4 <5		<4			9 48	30.2 48	
Formaldehyde	µg/L	168						423		
Acetaldehyde	µg/L	10.1						19		
m-Cresol	µg/L	<0.1						21.6		
o-Cresol	µg/L	<0.1						10.4		
p-Cresol	µg/L	<0.1						26		
Phenol (Phenolics 1) Phenol (Phenolics 2)	µg/L	<2 <0.1			<3			12 123		

Although a range of other parameters will require attention to satisfy required treated water quality (depending on the option selected), key contaminants of concern in the analyses to date are cyanide and fluoride, due to their toxic nature and relatively elevated concentrations.

5.5 Leachate Quantity

Although some volumetric information is available regarding flows pumped from leachate interception trenches, these flows comprise both leachate generated from the stockpile and natural groundwater intrusion, so they do not reflect the actual leachate generation volumes.

The leachate flows adopted as the design basis including leachate from excavation of the CWS and the new Containment Cell are presented in Appendix B. As design progresses on the proposed Containment Cell, these leachate quantities will be refined and the most up to date estimates of leachate quantity will be used in detailed design or specification developed for the particular leachate management system adopted.

Based on preliminary design of the new Containment Cell, GHD has estimated leachate generation for both the historical mean and high rainfall years for various stages of development of the new cell and excavation of the CWS. The derivation of the new containment cells flows are generally discussed in Section 4.12 In addition, the following assumptions have been adopted:

- Following final capping of the new containment cell, it has been assumed that the leachate volume generated from the containment cells will reduce to about 15% of the preceding year, reducing to approximately 1% of the final capped year flow after about 3 years, and continuing to taper further from there until the flow is at 0.01% of the final capped flow. This minimum flow is assumed to continue into the foreseeable future.
- During excavation of the CWS, leachate will be generated through rainfall on the exposed waste material and some groundwater ingress into the excavation will occur. The groundwater ingress volume is expected to be small relative to the direct rainfall leachate through the stockpile material and ingress is expected to be associated with stormwater events. It is considered that the estimated leachate flows will account for groundwater ingress during excavation of the CWS.
- Once the waste material and contaminated natural soil has been removed from the CWS and the excavation has been filled, no further extraction of leachate from the active leachate interception trench or from other extraction points related to the CWS will occur for the purposes of leachate treatment.

5.6 Regulatory requirements

The Environmental Protection Licence (EPL) for the site (NSW Licence number 1548) has a number of conditions relevant to the management of leachate on the site.

The only licensed discharge point is to the irrigation area per Section 2-P1 of the EPL. The licence notes that the licensee must comply with Section 120 of the Protection of the Environment Operations Act 1997 (Section 3-L1 of the EPL). The irrigation of effluent in this area must comply with the conditions outlined in Section 4-O4 of the EPL. To meet the conditions in Section 4-O4 the leachate must be treated to a quality acceptable for discharge (see Section 5.7.1).

A surface water monitoring program must be undertaken per Section 5-M2. A groundwater interception trench from the Capped Waste Stockpile must be in operation per Section 8-U1. A groundwater monitoring program must be implemented for groundwater adjacent to the Capped Waste Stockpile per Section 9-E1. The particulars of these conditions are included below for reference.

P1 Location of monitoring/discharge points and areas

P1.1 The following points referred to in the table are identified in this licence for the purposes of the monitoring and/or the setting of limits for discharges of pollutants to water from the point.

P1.2 The following utilisation areas referred to in the table below are identified in this licence for the purposes of the monitoring and/or the setting of limits for any application of solids or liquids to the utilisation area.

Table 11 Water and land

EPA Identification no.	Type of Monitoring Point	Type of Discharge Point	Location Description
11		Discharge to utilisation area	Irrigation area

L1 Pollution of waters

L1.1 Except as may be expressly provided in any other condition of this licence, the licensee must comply with Section 120 of the Protection of the Environment Operations Act 1997.

O4 Effluent application to land

O4.1 Effluent application must not occur in a manner that causes surface runoff.

O4.2 Spray from effluent application must not drift beyond the boundary of the premises.

O4.3 Livestock access to any effluent application area must be denied during effluent application and until the applied effluent area has dried.

O4.4 The quantity of effluent/solids applied to the utilisation area must not exceed the capacity of the area to effectively utilise the effluent/solids.

For the purpose of this condition, 'effectively utilise' include the use of the effluent/solids for pasture or crop production, as well as the ability of the soil to absorb the nutrient, salt, hydraulic load and organic material.

M2 Environmental monitoring

M2.1 The environmental monitoring program must include the following:

M2.2 Surface water monitoring.

The licensee must undertake a surface water monitoring program for potential pollutants, including fluoride, pH and conductivity and provide a report with each Annual Return. The report should include but need not be limited to the following:

a) Plan showing sampling locations;

b) Trend analysis of monitored parameters;

c) Conclusion and any recommendations from the assessment of surface water monitoring.

U1 Groundwater interception - Capped Waste Stockpile

U1.1 The licensee is to construct and operate a groundwater interception trench in accordance with the document titled "Leachate Interception Trench, Capped Waste Stockpile", provided to the EPA on 15 April 2014.

The licensee is to complete the construction of the leachate interception trench by no later than FRIDAY 31 OCTOBER 2014.

E1 Groundwater monitoring adjacent to the Capped Waste Stockpile

E1.1 The licensee is to implement a groundwater monitoring program in accordance with the "Groundwater Water Monitoring Program, Capped Waste Stockpile", provided to the EPA on 15 April 2014.

E1.2 At the completion of 12 months of monitoring, a report must be provided to the EPA that includes:

a) Aquifer characterisation, including aquifer behaviour;

b) Trend analysis of monitored parameters in key wells; and

c) Conclusion and recommendations from the assessment of leachate impact on groundwater.

This report is to be provided to the EPA no later than 31 MARCH 2015.

5.7 Treated water quality requirements

5.7.1 Dust suppression and irrigation

The leachate management strategy may involve the reuse of treated leachate, potentially reducing the extent and cost of treatment or disposal. Potential reuse applications for treated leachate include dust suppression during decommissioning and rehabilitation activities, and irrigation under the existing EPL.

To estimate the capacity of vegetation and soils in an irrigation area to sustain the applied contaminant load, background monitoring and irrigation modelling (for example Medli modelling) is typically used.

HAKK and Ramboll Environ have noted that the vegetation in the irrigation area does not show any visible adverse impact and has not previously been adversely impacted and this demonstrates the ability of the irrigation area to handle the historical loads of nutrients and salts. In addition, HAKK and Ramboll Environ note that there have been various analysis and assessments of the irrigation water and the surrounding environment undertaken e.g. water quality of North Dams 1 and 2 and downstream surface water quality, that can be used to demonstrate that irrigation can continue at the current hydraulic and contaminant loadings.

On this basis, an assessment has been made of the impact on current irrigation practice if treated and/or untreated leachate is added to site runoff in the North Dams.

The assessment is based on the following:

- Irrigation volumes from 2006 and 2008 (d tab 4.3 Rain 2008.xls) have been combined with North Dams electrical conductivity (EC) and fluoride (F) concentrations from 2012, 2013, 2014 (Leachate Analysis_KMcN.xlsx) to determine irrigated mass loads of TDS (calculated from EC) and F.
- The average of the annual rainfall from 2006 (below average) and 2008 (above average) was close to the average over a 20 year period from 1989 to 2008, so the average of the irrigated flows from 2006 and 2008 was assumed to approximate average irrigation volumes. Therefore, the average mass load from the above calculations was considered to be the “sustainable” irrigation mass load for TDS and F. The sustainable loads assumed are 96 t TDS/yr and 4.2 t F/yr.
- Average North Dams TDS and F concentrations were assumed to increase by 10% (from the averaged 2012 to 2015 concentrations) to reflect additional stormwater runoff contamination expected during the demolition activities.

- Leachate flows from the highest average flow 12 month period (using 50% AEP rainfall year data) over the various stages of the landfill exercise were used to determine the additional contaminant loads that leachate would contribute to the North Dams, the blended water quality and the subsequent contaminant loads to the irrigation area.
- 3 scenarios are considered below:

  A – Leachate is treated to meet the expected local runoff water quality so does not impact the concentrations in the North Dams

  B – 50% of the leachate is treated to the expected runoff water quality and the remaining leachate reports to the North Dams untreated

  C – All leachate reports to the North Dams untreated
- All 3 scenarios result in reductions to the average irrigation flows able to be applied to the existing irrigation area due to increase in the expected runoff concentrations during decommissioning, and this source representing a significant majority of the hydraulic flow to the North Dams.

The irrigation volume reductions due to the limiting contaminant overloading relative to the assumed sustainable irrigated mass load (TDS or F) are shown in Table 12.

Table 12 Indicative irrigation volume reductions due to expected North Dams water quality and leachate contribution

North Dam Leachate Scenario	Indicative Irrigation Volume Reduction
A – Leachate is treated to meet the expected runoff water quality so does not impact the concentrations in the North Dams	~ 10%
B – 50% of the leachate is treated to the expected runoff water quality and the remaining leachate is contributed to the North Dams untreated	~40-60%
C – All leachate is contributed to the North Dams untreated	~60-80%

To reduce the impact on irrigation loads and avoid further limiting the ability to manage water levels in the North Dams, the following may be worth further consideration:

- Can additional irrigation area be made available to increase irrigated flows/loads?
- How much dust suppression water can be utilised to offset the reduced irrigation potential?

Is the assessment of "sustainable loading" appropriate? It may be appropriate to consider a short term sustainable annual loading based on the higher of the two irrigation volume years provided (i.e. 2008). Corresponding water quality for 2008 could be used with irrigated flows from 2008 to calculate the load of TDS and F applied to the irrigation area in 2008. This would represent a real example of a potentially higher short term load successfully applied to the irrigation area without any identified adverse consequences (as far as GHD understands). If a short term (12-24 mths) application of up to the same annual loads was applied during the waste transfer exercise with considerably lower irrigated load in the future following decommissioning, the environmental impact may be considered acceptable by the EPA.

However, without site-specific irrigation modelling, the capacity of vegetation and soils in the irrigation area to sustain the proposed contaminant load is not known. The effect of an increased short term sustainable loading would be a reduced impact on the flows that could be irrigated, or conversely a reduction in the amount of additional area required to irrigate average flows. The combined capacity of the North Dams is approximately 33 ML (Pulver Cooper & Blackley (2016), Stormwater Management Report - Flood Modelling Review). At full capacity this represents a retention time of about 5 to 6 weeks based on an average 50% AEP month rainfall and 2 to 3 weeks based on a wet 90% AEP month rainfall.

It is not expected that these retention times will materially affect the annual contaminant loads applied to the irrigation area. However, assuming the North Dams are not well mixed, there is a risk that pockets of higher concentration leachate could be drawn into the irrigation pump suction and may have an acute adverse impact on the irrigation area. In developing leachate management options involving blending leachate in the North Dams, consideration will be given to encouraging mixing of the leachate with the balance of the North Dams inflows and avoiding short-circuiting of leachate to the irrigation pump suction.

The rudimentary assessment in Table 12 considers an average 50% AEP rainfall year and does not include any water balance modelling. Depending on the site water balance and the actual rainfall received, the assumed irrigated volumes (average of 2006 and 2008) may not be sufficient to manage the water levels in the North Dams. The irrigated contaminant loads should be monitored and a contingency should be developed in case the sustainable annual loads are irrigated in less than 12 months and additional water must be removed from the North Dams.

Site runoff estimation

The 50% AEP and 90% AEP rainfall year stormwater flow volumes into the North Dams were estimated and used in the calculation of blended North Dams water quality. The basis for determination of the annual runoff flows is outlined below.

Rainfall data is available from Kurri Kurri Golf Club (KKGC) - 3.4 km away from the site, or from Branxton (Dalwood Vineyard) - 17.7 km away from the site. The data for the site was sourced from Branxton (Dalwood Vineyard), understanding that it is a more complete representation. Rainfall information can be extracted from 1900 to 2015 from the Branxton (Dalwood Vineyard) station, whereas KKGC provides information beginning only in 2007. Both sets were compared for consistency for the years 2007 – 2016 and were considered to provide comparable information.

Historical monthly rainfall data spanning from 1900 till 2015 was used to estimate the stormwater flow volumes.

The catchment area outlined in pink in Figure 3 was delineated based upon the assumption that the total catchment of the pond is represented by the gravity catchment of the pond as well as the impervious area of the site. The assumed impervious area of the site is shown in yellow below. It has been assumed based on discussion with HAKK and Ramboll Environ that for the purpose of the irrigation assessment exercise all runoff from the given catchment reports via gravity or pumping to the North Dams.

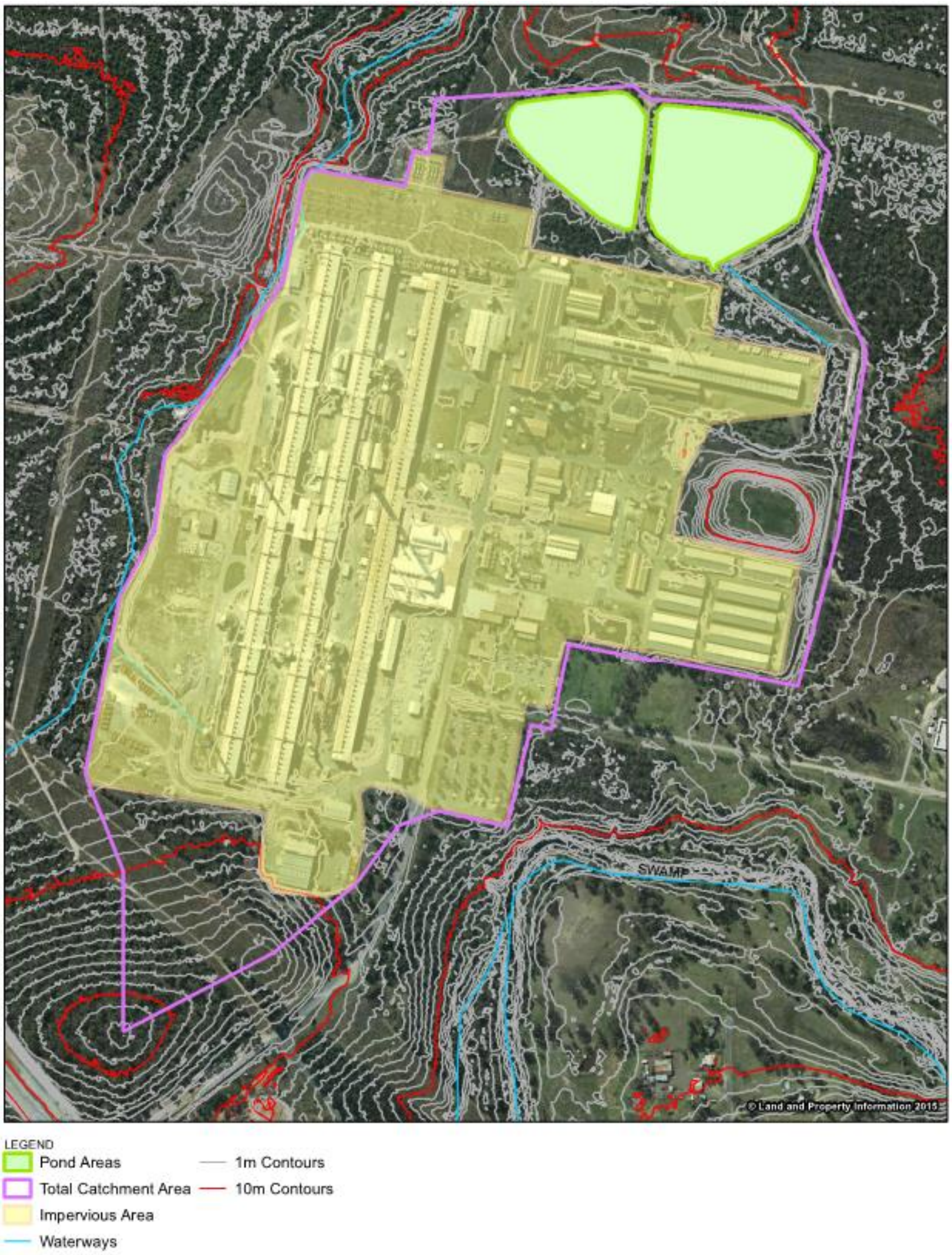

Figure 3 Site runoff catchment basis

The assumed runoff coefficient for pervious substances was estimated on the catchment properties Wollombi Brook catchment at Paynes Crossing (taken from Calibrations of the AWBM for use on ungauged catchments – pp42 of 48 - Calibrations of the AWBM). A potential runoff coefficient for the pervious areas may be equal to 0.11. A runoff coefficient of 0.11 was assumed.

For impervious areas a coefficient of 0.60 was conservatively assumed. This estimated was based upon available of literature and have conservatively adopted low runoff coefficient values. A runoff coefficient for asphalt may be equal to 0.85, however due to demolition and civil works, it is likely that the current impervious surface will become more pervious. As the required use of stormwater is to provide dilution for treated leachates, the conservative design corresponds to reduced stormwater flows (and reduced runoff coefficients). Accordingly, a runoff coefficient of 0.60 was assumed.

Based upon the historical rainfall data, monthly and yearly runoff volumes were determined using the catchment areas and runoff coefficient. It should be noted that development of runoff volumes have high levels of uncertainty without observed site data. Literature has been used to develop estimates as best as practical at this stage and estimates were conservative where applicable.

5.7.2 Trade waste

The Hydro smelter has been discharging process water to trade waste for treatment at the Kurri Kurri Wastewater Treatment Facility for some time. The discharge is licenced under an existing Trade Wastewater Agreement (2013) with Hunter Water Corporation.

The Minor Trade Wastewater General Conditions included with the 2013 agreement include the following requirements.

Table 13 General requirements for all trade wastewater discharged to sewer

Parameter	Requirement
Temperature	Not more than 38 degrees Celsius
Colour	Not noticeable when diluted 100 times in clear water
pH	7 to 10
Fibrous material	None which could block our sewer
Solids matter	Not longer than 20 millimetres, must not settle faster than 3 metres in an hour

A change in the nature/source of the trade waste would require consultation with Hunter Water Corporation and conditions of the agreement would be reviewed and likely revised to reflect the altered process and water quality.

The previous version of this agreement (Major Trade Waste Permit, 1999) included the conditions presented in Table 14. It is anticipated that at least these parameters would be included in any revised version of the current agreement to reflect the discharge of treated leachate to sewer.

Table 14 Previous major trade waste permit conditions

Parameter	Requirement
Non-Filterable Residue (Suspended Solids)	Not to exceed 500 mg/L
Fluoride	Not to exceed 5 mg/L
pH	Not to be less than 6.5 or greater than 10
Total Oil and Grease (TOG)	Not to exceed 70 mg/L
Instantaneous rate of discharge	Not to exceed 5 L/s
Maximum daily discharge	150 Kilolitres
Discharge times	Discharge permitted 24 hrs per day, 7 days per week

In developing a new suite of contaminant concentration conditions for the trade wastewater agreement, Hunter Water Corporation would likely take into consideration the Australian Sewage Quality Management Guidelines (Water Services Association of Australia, June 2012).

These guidelines assist utilities to better manage loads and concentrations of inputs to their sewerage system to manage risks to the sewerage collection system and to the sewage treatment system. General guidelines on contaminant concentrations for sewerage collection systems can be applied to all sewage systems without the need to determine limits for local treatment systems.

Guideline concentrations provided to protect sewage treatment systems should not be considered to represent a definite line of division between safe and unsafe acceptance of trade waste due to the highly variable nature of sewage systems in Australia. However, these provide indicative concentration limits to assist in assessing whether the leachate could be economically treated to the likely levels required by Hunter Water Corporation.

Relevant guideline concentrations tables have been extracted from the Australian Sewage Quality Management Guidelines for consideration during the options study and are included in Appendix C. These include:

- Table C3: Guideline concentrations for discharge to sewerage systems
- Table C4: BEARPIT threshold values (Best Economic and Reasonable Pre treatment Technology)
- Table C5: Typical threshold concentrations (mg/L) for common substances in sewage that are known to inhibit activated sludge, nitrification and anaerobic digestion processes.
- Table C7: Typical concentrations for common substances in 'domestic' sewage (Source: City West Water's data).

5.7.3 Contractor Disposal

In November 2015 a generic enquiry was made to Steve Fenton from Worth Recycling in Kurri Kurri regarding acceptance criteria for liquid waste from the broader region. Appendix D includes the specific criteria from Worth Recycling on which acceptance of liquid waste would be assessed. The criteria notes that if the stream is outside the limits specified above, Worth Recycling will examine and assess on case by case basis to see if they have treatment option suitable. Other waste contractors will also be consulted during the option study to confirm suitability of the leachate for contractor disposal.

5.8 Leachate management option considerations

5.8.1 Existing site constraints and opportunities

To reduce the capacity and cost of a leachate treatment system, buffer storage capacity could be utilised to attenuate peak flows. Storage capacity could also assist in landfill leachate management (i.e. receipt of pumped leachate from one leachate location to the other to enable single treatment location).

A number of existing systems have been identified that may be able to be incorporated into the leachate management system to reduce costs. Infrastructure identified as potentially reusable for this purpose is described below. As leachate management options are developed the ability to utilised this infrastructure will be further assessed.

Based on the site visit and discussion between Kostas Athanasiadis and Matt King on Friday 30th October 2016, GHD understands that a 1 ML tank may be available for use as part of the leachate collection and treatment system. Hydro advised at the leachate design basis workshop (23/5/16) that this tank is not likely to be available for use in the leachate management system.

The 32A compressor house could be a potential location for a centralised water treatment plant. Power can be supplied to this area from the new power supply as TL6 transformer used to supply the cooling towers for the compressors to the east of this building. This building may be retained for adaptive re-use or its demolition could be delayed until the end of Stage 2 demolition. After treatment the low fluoride clean water could be discharged to the nearby south surge pond where it would be pumped to the east surge pond and north dams.

Raw leachate could be trucked from the leachate collection ponds at the capped waste stockpile and the new containment cell and stored in Cooling Tower CT2, CT3 and CT4 cold wells. CT2 cold well will hold approximately 54,000 litres, CT3 and CT4 cold wells will hold up to approximately 136,000 litres each (very approximate). It is estimated that approximately 300,000 litres storage in total may be available in the cold wells. Lay flats and pumps could be used to pump the leachate from the cold wells to the WTP.

DC2 and DC3 emergency water head tanks will hold 502,655 litres of raw leachate each or a total of 1,005,310 litres. However, the underground cooling tower pumps in 34B pump house would be needed to pump from the cold well of CT3 and CT4 up to these head tanks. These pumps are no longer serviceable as this area was flooded. It would take some effort to get these pumps going again. 34B pump house is supplied from TL6 transformer, which will have power into the future.

There is an existing sewage pump station (37A sewerage pump house) and pipeline owned and maintained by Hydro that in additional transferring sewage from the site also transfers trade waste into the sewerage system under the existing Trade Wastewater Agreement. The condition of this pipeline is not known at this stage but the pipeline is assumed to be in satisfactory operational condition and may be able to be utilised for the leachate management system. The sewerage system will contract as buildings are demolished but part of it will be retained during Stage 1 demolition. However, it is likely to be shut down during Stage 2 demolition and would be unavailable for trade waste transfer from that time.

Contingent on the final design of proposed Containment Cell, limited space exists to facilitate storage and treatment of leachate to the east of the planned Containment Cell. An area of approximately up to 60 m x 40 m appears to be available between the new cell and the nominated stockpile area. This may restrict leachate management options incorporating storage and evaporation ponds.

A fixed power supply from a generator will be located adjacent to the new containment cell which is likely to have some spare capacity. Depending on the leachate management system power demand, some or all of the power requirements may be able to be met from the spare generator capacity if the leachate treatment system is located in that area.

5.8.2 Previous leachate management assessments

Ramboll Environ prepared a Stage 2 Water Treatment Options Report (December 2012) to assess options for treatment of leachate and leachate-affected shallow groundwater. It considered four options including:

- Disposal of intercepted/collected water by a waste contractor;
- Collection and storage of water followed by pump to site ponds for evaporative disposal;
- Collection and storage of water followed by treatment via a process developed by the University of Newcastle (following research conducted on the site over several years) coupled with disposal of treated effluent by evaporation; and

- Collection and storage of water followed by chemical treatment designed by ENVIRON coupled with disposal of treated effluent by evaporation.

The study concluded that for disposal of small volumes of water (<1 ML), removal by a waste contractor is the simplest and cheapest method. Once volumes of water are in excess of 1 ML (for example disposal of the estimated 50 ML of leachate-affected water), treatment by evaporation alone provides a cost effective solution with costs highly dependent on the construction requirements and sludge disposal.

It was noted that if sludge requires treatment prior to disposal, pre-treatment of the effluent using the ENVIRON designed process provides a more cost effective solution and that small scale evaporation trials would be required to assess the quality of resulting sludge and if treatment by stabilisation or similar is required prior to disposal.

Similar options will be reassessed under the current option study based on new information regarding leachate quality, quantity, constraints and opportunities.

Appendices

Appendix A - Leachate Sample Water Quality

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
Parameter	**Units**									
pH - field measured	pH Unit		9.08	9.14		9.16	10.28		10.68	10.97
Temp - field measured	^{o}C		21.2	28.2		21.9	22.3		23.4	24.3
Electrical Conductivity - field measured	µS/cm		26800	38344		17500	36800		42600	49204
Dissolved Oxygen - field measured	mg/L		0.08	-		0.15	0.24		0.06	-
REDOX - field measured	mV		-276	-189		-244	-147		-363	-367
pH Value - Laboratory	pH Unit				8.8					
Electrical Conductivity @ 25°C	µS/cm				35000			48400		
Total Dissolved Solids (Calc.)	mg/L				32000			44800		
Suspended Solids (SS)	mg/L				240			375		
Total Solids	mg/L				34000			58000		
Volatile Suspended Solids @ 550°C	mg/L				35			50		
Fixed Suspended Solids @ 550 C (Fraction of Susp	%							87		
Volatile Suspended Solids @ 550 C (Fraction of Su	%							13		
Colour (Apparent)	PCU							5000		
pH Colour	pH Unit							11.1		
Colour (True)	PCU				13000			4500		
pH Colour	pH Unit							11.1		
Gross alpha	Bq/L	<0.42						<0.74		
Gross beta activity - 40K	Bq/L	<0.83						<1.47		
Hydroxide Alkalinity as CaCO3	mg/L		<1		< 10			<1	<1	
Carbonate Alkalinity as CaCO3	mg/L		26700		6700			26200	24700	
Bicarbonate Alkalinity as CaCO3	mg/L		727		20000			1210	242	
Total Alkalinity as CaCO3	mg/L		27400		27000			27400	25000	
Silicon as SiO2	mg/L				< 200			47.5		
Chloride	mg/L		568		870			564	522	
Calcium (Dissolved)	mg/L				5			2		
Magnesium (Dissolved)	mg/L				41			<1		
Sodium (Dissolved)	mg/L		8300		12000			20100	16700	
Potassium (Dissolved)	mg/L		13		46			93	68	
Sodium Adsorption Ratio					360			3910		
Dissolved Metals										
Aluminium	mg/L		0.2	0.26			0.79	7.76	2.41	
Antimony	mg/L			<0.010				<0.010		
Arsenic	mg/L			0.251				0.509		
Beryllium	mg/L			<0.010				<0.010		
Barium	mg/L			0.239				0.034		
Cadmium	mg/L			<0.0010				<0.0010		
Chromium	mg/L			0.144				0.06		
Cobalt	mg/L			0.34				0.238		
Copper	mg/L			0.023				<0.010		
Lead	mg/L			<0.010				<0.010		
Lithium	mg/L			<0.010				<0.010		
Manganese	mg/L			0.54				0.02		
Molybdenum	mg/L			1.26				1.14		
Nickel	mg/L			0.288				0.115		
Selenium	mg/L			<0.10				<0.10		
Silver	mg/L			<0.010				<0.010		
Strontium	mg/L			0.199				0.038		
Thallium	mg/L			<0.010				<0.010		
Tin	mg/L			<0.010				0.012		
Titanium	mg/L							<0.10		
Vanadium	mg/L			1.76				0.25		
Zinc	mg/L			0.075				<0.050		
Boron	mg/L			<0.10				3.51		
Iron	mg/L			14.6				30.3		
Bromine	mg/L			6.8				4.7		
Iodine	mg/L			9.1				2.9		
Total Metals										
Aluminium	mg/L			9.02				7.01		
Antimony	mg/L			<0.010				<0.010		
Arsenic	mg/L			0.249				0.428		
Beryllium	mg/L			<0.010				<0.010		
Barium	mg/L			0.293				0.043		
Cadmium	mg/L			<0.0010				<0.0010		
Chromium	mg/L			0.15				0.057		
Cobalt	mg/L			0.375				0.263		
Copper	mg/L			0.032				<0.010		
Lead	mg/L			0.016				<0.010		
Lithium	mg/L			0.015				<0.010		
Manganese	mg/L			0.581				0.021		
Molybdenum	mg/L			1.41				1.46		
Nickel	mg/L			0.314				0.146		
Selenium	mg/L			<0.10				<0.10		
Silver	mg/L			<0.010				<0.010		
Strontium	mg/L			0.227				0.042		
Thallium	mg/L			<0.010				<0.010		
Tin	mg/L			<0.010				0.023		
Titanium	mg/L							<0.10		
Vanadium	mg/L			1.92				0.39		
Zinc	mg/L			0.129				<0.052		
Boron	mg/L			<0.10				3.87		
Iron	mg/L			19.4				44.3		
Bromine	mg/L			6.08				4.19		
Iodine	mg/L			7.49				2.56		
Arsenious Acid, As (III)	µg/L	<0.5						<0.5		
Arsenic Acid, As (V)	µg/L	72						310		
Organoarenic Compounds (indicative only - by dif	mg/L							0.118		

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
Mercury (Dissolved)	mg/L		<0.0001	<0.0001				<0.0001	<0.0001	
Mercury (Total)	mg/L			0.0122				<0.0001		
Hexavalent Chromium (Dissolved)	mg/L	<0.50						<0.50		
Chlorine - Free	mg/L				< 0.1			<1.0		
Chlorine - Total Residual	mg/L				< 0.1			<1.0		
Total Cyanide	mg/L		7.81		21		227	205	223	
Weak Acid Dissociable Cyanide	mg/L				0.047			<0.400		
Free Cyanide	mg/L		<0.040			<0.040	<0.040		<0.040	
Fluoride	mg/L		1880		250	0.2	1380	1700	1640	
Ammonia as N	mg/L				48			529		
Nitrite as N	mg/L				< 0.2			<0.01		
Nitrate as N	mg/L				< 0.2			0.55		
Nitrite + Nitrate as N	mg/L							0.55		
Organic Nitrogen (as N)	mg/L				27					
Total Kjeldahl Nitrogen as N	mg/L				75			593		
Total Nitrogen as N	mg/L				75			594		
Total Phosphorus as P	mg/L				5.2			8.6		
Reactive Phosphorus as P	mg/L				< 0.05			3.91		
Sulfide as S2-	mg/L	<1.0			< 0.15 (as S)			1.5		
Sulfite as SO3 2-	mg/L	<2			< 15 (as S)			<2		
Thiosulfate as S2O3 2-	mg/L	<20			< 30 (as S)			<20		
Total Sulphur	mg/L				680					
Sulfate as SO4 - Turbidimetric	mg/L		1250		2040			7660	9000	
Total Anions	meq/L							723		
Total Cations	meq/L							877		
Ionic Balance	%							9.56		
Total Organic Carbon	mg/L	2570			310			1890		
Formaldehyde	mg/L				< 0.2			<0.5		
Oil & Grease	mg/L	13						6		
Chemical Oxygen Demand	mg/L				2900			1700		
Nonionic Surfactants as CTAS	mg/L			<10				<5		
Anionic Surfactants as MBAS	mg/L			<0.2				0.1		
Acetates										
Butyl acetate	mg/L				< 0.5					< 0.5
Ethyl acetate	mg/L				< 1					< 1
Propyl acetate	mg/L				< 1					< 1
Vinyl acetate	mg/L				< 2.5					< 2.5
Alkanes										
n-Decane	mg/L				< 0.05					< 0.05
n-Heptane	mg/L				< 0.05					< 0.05
n-Hexane	mg/L				< 0.05					< 0.05
n-Nonane	mg/L				< 0.05					< 0.05
n-Octane	mg/L				< 0.05					< 0.05
n-Pentane	mg/L				< 0.05					< 0.05
Polychlorinated Biphenyls (PCB)										
Aroclor 1016	µg/L	<1						<1		
Aroclor 1221	µg/L	<1						<1		
Aroclor 1232	µg/L	<1						<1		
Aroclor 1242	µg/L	<1						<1		
Aroclor 1248	µg/L	<1						<1		
Aroclor 1254	µg/L	<1						<1		
Aroclor 1260	µg/L	<1						<1		
Aroclor 1262	µg/L	<1						<1		
Total Polychlorinated biphenyls	µg/L	<1	<1					<1	<1	
PCB Surrogate										
Decachlorobiphenyl	%	61						70		
Monocyclic Aromatic Hydrocarbons										
Benzene	µg/L	42			29			<5		
Toluene	µg/L	11			< 20			5		
Ethylbenzene	µg/L	<5			< 20			<5		
meta- & para-Xylene	µg/L	<10			< 40			<10		
Styrene	µg/L	<5			< 20			<5		
ortho-Xylene	µg/L	<5			< 20			<5		
Isopropylbenzene	µg/L	<5			< 20			<5		
n-Propylbenzene	µg/L	<5						<5		
1.3.5-Trimethylbenzene	µg/L	<5			< 20			<5		
sec-Butylbenzene	µg/L	<5						<5		
1.2.4-Trimethylbenzene	µg/L	<5			< 20			<5		
tert-Butylbenzene	µg/L	<5						<5		
p-Isopropyltoluene	µg/L	<5						<5		
n-Butylbenzene	µg/L	<5						<5		
Xylenes - Total	µg/L				< 60					
Oxygenated Compounds										
2-Propanone (Acetone)	µg/L	<50			< 20			340		
Vinyl Acetate	µg/L	<50						<50		
2-Butanone (MEK)	µg/L	<50			< 20			<50		
4-Methyl-2-pentanone (MIBK)	µg/L	<50			< 20			<50		
2-Hexanone (MBK)	µg/L	<50						<50		
Sulfonated Compounds										
Carbon disulfide	µg/L	<5			< 20			<5		
Fumigants										
2.2-Dichloropropane	µg/L	<5						<5		
1.2-Dichloropropane	µg/L	<5			< 20			<5		
cis-1.3-Dichloropropylene	µg/L	<5			< 20			<5		
trans-1.3-Dichloropropylene	µg/L	<5			< 20			<5		
1.2-Dibromoethane (EDB)	µg/L	<5			< 20			<5		
Halogenated Aliphatic Compounds										
Dichlorodifluoromethane	µg/L	<50			< 20			<50		

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
Chloromethane	µg/L	<50			< 20			<50		
Vinyl chloride	µg/L	<50			< 20			<50		
Bromomethane	µg/L	<50			< 20			<50		
Chloroethane	µg/L	<50			< 20			<50		
Trichlorofluoromethane	µg/L	<50			< 20			<50		
1.1-Dichloroethene	µg/L	<5			< 20			<5		
Iodomethane	µg/L	<5			< 20			<5		
Methylene chloride	µg/L	<5			< 20			<5		
trans-1.2-Dichloroethene	µg/L	<5			< 20			<5		
1.1-Dichloroethane	µg/L	<5			< 20			<5		
cis-1.2-Dichloroethene	µg/L	<5			< 20			<5		
1.1.1-Trichloroethane	µg/L	<5			< 20			<5		
1.1-Dichloropropylene	µg/L	<5						<5		
Carbon Tetrachloride	µg/L	<5			< 20			<5		
1.2-Dichloroethane	µg/L	<5			< 20			<5		
Trichloroethene	µg/L	<5			< 20			<5		
Dibromomethane	µg/L	<5			< 20			<5		
1.1.2-Trichloroethane	µg/L	<5			< 20			<5		
1.3-Dichloropropane	µg/L	<5			< 20			<5		
Tetrachloroethene	µg/L	<5			< 20			<5		
1.1.1.2-Tetrachloroethane	µg/L	<5			< 20			<5		
trans-1.4-Dichloro-2-butene	µg/L	<5						<5		
cis-1.4-Dichloro-2-butene	µg/L	<5						<5		
1.1.2.2-Tetrachloroethane	µg/L	<5			< 20			<5		
1.2.3-Trichloropropane	µg/L	<5			< 20			<5		
Pentachloroethane	µg/L	<5						<5		
1.2-Dibromo-3-chloropropane	µg/L	<5						<5		
Hexachlorobutadiene	µg/L	<5						<5		
Allyl chloride (3-Chloropropene)	µg/L				< 20					
Bis(2-chloroisopropyl)ether	µg/L				< 10					
Halogenated Aromatic Compounds										
Chlorobenzene	µg/L	<5			< 20			<5		
Bromobenzene	µg/L	<5			< 20			<5		
2-Chlorotoluene	µg/L	<5						<5		
4-Chlorotoluene	µg/L	<5			< 20			<5		
1.3-Dichlorobenzene	µg/L	<5			< 20			<5		
1.4-Dichlorobenzene	µg/L	<5			< 20			<5		
1.2-Dichlorobenzene	µg/L	<5			< 20			<5		
1.2.4-Trichlorobenzene	µg/L	<5			< 10			<5		
1.2.3-Trichlorobenzene	µg/L	<5			< 10			<5		
1.2.3.4-Tetrachlorobenzene	µg/L				< 10					
1.2.3.5-Tetrachlorobenzene	µg/L				< 10					
1.2.4.5-Tetrachlorobenzene	µg/L				< 10					
1.3.5-Trichlorobenzene	µg/L				< 10					
Benzyl chloride	µg/L				< 10					
Trihalomethanes										
Chloroform	µg/L	19			< 20			8		
Bromodichloromethane	µg/L	<5			< 20			<5		
Dibromochloromethane	µg/L	<5			< 20			<5		
Bromoform	µg/L	<5			< 20			<5		
Bromochloromethane	µg/L				< 20					
VOC Surrogates										
1.2-Dichloroethane-D4	%	108						104		
Toluene-D8	%	123						121		
4-Bromofluorobenzene	%	111			97			107		
Fluorobenzene	%				93					
Polynuclear Aromatic Hydrocarbons										
Naphthalene	µg/L	<2	1.4		< 4			9	30.2	
2-Methylnaphthalene	µg/L	<2			< 10			<2		
2-Chloronaphthalene	µg/L	<2			< 10			<2		
Acenaphthylene	µg/L	<2	<1.0		< 1			<2	<1.0	
Acenaphthene	µg/L	<2	<1.0		< 1			<2	3.5	
Fluorene	µg/L	<2	<1.0		< 1			<2	2.1	
Phenanthrene	µg/L	<2	<1.0		< 1			3	6	
Anthracene	µg/L	<2	<1.0		< 1			<2	2.7	
Fluoranthene	µg/L	<2	<1.0		< 1			8	8.8	
Pyrene	µg/L	<2	1		< 1			7	8.7	
N-2-Fluorenyl Acetamide	µg/L	<2						<2		
Benz(a)anthracene	µg/L	<2	<1.0		< 1			7	9.2	
Chrysene	µg/L	<2	<1.0		< 1			7	8.4	
Benzo(b+j) & Benzo(k)fluoranthene	µg/L	<4			< 1			17		
Benzo(b&j)fluorantheneN07	µg/L		<1.0		< 1				12.3	
Benzo(k)fluoranthene	µg/L		<1.0		< 1				3.9	
7.12-Dimethylbenz(a)anthracene	µg/L	<2			< 10			<2		
Benzo(a)pyrene	µg/L	<2	<0.5		< 1			10	9.6	
3-Methylcholanthrene	µg/L	<2			< 10			<2		
Indeno(1.2.3.cd)pyrene	µg/L	<2	<1.0		< 1			5	7	
Dibenz(a.h)anthracene	µg/L	<2	<1.0		< 1			<2	1.7	
Benzo(g.h.i)perylene	µg/L	<2	<1.0		< 1			6	8.2	
Sum of PAHs	µg/L	<2	2.4					79	122	
Benzo(a)pyrene TEQ (zero)	µg/L	<2	<0.5					13	14.7	
Dibenz(a.j)acridine	µg/L				< 10					
Phthalate Esters										
Dimethyl phthalate	µg/L	<2			< 10			<2		
Diethyl phthalate	µg/L	<2			< 10			<2		
Di-n-butyl phthalate	µg/L	<2			< 10			<2		
Butyl benzyl phthalate	µg/L	<2			< 10			<2		
bis(2-ethylhexyl) phthalate	µg/L	<10			< 10			<10		

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
Di-n-octylphthalate	µg/L	<2			< 10			<2		
Nitrosamines										
N-Nitrosomethylethylamine	µg/L	<2						<2		
N-Nitrosodiethylamine	µg/L	<2						<2		
N-Nitrosopyrrolidine	µg/L	<4						<4		
N-Nitrosomorpholine	µg/L	<2						<2		
N-Nitrosodi-n-propylamine	µg/L	<2			< 10			<2		
N-Nitrosopiperidine	µg/L	<2			< 10			<2		
N-Nitrosodibutylamine	µg/L	<2			< 10			<2		
N-Nitrosodiphenyl & Diphenylamine	µg/L	<4						<4		
Methapyrilene	µg/L	<2						<2		
Diphenylamine	µg/L				< 10					
Nitroaromatics and Ketones										
2-Picoline	µg/L	<2			< 10			<2		
Acetophenone	µg/L	<2			< 10			<2		
Nitrobenzene	µg/L	<2			< 50			<2		
Isophorone	µg/L	<2						<2		
2.6-Dinitrotoluene	µg/L	<4			< 10			<4		
2.4-Dinitrotoluene	µg/L	<4			< 10			<4		
1-Naphthylamine	µg/L	<2			< 10			<2		
4-Nitroquinoline-N-oxide	µg/L	<2						<2		
5-Nitro-o-toluidine	µg/L	<2						<2		
Azobenzene	µg/L	<2						<2		
1.3.5-Trinitrobenzene	µg/L	<2						<2		
Phenacetin	µg/L	<2						<2		
4-Aminobiphenyl	µg/L	<2			< 10			<2		
Pentachloronitrobenzene	µg/L	<2			< 10			<2		
Pronamide	µg/L	<2			< 10			<2		
Dimethylaminoazobenzene	µg/L	<2			< 10			<2		
Chlorobenzilate	µg/L	<2						<2		
2-Naphthylamine	µg/L				< 10					
Haloethers										
Bis(2-chloroethyl) ether	µg/L	<2						<2		
Bis(2-chloroethoxy) methane	µg/L	<2			< 10			<2		
4-Chlorophenyl phenyl ether	µg/L	<2			< 10			<2		
4-Bromophenyl phenyl ether	µg/L	<2			< 10			<2		
Chlorinated Hydrocarbons										
1.4-Dichlorobenzene	µg/L	<2			< 10			<2		
1.3-Dichlorobenzene	µg/L	<2			< 10			<2		
1.2-Dichlorobenzene	µg/L	<2			< 10			<2		
Hexachloroethane	µg/L	<2			< 10			<2		
1.2.4-Trichlorobenzene	µg/L	<2						<2		
Hexachloropropylene	µg/L	<2						<2		
Hexachlorobutadiene	µg/L	<2			< 10			<2		
Hexachlorocyclopentadiene	µg/L	<10			< 10			<10		
Pentachlorobenzene	µg/L	<2			< 10			<2		
Hexachlorobenzene (HCB)	µg/L	<4			< 10			<4		
Anilines and Benzidines										
Aniline	µg/L	<2			< 10			<2		
4-Chloroaniline	µg/L	<2						<2		
2-Nitroaniline	µg/L	<4			< 10			<4		
3-Nitroaniline	µg/L	<4						<4		
Dibenzofuran	µg/L	<2			< 10			<2		
4-Nitroaniline	µg/L	<2						<2		
Carbazole	µg/L	<2						4		
3.3`-Dichlorobenzidine	µg/L	<2			< 10			<2		
Organochlorine Pesticides (OC)										
alpha-BHC	µg/L	<0.5						<0.5		
Hexachlorobenzene (HCB)	µg/L	<0.5						<0.5		
beta-BHC	µg/L	<0.5						<0.5		
gamma-BHC	µg/L	<0.5						<0.5		
delta-BHC	µg/L	<0.5						<0.5		
Heptachlor	µg/L	<0.5						<0.5		
Aldrin	µg/L	<0.5			< 10			<0.5		
Heptachlor epoxide	µg/L	<0.5						<0.5		
trans-Chlordane	µg/L	<0.5						<0.5		
alpha-Endosulfan	µg/L	<0.5						<0.5		
cis-Chlordane	µg/L	<0.5						<0.5		
Dieldrin	µg/L	<0.5			< 10			<0.5		
4.4`-DDE	µg/L	<0.5			< 10			<0.5		
Endrin	µg/L	<0.5			< 10			<0.5		
beta-Endosulfan	µg/L	<0.5						<0.5		
4.4`-DDD	µg/L	<0.5			< 10			<0.5		
Endrin aldehyde	µg/L	<0.5			< 10			<0.5		
Endosulfan sulfate	µg/L	<0.5			< 10			<0.5		
4.4`-DDT	µg/L	<2.0			< 10			<2.0		
Endrin ketone	µg/L	<0.5			< 10			<0.5		
Methoxychlor	µg/L	<2.0			< 10			<2.0		
Total Chlordane (sum)	µg/L	<0.5						<0.5		
Sum of DDD + DDE + DDT	µg/L	<0.5						<0.5		
Sum of Aldrin + Dieldrin	µg/L	<0.5						<0.5		
Endosulfan I	µg/L				< 10					
Endosulfan II	µg/L				< 10					
Organochlorine Pesticide Surrogate										
Dibromo-DDE	%	62.6						70.6		
Organochlorine Pesticides										
alpha-BHC	µg/L	<2			< 10			<2		
beta-BHC	µg/L	<2			< 10			<2		

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
gamma-BHC	µg/L	<2			< 10			<2		
delta-BHC	µg/L	<2			< 10			<2		
Heptachlor	µg/L	<2			< 10			<2		
Aldrin	µg/L	<2						<2		
Heptachlor epoxide	µg/L	<2			< 10			<2		
alpha-Endosulfan	µg/L	<2						<2		
4.4`-DDE	µg/L	<2						<2		
Dieldrin	µg/L	<2						<2		
Endrin	µg/L	<2						<2		
beta-Endosulfan	µg/L	<2						<2		
4.4`-DDD	µg/L	<2						<2		
Endosulfan sulfate	µg/L	<2						<2		
4.4`-DDT	µg/L	<4						<4		
Sum of Aldrin + Dieldrin	µg/L	<4						<4		
Sum of DDD + DDE + DDT	µg/L	<4						<4		
Organophosphorus Pesticides (OP)										
Dichlorvos	µg/L	<0.5						<0.5		
Demeton-S-methyl	µg/L	<0.5						<0.5		
Monocrotophos	µg/L	<2.0						<2.0		
Dimethoate	µg/L	<0.5						<0.5		
Diazinon	µg/L	<0.5						<0.5		
Chlorpyrifos-methyl	µg/L	<0.5						<0.5		
Parathion-methyl	µg/L	<2.0						<2.0		
Malathion	µg/L	<0.5						<0.5		
Fenthion	µg/L	<0.5						<0.5		
Chlorpyrifos	µg/L	<0.5						<0.5		
Parathion	µg/L	<2.0						<2.0		
Pirimphos-ethyl	µg/L	<0.5						<0.5		
Chlorfenvinphos	µg/L	<0.5						<0.5		
Bromophos-ethyl	µg/L	<0.5						<0.5		
Fenamiphos	µg/L	<0.5						<0.5		
Prothiofos	µg/L	<0.5						<0.5		
Ethion	µg/L	<0.5						<0.5		
Carbophenothion	µg/L	<0.5						<0.5		
Azinphos Methyl	µg/L	<0.5						<0.5		
Organophosphorus Pesticide Surrogate										
DEF	%	62.7						68.9		
Organophosphorus Pesticides										
Dichlorvos	µg/L	<2						<2		
Dimethoate	µg/L	<2						<2		
Diazinon	µg/L	<2						<2		
Chlorpyrifos-methyl	µg/L	<2						<2		
Malathion	µg/L	<2						<2		
Fenthion	µg/L	<2						<2		
Chlorpyrifos	µg/L	<2						<2		
Pirimphos-ethyl	µg/L	<2						<2		
Chlorfenvinphos	µg/L	<2						<2		
Prothiofos	µg/L	<2						<2		
Ethion	µg/L	<2						<2		
OP Pesticides										
Azinphos-methyl	µg/L	<0.02						<0.02		
Azinphos-ethyl	µg/L	<0.02						<0.02		
Bromophos-ethyl	µg/L	<0.10						<0.10		
Carbofenothion	µg/L	<0.02						<0.02		
Chlorfenvinphos	µg/L	<0.02						<0.02		
Chlorpyrifos	µg/L	<0.02						<0.02		
Chlorpyrifos-methyl	µg/L	<0.2						<0.2		
Coumaphos	µg/L	<0.01						<0.01		
Demeton-O & Demeton-S	µg/L	<0.02						<0.02		
Demeton-S-methyl	µg/L	<0.02						<0.02		
Diazinon	µg/L	<0.01						<0.01		
Dichlorvos	µg/L	<0.20						<0.20		
Dimethoate	µg/L	<0.02						<0.02		
Disulfoton	µg/L	<0.05						<0.05		
EPN	µg/L	<0.05						<0.05		
Ethion	µg/L	<0.02						<0.02		
Ethoprophos	µg/L	<0.01						<0.01		
Fenamiphos	µg/L	<0.01						<0.01		
Fenchlorphos (Ronnel)	µg/L	<10						<10		
Fenitrothion	µg/L	<2						<2		
Fensulfothion	µg/L	<0.01						<0.01		
Fenthion	µg/L	<0.05						<0.05		
Malathion	µg/L	<0.02						<0.02		
Mevinphos	µg/L	<0.02						<0.02		
Monocrotophos	µg/L	<0.02						<0.02		
Omethoate	µg/L	<0.01						<0.01		
Parathion	µg/L	<0.2						<0.2		
Parathion-methyl	µg/L	<2.0						<2.0		
Phorate	µg/L	<0.1						<0.1		
Pirimiphos-ethyl	µg/L	<0.01						<0.01		
Pirimiphos-methyl	µg/L	<0.01						<0.01		
Profenofos	µg/L	<0.01						<0.01		
Prothiofos	µg/L	<0.1						<0.1		
Sulfotep	µg/L	<0.005						<0.005		
Sulprofos	µg/L	<0.05						<0.05		
Temephos	µg/L	<0.02						<0.02		
Terbufos	µg/L	<0.01						<0.01		
Tetrachlorvinphos	µg/L	<0.01						<0.01		

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
Triazophos	µg/L	<0.005						<0.005		
Trichlorfon	µg/L	<0.02						<0.02		
Trichloronate	µg/L	<0.5						<0.5		
Miscellaneous (ESI Positive Mode) Pesticides										
Diclofop-methyl	µg/L	<0.05						<0.05		
Fenarimol	µg/L	<0.02						<0.02		
Irgarol	µg/L	<0.002						<0.002		
Oxyfluorfen	µg/L	<1.0						<1.0		
Thiamethoxam	µg/L	<0.02						<0.02		
Acid Extractable Surrogates										
2-Fluorophenol	%	19.4						27.2		
Phenol-d6	%	23.5			27			26.5		
2-Chlorophenol-D4	%	32.3						18		
2.4.6-Tribromophenol	%	39.1			42			25.3		
Base/Neutral Extractable Surrogates										
Nitrobenzene-D5	%	38			56			53.6		
1.2-Dichlorobenzene-D4	%	31						44.2		
2-Fluorobiphenyl	%	36.1			53			61.8		
Anthracene-d10	%	76.7						113		
4-Terphenyl-d14	%	47.9						70.5		
Additional SVOC										
1,2-Diphenylhydrazine	µg/L				< 1					< 1
Surrogate Fluorobiphenyl	%				90					83
Total Petroleum Hydrocarbons										
C6 - C9 Fraction	µg/L	<100	110					<100	330	
C10 - C14 Fraction	µg/L	<50	<50					80	200	
C15 - C28 Fraction	µg/L	270	<100					380	540	
C29 - C36 Fraction	µg/L	240	120					50	100	
C10 - C36 Fraction (sum)	µg/L	510	120					510	840	
Total Recoverable Hydrocarbons - NEPM 2013 Fractions										
C6 - C10 Fraction	µg/L	<100	120					<100	330	
C6 - C10 Fraction minus BTEX (F1)	µg/L	<100	90					<100	320	
>C10 - C16 Fraction	µg/L	<100	<100					120	330	
>C16 - C34 Fraction	µg/L	340	460					430	540	
>C34 - C40 Fraction	µg/L	200	140					<100	<100	
>C10 - C40 Fraction (sum)	µg/L	540	600					550	870	
>C10 - C16 Fraction minus Naphthalene (F2)	µg/L	<100	<100					<100	280	
BTEXN										
Benzene	µg/L	44	23					<5	3	
Toluene	µg/L	10	6					<5	4	
Ethylbenzene	µg/L	<5	<2					<5	<2	
meta- & para-Xylene	µg/L	<5	<2					<5	3	
ortho-Xylene	µg/L	<5	<2					<5	<2	
Total Xylenes	µg/L	<5	<2					<5	3	
Sum of BTEX	µg/L	54	29					<5	10	
Naphthalene	µg/L	5	<5					48	48	
TPH(V)/BTEX Surrogates										
1.2-Dichloroethane-D4	%	111						107		
Toluene-D8	%	114						112		
4-Bromofluorobenzene	%	112						107		
Organotin Compounds (Soluble)										
Tributyltin	ngSn/L	<15						<15		
Organotin Surrogate										
Tripropyltin	%	83.9						67.1		
Nitrogenated Compounds										
Acrylonitrile	µg/L	<1						<1		
Aldehydes										
Formaldehyde	µg/L	168						423		
Acetaldehyde	µg/L	10.1						19		
Propionaldehyde	µg/L	<2.0						<2.0		
Acrolein (Propenal)	µg/L	<2.0						<2.0		
Butyraldehyde	µg/L	<2.0						2.7		
Phenolic Compounds										
Phenol	µg/L	<2			< 3			12		
2-Chlorophenol	µg/L	<2			< 3			<2		
2-Methylphenol	µg/L	<2			< 3			<2		
3- & 4-Methylphenol	µg/L	<4			< 6			8		
2-Nitrophenol	µg/L	<2			< 10			<2		
2.4-Dimethylphenol	µg/L	2			< 3			<2		
2.4-Dichlorophenol	µg/L	<2			< 3			<2		
2.6-Dichlorophenol	µg/L	<2			< 3			<2		
4-Chloro-3-methylphenol	µg/L	<2			< 10			<2		
2.4.6-Trichlorophenol	µg/L	<2			< 10			<2		
2.4.5-Trichlorophenol	µg/L	<2			< 10			<2		
Pentachlorophenol	µg/L	<4			< 10			<4		
1-Chloronaphthalene	µg/L				< 10					
Phenolic Compounds										
2-Chlorophenol	µg/L	<0.05						<0.05		
4-Chloro-3-methylphenol (Para-chloro-meta-cre	µg/L	<0.05						<0.05		
m-Cresol	µg/L	<0.1						21.6		
o-Cresol	µg/L	<0.1						10.4		
p-Cresol	µg/L	<0.1						26		
2.4-Dichlorophenol	µg/L	1.6						0.3		
2.6-Dichlorophenol	µg/L	0.5						0.3		
2.4-Dimethylphenol	µg/L	0.7						4.3		
Hexachlorophene	µg/L	<0.1						<0.1		
2-Nitrophenol	µg/L	<0.1						<0.1		

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
4-Nitrophenol	µg/L	<0.1			< 30			<0.1		
Pentachlorophenol	µg/L	<0.05						0.39		
Phenol	µg/L	<0.1						123		
2.3.4.6-Tetrachlorophenol	µg/L	<0.1			< 20			<0.1		
2.4.5-Trichlorophenol	µg/L	<0.1						0.1		
2.4.6-Trichlorophenol	µg/L	0.3						<0.1		
2-Methyl-4.6-dinitrophenol	µg/L				< 30					
2.4-Dinitrophenol	µg/L				< 30					
Acid Extractable Surrogates										
2-Fluorophenol	%	54.1						34.4		
Phenol-d6	%	58.4						76.8		
2-Chlorophenol-D4	%	58.4						62.6		
2.4.6-Tribromophenol	%	69.8						57		
Base/Neutral Extractable Surrogates										
2-Fluorobiphenyl	%	53.5						93.2		
Anthracene-d10	%	63.6						116		
4-Terphenyl-d14	%	56.8						107		
Phenoxyacetic Acid Herbicides by LCMS										
4-Chlorophenoxy acetic acid	µg/L	<10						<10		
2.4-DB	µg/L	<10						<10		
Dicamba	µg/L	<10						<10		
Mecoprop	µg/L	<10						<10		
MCPA	µg/L	<10						<10		
2.4-DP	µg/L	<10						<10		
2.4-D	µg/L	<10						<10		
Triclopyr	µg/L	<10						<10		
Silvex (2.4.5-TP/Fenoprop)	µg/L	<10						<10		
2.4.5-T	µg/L	<10						<10		
MCPB	µg/L	<10						<10		
Picloram	µg/L	<10						<10		
Clopyralid	µg/L	<10						<10		
Fluroxypyr	µg/L	<10						<10		
2.6-D	µg/L	<10						<10		
2.4.6-T	µg/L	<10						<10		
Phenoxyacetic Acid Herbicide Surrogate										
2.4-Dichlorophenyl Acetic Acid	%	69.9						72.4		
Explosives										
HMX	µg/L	<20						<20		
RDX	µg/L	<20						<20		
1.3.5-Trinitrobenzene	µg/L	<20						<20		
1.3-Dinitrobenzene	µg/L	<20						<20		
Tetryl	µg/L	<20						<20		
2.4.6-TNT	µg/L	<20						<20		
4-Amino.2.6-DNT	µg/L	<20						<20		
2-Amino-4.6-DNT	µg/L	<20						<20		
4-& 2-AM-DNT(Isomeric Mixture)	µg/L	<20						<20		
2.4-Dinitrotoluene	µg/L	<20						<20		
2.6-Dinitrotoluene	µg/L	<20						<20		
2.4-& 2.6-DNT(Isomeric Mixture)	µg/L	<20						<20		
Nitrobenzene	µg/L	<20						<20		
2-Nitrotoluene	µg/L	<20						<20		
3-Nitrotoluene	µg/L	<20						<20		
4-Nitrotoluene	µg/L	<20						<20		
Nitroglycerine	µg/L	<200						<200		
PETN	µg/L	<200						<200		
Explosives Surrogate										
o-Dinitrobenzene	%	114						97.2		
Perfluorinated Compounds										
PFOS	µg/L	<0.05						<0.05		
PFOA	µg/L	<0.05						<0.05		
6:2 Fluorotelomer sulfonate (6:2 FtS)	µg/L	<0.5						<0.5		
8:2 Fluorotelomer sulfonate	µg/L	<0.5						<0.5		
PFOSA	µg/L	<0.10						<0.10		
N-Me-FOSA	µg/L	<0.5						<0.5		
N-Et-FOSA	µg/L	<0.10						<0.10		
N-Me-FOSE	µg/L	<0.5						<0.5		
N-Et-FOSE	µg/L	<0.5						<0.5		
PFBS	µg/L	<0.10						<0.10		
PFHxS	µg/L	<0.10						<0.10		
PFDcS	µg/L	<0.10						<0.10		
PFHxA	µg/L	<0.10						<0.10		
PFHpA	µg/L	<0.10						<0.10		
PFNA	µg/L	<0.10						<0.10		
PFDcA	µg/L	<0.10						<0.10		
PFUnA	µg/L	<0.10						<0.10		
PFDoA	µg/L	<0.10						<0.10		
PFTriA	µg/L	<0.10						<0.10		
PFTeA	µg/L	<0.5						<0.5		
Thiocarbamates and Carbamates										
Aldicarb	µg/L	<0.05						<0.05		
Bendiocarb	µg/L	<0.10						<0.10		
Benomyl	µg/L	<0.01						<0.01		
Carbaryl	µg/L	<0.01						<0.01		
Carbofuran	µg/L	<0.01						<0.01		
3-Hydroxy Carbofuran	µg/L	<0.02						<0.02		
Methiocarb	µg/L	<0.01						<0.01		
Methomyl	µg/L	<0.01						<0.01		
Molinate	µg/L	<0.1						<0.1		

Capped Waste Stockpile - Leachate Sample Water Quality

Sample ID		MW202 (Waste Level)				MW203 (Natural Ground)	MW204 (Natural Ground)	MW206 (Natural Ground)		
Sample date		11/11/2015	11/11/2015	9/12/2015		11/11/2015	11/11/2015	11/11/2015	11/11/2015	9/12/2015
Laboratory		ALS	per Environ	ALS	Eurofins	per Environ	per Environ	ALS	per Environ	Eurofins
Oxamyl	µg/L	<0.01						<0.01		
Thiobencarb	µg/L	<0.01						<0.01		
Thiodicarb	µg/L	<0.01						<0.01		
Dinitroanilines										
Pendimethalin	µg/L	<0.05						<0.05		
Trifluralin	µg/L	<10.0			< 10			<10.0		
Triazinone Herbicides										
Hexazinone	µg/L	<0.02						<0.02		
Metribuzin	µg/L	<0.02						<0.02		
Conazole and Aminopyrimidine Fungicides										
Cyproconazole	µg/L	<0.02						<0.02		
Difenoconazole	µg/L	<0.02						<0.02		
Flusilazole	µg/L	<0.02						<0.02		
Hexaconazole	µg/L	<0.02						<0.02		
Paclobutrazole	µg/L	<0.05						<0.05		
Penconazole	µg/L	<0.01						<0.01		
Propiconazole	µg/L	<0.05						<0.05		
Tebuconazole	µg/L	<0.01						<0.01		
Cyprodinil	µg/L	<0.01						<0.01		
Pyrimethanil	µg/L	<0.02						<0.02		
Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides										
Diuron	µg/L	<0.02						<0.02		
Fluometuron	µg/L	<0.01						<0.01		
Tebuthiuron	µg/L	<0.02						<0.02		
Bromacil	µg/L	<0.02						<0.02		
Chlorsulfuron	µg/L	<0.2						<0.2		
Chloracetanilides										
Metolachlor	µg/L	<0.01						<0.01		
Triazine Herbicides										
Ametryn	µg/L	<0.01						<0.01		
Atrazine	µg/L	<0.01						<0.01		
Cyanazine	µg/L	<0.02						<0.02		
Cyromazine	µg/L	<0.05						<0.05		
Prometryn	µg/L	<0.01						<0.01		
Propazine	µg/L	<0.01						<0.01		
Simazine	µg/L	<0.02						<0.02		
Terbuthylazine	µg/L	<0.01						<0.01		
Terbutryn	µg/L	<0.01						<0.01		
Organic Mercaptans										
Methyl Mercaptan	mg/L				<0.05					
Ethyl Mercaptan	mg/L				<0.05					
Isobutyl Mercaptan	mg/L				<0.05					
Propyl Mercaptan	mg/L				<0.05					
Butyl Mercaptan	mg/L				<0.05					

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1535966**	Page	: 1 of 23
Amendment	: **1**		
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR DAVE BARRETT	Contact	:
Address	: PO BOX 5403 NEWCASTLE WEST NSW, AUSTRALIA 2302	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: dave.barrett@ghd.com.au	E-mail	:
Telephone	: +61 07 4972 6377	Telephone	: +61-2-8784 8555
Facsimile	: +61 07 4972 6236	Facsimile	: +61-2-8784 8500
Project	: LEACHATE ASSESSMENT	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: 2218015	Date Samples Received	: 11-Nov-2015 16:00
C-O-C number	: ----	Date Analysis Commenced	: 11-Nov-2015
Sampler	: JESSE SIMKUS	Issue Date	: 04-Dec-2015 12:19
Site	: ----		
		No. of samples received	: 2
Quote number	: ----	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Dian Dao		Sydney Inorganics
Dianne Blane	Laboratory Coordinator (2IC)	Newcastle - Inorganics
Matt Frost	Senior Organic Chemist	Brisbane Organics
Pabi Subba	Senior Organic Chemist	Sydney Organics
Phalak Inthakesone	Laboratory Manager - Organics	Sydney Organics
Titus Vimalasiri	Senior Scientist	Radionuclides

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- EG020: Bromine & Iodine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.
- EG020: Sample ES1535966-001 was diluted and rerun due to matrix interference and LOR's have been raised accordingly. (High Total Dissolved Solids)
- EG020:It is recognised that total concentration is less than dissolved for some metal analytes. However, the difference is within experimental variation of the methods.
- EP202: Poor matrix spike recoveries for Clopyralid due to matrix effects.
- Sampling time not provided. For operational reasons an assumed date/time (3pm on date of receipt) is used. Sample results may be affected if the analysis falls outside of actual holding time.
- Gross Alpha and Beta Activity analyses are performed by ALS Fyshwick (NATA Accreditation number 992).
- EK085: LOR has been raised for sample ID MW202 for sulphide due to sample matrix interference.
- EG050G-F: LOR raised for Hexavalent Chromium analysis on a few samples due to matrix interferences.
- EK087 : LOR was raised for Thiosulfate due to sample matrix.
- EK010 : LOR was raised for Chlorine due to sample matrix.
- EP010 : LOR was raised for Formaldehyde due to sample matrix.
- EP121: Poor matrix spike recovery due to sample matrix effects. This has been confirmed by re-analysis.
- EK028SF:LOR raised for Weak Acid Dissociable Cyanide analysis on sample ID(MW206) due to sample matrix.
- LOR for gross alpha and beta raised due to the high amount of solid present.
- EP231: Particular samples required dilution due to matrix interferences. LOR values have been adjusted accordingly.
- EP090S: Samples 'MW206' and 'MW202' required dilution prior to extraction due to matrix interferences. LOR values have been adjusted accordingly.
- EP050: The MBAS reported is calculated as LAS, mol wt 342.
- EP074/80: Particular samples required dilution due to sample matrix . LOR values have been adjusted accordingly.
- Total PAH reported as the sum of Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene and Benzo(g,h,i)perylene.
- EP075: 'Sum of PAH' is the sum of the USEPA 16 priority PAHs
- EA250 LSC : LOR for Gross Alpha and Beta raised due to high solid content
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.
- PFOS and PFOA results are reported as an aggregate of linear and branched isomers.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EA005: pH													
pH Value	----	0.01	pH Unit	10.8		----		----		----		----	
EA010P: Conductivity by PC Titrator													
Electrical Conductivity @ 25°C	----	1	µS/cm	48400		----		----		----		----	
EA017: TDS (Calc)													
Total Dissolved Solids (Calc.)	----	1	mg/L	44800		----		----		----		----	
EA025: Total Suspended Solids dried at 104 ± 2°C													
Suspended Solids (SS)	----	5	mg/L	375		----		----		----		----	
EA030: Total Solids dried at 104 ± 2°C													
Total Solids	----	10	mg/L	58000		----		----		----		----	
EA036: Fixed/Volatile Suspended Solids													
Volatile Suspended Solids @ 550°C	----	5	mg/L	50		----		----		----		----	
Fixed Suspended Solids @ 550 C (Fraction of Suspended S)	----	0.1	%	87		----		----		----		----	
Volatile Suspended Solids @ 550 C (Fraction of Suspended S)	----	0.1	%	13		----		----		----		----	
EA040: Colour (Apparent)													
Colour (Apparent)	----	1	PCU	5000		----		----		----		----	
pH Colour	----	0.01	pH Unit	11.1		----		----		----		----	
EA041: Colour (True)													
Colour (True)	----	1	PCU	4500		----		----		----		----	
pH Colour	----	0.01	pH Unit	11.1		----		----		----		----	
EA250: Gross Alpha and Beta Activity													
Gross alpha	----	0.05	Bq/L	<0.74	--	<0.42	--	----		----		----	
Gross beta activity - 40K	----	0.1	Bq/L	<1.47	--	<0.83	--	----		----		----	
ED037P: Alkalinity by PC Titrator													
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1		----		----		----		----	
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	26200		----		----		----		----	
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	1210		----		----		----		----	
Total Alkalinity as CaCO3	----	1	mg/L	27400		----		----		----		----	
ED040F: Dissolved Major Anions													
Silicon as SiO2	14464-46-1	0.1	mg/L	47.5		----		----		----		----	
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA													
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	7660		----		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
ED045G: Chloride by Discrete Analyser													
Chloride	16887-00-6	1	mg/L	**564**		----		----		----		----	
ED093F: Dissolved Major Cations													
Calcium	7440-70-2	1	mg/L	**2**		----		----		----		----	
Magnesium	7439-95-4	1	mg/L	<1		----		----		----		----	
Sodium	7440-23-5	1	mg/L	**20100**		----		----		----		----	
Potassium	7440-09-7	1	mg/L	**93**		----		----		----		----	
ED093F: SAR and Hardness Calculations													
Sodium Adsorption Ratio	----	0.01	-	**3910**		----		----		----		----	
EG020F: Dissolved Metals by ICP-MS													
Aluminium	7429-90-5	0.01	mg/L	**7.76**		----		----		----		----	
Antimony	7440-36-0	0.001	mg/L	<0.010		----		----		----		----	
Arsenic	7440-38-2	0.001	mg/L	**0.509**		----		----		----		----	
Boron	7440-42-8	0.05	mg/L	**3.51**		----		----		----		----	
Barium	7440-39-3	0.001	mg/L	**0.034**		----		----		----		----	
Beryllium	7440-41-7	0.001	mg/L	<0.010		----		----		----		----	
Cadmium	7440-43-9	0.0001	mg/L	<0.0010		----		----		----		----	
Cobalt	7440-48-4	0.001	mg/L	**0.238**		----		----		----		----	
Chromium	7440-47-3	0.001	mg/L	**0.060**		----		----		----		----	
Copper	7440-50-8	0.001	mg/L	<0.010		----		----		----		----	
Manganese	7439-96-5	0.001	mg/L	**0.020**		----		----		----		----	
Nickel	7440-02-0	0.001	mg/L	**0.115**		----		----		----		----	
Lead	7439-92-1	0.001	mg/L	<0.010		----		----		----		----	
Selenium	7782-49-2	0.01	mg/L	<0.10		----		----		----		----	
Vanadium	7440-62-2	0.01	mg/L	**0.25**		----		----		----		----	
Zinc	7440-66-6	0.005	mg/L	<0.050		----		----		----		----	
Lithium	7439-93-2	0.001	mg/L	<0.010		----		----		----		----	
Molybdenum	7439-98-7	0.001	mg/L	**1.14**		----		----		----		----	
Silver	7440-22-4	0.001	mg/L	<0.010		----		----		----		----	
Strontium	7440-24-6	0.001	mg/L	**0.038**		----		----		----		----	
Thallium	7440-28-0	0.001	mg/L	<0.010		----		----		----		----	
Tin	7440-31-5	0.001	mg/L	**0.012**		----		----		----		----	
Titanium	7440-32-6	0.01	mg/L	<0.10		----		----		----		----	
Iron	7439-89-6	0.05	mg/L	**30.3**		----		----		----		----	
Bromine	7726-95-6	0.1	mg/L	**4.7**		----		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EG020F: Dissolved Metals by ICP-MS - Continued													
Iodine	7553-56-2	0.1	mg/L	**2.9**		----		----		----		----	
EG020T: Total Metals by ICP-MS													
Aluminium	7429-90-5	0.01	mg/L	**7.01**		----		----		----		----	
Antimony	7440-36-0	0.001	mg/L	<0.010		----		----		----		----	
Arsenic	7440-38-2	0.001	mg/L	**0.428**		----		----		----		----	
Boron	7440-42-8	0.05	mg/L	**3.87**		----		----		----		----	
Barium	7440-39-3	0.001	mg/L	**0.043**		----		----		----		----	
Beryllium	7440-41-7	0.001	mg/L	<0.010		----		----		----		----	
Cadmium	7440-43-9	0.0001	mg/L	<0.0010		----		----		----		----	
Cobalt	7440-48-4	0.001	mg/L	**0.263**		----		----		----		----	
Chromium	7440-47-3	0.001	mg/L	**0.057**		----		----		----		----	
Copper	7440-50-8	0.001	mg/L	<0.010		----		----		----		----	
Manganese	7439-96-5	0.001	mg/L	**0.021**		----		----		----		----	
Nickel	7440-02-0	0.001	mg/L	**0.146**		----		----		----		----	
Lead	7439-92-1	0.001	mg/L	<0.010		----		----		----		----	
Selenium	7782-49-2	0.01	mg/L	<0.10		----		----		----		----	
Vanadium	7440-62-2	0.01	mg/L	**0.39**		----		----		----		----	
Zinc	7440-66-6	0.005	mg/L	<0.052		----		----		----		----	
Lithium	7439-93-2	0.001	mg/L	<0.010		----		----		----		----	
Molybdenum	7439-98-7	0.001	mg/L	**1.46**		----		----		----		----	
Silver	7440-22-4	0.001	mg/L	<0.010		----		----		----		----	
Strontium	7440-24-6	0.001	mg/L	**0.042**		----		----		----		----	
Thallium	7440-28-0	0.001	mg/L	<0.010		----		----		----		----	
Tin	7440-31-5	0.001	mg/L	**0.023**		----		----		----		----	
Titanium	7440-32-6	0.01	mg/L	<0.10		----		----		----		----	
Iron	7439-89-6	0.05	mg/L	**44.3**		----		----		----		----	
EG020U: Unfiltered Metals by ICP-MS													
Bromine	7726-95-6	0.05	mg/L	**4.19**		----		----		----		----	
Iodine	7553-56-2	0.05	mg/L	**2.56**		----		----		----		----	
EG032: Arsenic Speciation by LC-ICPMS													
Arsenious Acid, As (III)	----	0.5	µg/L	<0.5		<0.5		----		----		----	
Arsenic Acid, As (V)	----	0.5	µg/L	**310**		**72.0**		----		----		----	
EG035F: Dissolved Mercury by FIMS													
Mercury	7439-97-6	0.0001	mg/L	<0.0001		----		----		----		----	

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	MW206 Result	MW206 MU	MW202 Result	MW202 MU	---- Result	---- MU	---- Result	---- MU	---- Result	---- MU
Client sampling date / time				[11-Nov-2015]		[11-Nov-2015]		----		----		----	
				ES1535966-001		ES1535966-002		--------		--------		--------	
EG035T: Total Recoverable Mercury by FIMS													
Mercury	7439-97-6	0.0001	mg/L	<0.0001		----		----		----		----	
EG050F: Dissolved Hexavalent Chromium													
Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.50		<0.50		----		----		----	
EK010/011: Chlorine													
Chlorine - Free	----	0.2	mg/L	<1.0		----		----		----		----	
Chlorine - Total Residual	----	0.2	mg/L	<1.0		----		----		----		----	
EK026SF: Total CN by Segmented Flow Analyser													
Total Cyanide	57-12-5	0.004	mg/L	**205**		----		----		----		----	
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser													
Weak Acid Dissociable Cyanide	----	0.004	mg/L	<0.400		----		----		----		----	
EK040P: Fluoride by PC Titrator													
Fluoride	16984-48-8	0.1	mg/L	**1700**		----		----		----		----	
EK055G: Ammonia as N by Discrete Analyser													
Ammonia as N	7664-41-7	0.01	mg/L	**529**		----		----		----		----	
EK057G: Nitrite as N by Discrete Analyser													
Nitrite as N	14797-65-0	0.01	mg/L	<0.01		----		----		----		----	
EK058G: Nitrate as N by Discrete Analyser													
Nitrate as N	14797-55-8	0.01	mg/L	**0.55**		----		----		----		----	
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser													
Nitrite + Nitrate as N	----	0.01	mg/L	**0.55**		----		----		----		----	
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser													
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**593**		----		----		----		----	
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser													
^ **Total Nitrogen as N**	----	0.1	mg/L	**594**		----		----		----		----	
EK067G: Total Phosphorus as P by Discrete Analyser													
Total Phosphorus as P	----	0.01	mg/L	**8.60**		----		----		----		----	
EK071G: Reactive Phosphorus as P by discrete analyser													
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**3.91**		----		----		----		----	
EK085M: Sulfide as S2-													
Sulfide as S2-	18496-25-8	0.1	mg/L	**1.5**		<1.0		----		----		----	
EK086: Sulfite as SO3 2-													
Sulfite as SO3 2-	14265-45-3	2	mg/L	<2		<2		----		----		----	
EK087: Thiosulfate as S2O3 2-													

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EK087: Thiosulfate as S2O3 2- - Continued													
Thiosulfate as S2O3 2-	----	2	mg/L	<20		<20		----		----		----	
EN055: Ionic Balance													
Total Anions	----	0.01	meq/L	**723**		----		----		----		----	
Total Cations	----	0.01	meq/L	**877**		----		----		----		----	
Ionic Balance	----	0.01	%	**9.56**		----		----		----		----	
EP005: Total Organic Carbon (TOC)													
Total Organic Carbon	----	1	mg/L	**1890**		**2570**		----		----		----	
EP010: Formaldehyde													
Formaldehyde	50-00-0	0.1	mg/L	<0.5		----		----		----		----	
EP020: Oil and Grease (O&G)													
Oil & Grease	----	5	mg/L	**6**		**13**		----		----		----	
EP026SP: Chemical Oxygen Demand (Spectrophotometric)													
Chemical Oxygen Demand	----	10	mg/L	**1700**		----		----		----		----	
EP041A: Nonionic Surfactants													
Nonionic Surfactants as CTAS	----	5	mg/L	<5		----		----		----		----	
EP050: Anionic Surfactants as MBAS													
Anionic Surfactants as MBAS	----	0.1	mg/L	**0.1**		----		----		----		----	
EP066: Polychlorinated Biphenyls (PCB)													
Aroclor 1016	12674-11-2	1	µg/L	<1		<1		----		----		----	
Aroclor 1221	11104-28-2	1	µg/L	<1		<1		----		----		----	
Aroclor 1232	11141-16-5	1	µg/L	<1		<1		----		----		----	
Aroclor 1242	53469-21-9	1	µg/L	<1		<1		----		----		----	
Aroclor 1248	12672-29-6	1	µg/L	<1		<1		----		----		----	
Aroclor 1254	11097-69-1	1	µg/L	<1		<1		----		----		----	
Aroclor 1260	11096-82-5	1	µg/L	<1		<1		----		----		----	
Aroclor 1262	37324-23-5	1	µg/L	<1		<1		----		----		----	
Total Polychlorinated biphenyls	----	1	µg/L	<1		<1		----		----		----	
EP068A: Organochlorine Pesticides (OC)													
alpha-BHC	319-84-6	0.5	µg/L	<0.5		<0.5		----		----		----	
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5		<0.5		----		----		----	
beta-BHC	319-85-7	0.5	µg/L	<0.5		<0.5		----		----		----	
gamma-BHC	58-89-9	0.5	µg/L	<0.5		<0.5		----		----		----	
delta-BHC	319-86-8	0.5	µg/L	<0.5		<0.5		----		----		----	
Heptachlor	76-44-8	0.5	µg/L	<0.5		<0.5		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP068A: Organochlorine Pesticides (OC) - Continued													
Aldrin	309-00-2	0.5	µg/L	<0.5		<0.5		----		----		----	
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5		<0.5		----		----		----	
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5		<0.5		----		----		----	
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5		<0.5		----		----		----	
cis-Chlordane	5103-71-9	0.5	µg/L	<0.5		<0.5		----		----		----	
Dieldrin	60-57-1	0.5	µg/L	<0.5		<0.5		----		----		----	
4.4`-DDE	72-55-9	0.5	µg/L	<0.5		<0.5		----		----		----	
Endrin	72-20-8	0.5	µg/L	<0.5		<0.5		----		----		----	
beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5		<0.5		----		----		----	
4.4`-DDD	72-54-8	0.5	µg/L	<0.5		<0.5		----		----		----	
Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5		<0.5		----		----		----	
Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5		<0.5		----		----		----	
4.4`-DDT	50-29-3	2	µg/L	<2.0		<2.0		----		----		----	
Endrin ketone	53494-70-5	0.5	µg/L	<0.5		<0.5		----		----		----	
Methoxychlor	72-43-5	2	µg/L	<2.0		<2.0		----		----		----	
^ Total Chlordane (sum)	----	0.5	µg/L	<0.5		<0.5		----		----		----	
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L	<0.5		<0.5		----		----		----	
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L	<0.5		<0.5		----		----		----	
EP068B: Organophosphorus Pesticides (OP)													
Dichlorvos	62-73-7	0.5	µg/L	<0.5		<0.5		----		----		----	
Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5		<0.5		----		----		----	
Monocrotophos	6923-22-4	2	µg/L	<2.0		<2.0		----		----		----	
Dimethoate	60-51-5	0.5	µg/L	<0.5		<0.5		----		----		----	
Diazinon	333-41-5	0.5	µg/L	<0.5		<0.5		----		----		----	
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5		<0.5		----		----		----	
Parathion-methyl	298-00-0	2	µg/L	<2.0		<2.0		----		----		----	
Malathion	121-75-5	0.5	µg/L	<0.5		<0.5		----		----		----	
Fenthion	55-38-9	0.5	µg/L	<0.5		<0.5		----		----		----	
Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5		<0.5		----		----		----	
Parathion	56-38-2	2	µg/L	<2.0		<2.0		----		----		----	
Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5		<0.5		----		----		----	
Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5		<0.5		----		----		----	
Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5		<0.5		----		----		----	
Fenamiphos	22224-92-6	0.5	µg/L	<0.5		<0.5		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP068B: Organophosphorus Pesticides (OP) - Continued													
Prothiofos	34643-46-4	0.5	µg/L	<0.5		<0.5		----		----		----	
Ethion	563-12-2	0.5	µg/L	<0.5		<0.5		----		----		----	
Carbophenothion	786-19-6	0.5	µg/L	<0.5		<0.5		----		----		----	
Azinphos Methyl	86-50-0	0.5	µg/L	<0.5		<0.5		----		----		----	
EP074A: Monocyclic Aromatic Hydrocarbons													
Benzene	71-43-2	1	µg/L	<5		**42**		----		----		----	
Toluene	108-88-3	2	µg/L	**5**		**11**		----		----		----	
Ethylbenzene	100-41-4	2	µg/L	<5		<5		----		----		----	
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<10		<10		----		----		----	
Styrene	100-42-5	5	µg/L	<5		<5		----		----		----	
ortho-Xylene	95-47-6	2	µg/L	<5		<5		----		----		----	
Isopropylbenzene	98-82-8	5	µg/L	<5		<5		----		----		----	
n-Propylbenzene	103-65-1	5	µg/L	<5		<5		----		----		----	
1.3.5-Trimethylbenzene	108-67-8	5	µg/L	<5		<5		----		----		----	
sec-Butylbenzene	135-98-8	5	µg/L	<5		<5		----		----		----	
1.2.4-Trimethylbenzene	95-63-6	5	µg/L	<5		<5		----		----		----	
tert-Butylbenzene	98-06-6	5	µg/L	<5		<5		----		----		----	
p-Isopropyltoluene	99-87-6	5	µg/L	<5		<5		----		----		----	
n-Butylbenzene	104-51-8	5	µg/L	<5		<5		----		----		----	
EP074B: Oxygenated Compounds													
2-Propanone (Acetone)	67-64-1	50	µg/L	**340**		<50		----		----		----	
Vinyl Acetate	108-05-4	50	µg/L	<50		<50		----		----		----	
2-Butanone (MEK)	78-93-3	50	µg/L	<50		<50		----		----		----	
4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L	<50		<50		----		----		----	
2-Hexanone (MBK)	591-78-6	50	µg/L	<50		<50		----		----		----	
EP074C: Sulfonated Compounds													
Carbon disulfide	75-15-0	5	µg/L	<5		<5		----		----		----	
EP074D: Fumigants													
2.2-Dichloropropane	594-20-7	5	µg/L	<5		<5		----		----		----	
1.2-Dichloropropane	78-87-5	5	µg/L	<5		<5		----		----		----	
cis-1.3-Dichloropropylene	10061-01-5	5	µg/L	<5		<5		----		----		----	
trans-1.3-Dichloropropylene	10061-02-6	5	µg/L	<5		<5		----		----		----	
1.2-Dibromoethane (EDB)	106-93-4	5	µg/L	<5		<5		----		----		----	
EP074E: Halogenated Aliphatic Compounds													

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP074E: Halogenated Aliphatic Compounds - Continued													
Dichlorodifluoromethane	75-71-8	50	µg/L	<50		<50		----		----		----	
Chloromethane	74-87-3	50	µg/L	<50		<50		----		----		----	
Vinyl chloride	75-01-4	50	µg/L	<50		<50		----		----		----	
Bromomethane	74-83-9	50	µg/L	<50		<50		----		----		----	
Chloroethane	75-00-3	50	µg/L	<50		<50		----		----		----	
Trichlorofluoromethane	75-69-4	50	µg/L	<50		<50		----		----		----	
1.1-Dichloroethene	75-35-4	5	µg/L	<5		<5		----		----		----	
Iodomethane	74-88-4	5	µg/L	<5		<5		----		----		----	
Methylene chloride	75-09-2	5	µg/L	<5		<5		----		----		----	
trans-1.2-Dichloroethene	156-60-5	5	µg/L	<5		<5		----		----		----	
1.1-Dichloroethane	75-34-3	5	µg/L	<5		<5		----		----		----	
cis-1.2-Dichloroethene	156-59-2	5	µg/L	<5		<5		----		----		----	
1.1.1-Trichloroethane	71-55-6	5	µg/L	<5		<5		----		----		----	
1.1-Dichloropropylene	563-58-6	5	µg/L	<5		<5		----		----		----	
Carbon Tetrachloride	56-23-5	5	µg/L	<5		<5		----		----		----	
1.2-Dichloroethane	107-06-2	5	µg/L	<5		<5		----		----		----	
Trichloroethene	79-01-6	5	µg/L	<5		<5		----		----		----	
Dibromomethane	74-95-3	5	µg/L	<5		<5		----		----		----	
1.1.2-Trichloroethane	79-00-5	5	µg/L	<5		<5		----		----		----	
1.3-Dichloropropane	142-28-9	5	µg/L	<5		<5		----		----		----	
Tetrachloroethene	127-18-4	5	µg/L	<5		<5		----		----		----	
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L	<5		<5		----		----		----	
trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L	<5		<5		----		----		----	
cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L	<5		<5		----		----		----	
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L	<5		<5		----		----		----	
1.2.3-Trichloropropane	96-18-4	5	µg/L	<5		<5		----		----		----	
Pentachloroethane	76-01-7	5	µg/L	<5		<5		----		----		----	
1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L	<5		<5		----		----		----	
Hexachlorobutadiene	87-68-3	5	µg/L	<5		<5		----		----		----	
EP074F: Halogenated Aromatic Compounds													
Chlorobenzene	108-90-7	5	µg/L	<5		<5		----		----		----	
Bromobenzene	108-86-1	5	µg/L	<5		<5		----		----		----	
2-Chlorotoluene	95-49-8	5	µg/L	<5		<5		----		----		----	
4-Chlorotoluene	106-43-4	5	µg/L	<5		<5		----		----		----	
1.3-Dichlorobenzene	541-73-1	5	µg/L	<5		<5		----		----		----	

Analytical Results

Sub-Matrix: WATER
(Matrix: WATER)

Compound	CAS Number	LOR	Unit	MW206 Result	MW206 MU	MW202 Result	MW202 MU	---- Result	---- MU	---- Result	---- MU	---- Result	---- MU
Client sampling date / time				[11-Nov-2015]		[11-Nov-2015]		----		----		----	
				ES1535966-001		ES1535966-002		--------		--------		--------	
EP074F: Halogenated Aromatic Compounds - Continued													
1.4-Dichlorobenzene	106-46-7	5	µg/L	<5		<5		----		----		----	
1.2-Dichlorobenzene	95-50-1	5	µg/L	<5		<5		----		----		----	
1.2.4-Trichlorobenzene	120-82-1	5	µg/L	<5		<5		----		----		----	
1.2.3-Trichlorobenzene	87-61-6	5	µg/L	<5		<5		----		----		----	
EP074G: Trihalomethanes													
Chloroform	67-66-3	5	µg/L	**8**		**19**		----		----		----	
Bromodichloromethane	75-27-4	5	µg/L	<5		<5		----		----		----	
Dibromochloromethane	124-48-1	5	µg/L	<5		<5		----		----		----	
Bromoform	75-25-2	5	µg/L	<5		<5		----		----		----	
EP075A: Phenolic Compounds													
Phenol	108-95-2	2	µg/L	**12**		<2		----		----		----	
2-Chlorophenol	95-57-8	2	µg/L	<2		<2		----		----		----	
2-Methylphenol	95-48-7	2	µg/L	<2		<2		----		----		----	
3- & 4-Methylphenol	1319-77-3	4	µg/L	**8**		<4		----		----		----	
2-Nitrophenol	88-75-5	2	µg/L	<2		<2		----		----		----	
2.4-Dimethylphenol	105-67-9	2	µg/L	<2		**2**		----		----		----	
2.4-Dichlorophenol	120-83-2	2	µg/L	<2		<2		----		----		----	
2.6-Dichlorophenol	87-65-0	2	µg/L	<2		<2		----		----		----	
4-Chloro-3-methylphenol	59-50-7	2	µg/L	<2		<2		----		----		----	
2.4.6-Trichlorophenol	88-06-2	2	µg/L	<2		<2		----		----		----	
2.4.5-Trichlorophenol	95-95-4	2	µg/L	<2		<2		----		----		----	
Pentachlorophenol	87-86-5	4	µg/L	<4		<4		----		----		----	
EP075B: Polynuclear Aromatic Hydrocarbons													
Naphthalene	91-20-3	2	µg/L	**9**		<2		----		----		----	
2-Methylnaphthalene	91-57-6	2	µg/L	<2		<2		----		----		----	
2-Chloronaphthalene	91-58-7	2	µg/L	<2		<2		----		----		----	
Acenaphthylene	208-96-8	2	µg/L	<2		<2		----		----		----	
Acenaphthene	83-32-9	2	µg/L	<2		<2		----		----		----	
Fluorene	86-73-7	2	µg/L	<2		<2		----		----		----	
Phenanthrene	85-01-8	2	µg/L	**3**		<2		----		----		----	
Anthracene	120-12-7	2	µg/L	<2		<2		----		----		----	
Fluoranthene	206-44-0	2	µg/L	**8**		<2		----		----		----	
Pyrene	129-00-0	2	µg/L	**7**		<2		----		----		----	
N-2-Fluorenyl Acetamide	53-96-3	2	µg/L	<2		<2		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP075B: Polynuclear Aromatic Hydrocarbons - Continued													
Benz(a)anthracene	56-55-3	2	µg/L	**7**		<2		----		----		----	
Chrysene	218-01-9	2	µg/L	**7**		<2		----		----		----	
Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	4	µg/L	**17**		<4		----		----		----	
7.12-Dimethylbenz(a)anthracene	57-97-6	2	µg/L	<2		<2		----		----		----	
Benzo(a)pyrene	50-32-8	2	µg/L	**10**		<2		----		----		----	
3-Methylcholanthrene	56-49-5	2	µg/L	<2		<2		----		----		----	
Indeno(1.2.3.cd)pyrene	193-39-5	2	µg/L	**5**		<2		----		----		----	
Dibenz(a.h)anthracene	53-70-3	2	µg/L	<2		<2		----		----		----	
Benzo(g.h.i)perylene	191-24-2	2	µg/L	**6**		<2		----		----		----	
^ Sum of PAHs	----	2	µg/L	**79**		<2		----		----		----	
^ Benzo(a)pyrene TEQ (zero)	----	2	µg/L	**13**		<2		----		----		----	
EP075C: Phthalate Esters													
Dimethyl phthalate	131-11-3	2	µg/L	<2		<2		----		----		----	
Diethyl phthalate	84-66-2	2	µg/L	<2		<2		----		----		----	
Di-n-butyl phthalate	84-74-2	2	µg/L	<2		<2		----		----		----	
Butyl benzyl phthalate	85-68-7	2	µg/L	<2		<2		----		----		----	
bis(2-ethylhexyl) phthalate	117-81-7	10	µg/L	<10		<10		----		----		----	
Di-n-octylphthalate	117-84-0	2	µg/L	<2		<2		----		----		----	
EP075D: Nitrosamines													
N-Nitrosomethylethylamine	10595-95-6	2	µg/L	<2		<2		----		----		----	
N-Nitrosodiethylamine	55-18-5	2	µg/L	<2		<2		----		----		----	
N-Nitrosopyrrolidine	930-55-2	4	µg/L	<4		<4		----		----		----	
N-Nitrosomorpholine	59-89-2	2	µg/L	<2		<2		----		----		----	
N-Nitrosodi-n-propylamine	621-64-7	2	µg/L	<2		<2		----		----		----	
N-Nitrosopiperidine	100-75-4	2	µg/L	<2		<2		----		----		----	
N-Nitrosodibutylamine	924-16-3	2	µg/L	<2		<2		----		----		----	
N-Nitrosodiphenyl & Diphenylamine	86-30-6 122-39-4	4	µg/L	<4		<4		----		----		----	
Methapyrilene	91-80-5	2	µg/L	<2		<2		----		----		----	
EP075E: Nitroaromatics and Ketones													
2-Picoline	109-06-8	2	µg/L	<2		<2		----		----		----	
Acetophenone	98-86-2	2	µg/L	<2		<2		----		----		----	
Nitrobenzene	98-95-3	2	µg/L	<2		<2		----		----		----	
Isophorone	78-59-1	2	µg/L	<2		<2		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Compound	CAS Number	LOR	Unit	MW206 Result	MW206 MU	MW202 Result	MW202 MU	---- Result	---- MU	---- Result	---- MU	---- Result	---- MU
Client sampling date / time				[11-Nov-2015]		[11-Nov-2015]		----		----		----	
				ES1535966-001		ES1535966-002		--------		--------		--------	
EP075E: Nitroaromatics and Ketones - Continued													
2.6-Dinitrotoluene	606-20-2	4	µg/L	<4		<4		----		----		----	
2.4-Dinitrotoluene	121-14-2	4	µg/L	<4		<4		----		----		----	
1-Naphthylamine	134-32-7	2	µg/L	<2		<2		----		----		----	
4-Nitroquinoline-N-oxide	56-57-5	2	µg/L	<2		<2		----		----		----	
5-Nitro-o-toluidine	99-55-8	2	µg/L	<2		<2		----		----		----	
Azobenzene	103-33-3	2	µg/L	<2		<2		----		----		----	
1.3.5-Trinitrobenzene	99-35-4	2	µg/L	<2		<2		----		----		----	
Phenacetin	62-44-2	2	µg/L	<2		<2		----		----		----	
4-Aminobiphenyl	92-67-1	2	µg/L	<2		<2		----		----		----	
Pentachloronitrobenzene	82-68-8	2	µg/L	<2		<2		----		----		----	
Pronamide	23950-58-5	2	µg/L	<2		<2		----		----		----	
Dimethylaminoazobenzene	60-11-7	2	µg/L	<2		<2		----		----		----	
Chlorobenzilate	510-15-6	2	µg/L	<2		<2		----		----		----	
EP075F: Haloethers													
Bis(2-chloroethyl) ether	111-44-4	2	µg/L	<2		<2		----		----		----	
Bis(2-chloroethoxy) methane	111-91-1	2	µg/L	<2		<2		----		----		----	
4-Chlorophenyl phenyl ether	7005-72-3	2	µg/L	<2		<2		----		----		----	
4-Bromophenyl phenyl ether	101-55-3	2	µg/L	<2		<2		----		----		----	
EP075G: Chlorinated Hydrocarbons													
1.3-Dichlorobenzene	541-73-1	2	µg/L	<2		<2		----		----		----	
1.4-Dichlorobenzene	106-46-7	2	µg/L	<2		<2		----		----		----	
1.2-Dichlorobenzene	95-50-1	2	µg/L	<2		<2		----		----		----	
Hexachloroethane	67-72-1	2	µg/L	<2		<2		----		----		----	
1.2.4-Trichlorobenzene	120-82-1	2	µg/L	<2		<2		----		----		----	
Hexachloropropylene	1888-71-7	2	µg/L	<2		<2		----		----		----	
Hexachlorobutadiene	87-68-3	2	µg/L	<2		<2		----		----		----	
Hexachlorocyclopentadiene	77-47-4	10	µg/L	<10		<10		----		----		----	
Pentachlorobenzene	608-93-5	2	µg/L	<2		<2		----		----		----	
Hexachlorobenzene (HCB)	118-74-1	4	µg/L	<4		<4		----		----		----	
EP075H: Anilines and Benzidines													
Aniline	62-53-3	2	µg/L	<2		<2		----		----		----	
4-Chloroaniline	106-47-8	2	µg/L	<2		<2		----		----		----	
2-Nitroaniline	88-74-4	4	µg/L	<4		<4		----		----		----	
3-Nitroaniline	99-09-2	4	µg/L	<4		<4		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP075H: Anilines and Benzidines - Continued													
Dibenzofuran	132-64-9	2	µg/L	<2		<2		----		----		----	
4-Nitroaniline	100-01-6	2	µg/L	<2		<2		----		----		----	
Carbazole	86-74-8	2	µg/L	**4**		<2		----		----		----	
3.3`-Dichlorobenzidine	91-94-1	2	µg/L	<2		<2		----		----		----	
EP075I: Organochlorine Pesticides													
alpha-BHC	319-84-6	2	µg/L	<2		<2		----		----		----	
beta-BHC	319-85-7	2	µg/L	<2		<2		----		----		----	
gamma-BHC	58-89-9	2	µg/L	<2		<2		----		----		----	
delta-BHC	319-86-8	2	µg/L	<2		<2		----		----		----	
Heptachlor	76-44-8	2	µg/L	<2		<2		----		----		----	
Aldrin	309-00-2	2	µg/L	<2		<2		----		----		----	
Heptachlor epoxide	1024-57-3	2	µg/L	<2		<2		----		----		----	
alpha-Endosulfan	959-98-8	2	µg/L	<2		<2		----		----		----	
4.4`-DDE	72-55-9	2	µg/L	<2		<2		----		----		----	
Dieldrin	60-57-1	2	µg/L	<2		<2		----		----		----	
Endrin	72-20-8	2	µg/L	<2		<2		----		----		----	
beta-Endosulfan	33213-65-9	2	µg/L	<2		<2		----		----		----	
4.4`-DDD	72-54-8	2	µg/L	<2		<2		----		----		----	
Endosulfan sulfate	1031-07-8	2	µg/L	<2		<2		----		----		----	
4.4`-DDT	50-29-3	4	µg/L	<4		<4		----		----		----	
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	4	µg/L	<4		<4		----		----		----	
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	4	µg/L	<4		<4		----		----		----	
EP075J: Organophosphorus Pesticides													
Dichlorvos	62-73-7	2	µg/L	<2		<2		----		----		----	
Dimethoate	60-51-5	2	µg/L	<2		<2		----		----		----	
Diazinon	333-41-5	2	µg/L	<2		<2		----		----		----	
Chlorpyrifos-methyl	5598-13-0	2	µg/L	<2		<2		----		----		----	
Malathion	121-75-5	2	µg/L	<2		<2		----		----		----	
Fenthion	55-38-9	2	µg/L	<2		<2		----		----		----	
Chlorpyrifos	2921-88-2	2	µg/L	<2		<2		----		----		----	
Pirimphos-ethyl	23505-41-1	2	µg/L	<2		<2		----		----		----	
Chlorfenvinphos	470-90-6	2	µg/L	<2		<2		----		----		----	
Prothiofos	34643-46-4	2	µg/L	<2		<2		----		----		----	
Ethion	563-12-2	2	µg/L	<2		<2		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP075J: Organophosphorus Pesticides - Continued													
EP080/071: Total Petroleum Hydrocarbons													
C6 - C9 Fraction	----	20	µg/L	<100		<100		----		----		----	
C10 - C14 Fraction	----	50	µg/L	**80**		<50		----		----		----	
C15 - C28 Fraction	----	100	µg/L	**380**		**270**		----		----		----	
C29 - C36 Fraction	----	50	µg/L	**50**		**240**		----		----		----	
^ C10 - C36 Fraction (sum)	----	50	µg/L	**510**		**510**		----		----		----	
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions													
C6 - C10 Fraction	C6_C10	20	µg/L	<100		<100		----		----		----	
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<100		<100		----		----		----	
>C10 - C16 Fraction	----	100	µg/L	**120**		<100		----		----		----	
>C16 - C34 Fraction	----	100	µg/L	**430**		**340**		----		----		----	
>C34 - C40 Fraction	----	100	µg/L	<100		**200**		----		----		----	
^ >C10 - C40 Fraction (sum)	----	100	µg/L	**550**		**540**		----		----		----	
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L	<100		<100		----		----		----	
EP080: BTEXN													
Benzene	71-43-2	1	µg/L	<5		**44**		----		----		----	
Toluene	108-88-3	2	µg/L	<5		**10**		----		----		----	
Ethylbenzene	100-41-4	2	µg/L	<5		<5		----		----		----	
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<5		<5		----		----		----	
ortho-Xylene	95-47-6	2	µg/L	<5		<5		----		----		----	
^ Total Xylenes	1330-20-7	2	µg/L	<5		<5		----		----		----	
^ Sum of BTEX	----	1	µg/L	<5		**54**		----		----		----	
Naphthalene	91-20-3	5	µg/L	**48**		**5**		----		----		----	
EP090: Organotin Compounds (Soluble)													
Tributyltin	56573-85-4	2	ngSn/L	<15		<15		----		----		----	
EP118: Nitrogenated Compounds													
Acrylonitrile	107-13-1	1	µg/L	<1		<1		----		----		----	
EP121: Aldehydes													
Formaldehyde	50-00-0	2	µg/L	**423**		**168**		----		----		----	
Acetaldehyde	75-07-0	2	µg/L	**19.0**		**10.1**		----		----		----	
Propionaldehyde	123-38-6	2	µg/L	<2.0		<2.0		----		----		----	
Acrolein (Propenal)	107-02-8	2	µg/L	<2.0		<2.0		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Compound	CAS Number	LOR	Unit	MW206 Result	MW206 MU	MW202 Result	MW202 MU	---- Result	---- MU	---- Result	---- MU	---- Result	---- MU
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
				ES1535966-001		ES1535966-002		--------		--------		--------	
EP121: Aldehydes - Continued													
Butyraldehyde	123-72-8	2	µg/L	**2.7**		<2.0		----		----		----	
EP132A: Phenolic Compounds													
2-Chlorophenol	95-57-8	0.05	µg/L	<0.05		<0.05		----		----		----	
4-Chloro-3-methylphenol	59-50-7	0.05	µg/L	<0.05		<0.05		----		----		----	
m-Cresol	108-39-4	0.1	µg/L	**21.6**		<0.1		----		----		----	
o-Cresol	95-48-7	0.1	µg/L	**10.4**		<0.1		----		----		----	
p-Cresol	106-44-5	0.1	µg/L	**26.0**		<0.1		----		----		----	
2.4-Dichlorophenol	120-83-2	0.1	µg/L	**0.3**		**1.6**		----		----		----	
2.6-Dichlorophenol	87-65-0	0.1	µg/L	**0.3**		**0.5**		----		----		----	
2.4-Dimethylphenol	105-67-9	0.1	µg/L	**4.3**		**0.7**		----		----		----	
Hexachlorophene	70-30-4	0.1	µg/L	<0.1		<0.1		----		----		----	
2-Nitrophenol	88-75-5	0.1	µg/L	<0.1		<0.1		----		----		----	
4-Nitrophenol	100-02-7	0.1	µg/L	<0.1		<0.1		----		----		----	
Pentachlorophenol	87-86-5	0.05	µg/L	**0.39**		<0.05		----		----		----	
Phenol	108-95-2	0.1	µg/L	**123**		<0.1		----		----		----	
2.3.4.6-Tetrachlorophenol	58-90-2	0.1	µg/L	<0.1		<0.1		----		----		----	
2.4.5-Trichlorophenol	95-95-4	0.1	µg/L	**0.1**		<0.1		----		----		----	
2.4.6-Trichlorophenol	88-06-2	0.1	µg/L	<0.1		**0.3**		----		----		----	
EP202A: Phenoxyacetic Acid Herbicides by LCMS													
4-Chlorophenoxy acetic acid	122-88-3	10	µg/L	<10		<10		----		----		----	
2.4-DB	94-82-6	10	µg/L	<10		<10		----		----		----	
Dicamba	1918-00-9	10	µg/L	<10		<10		----		----		----	
Mecoprop	93-65-2	10	µg/L	<10		<10		----		----		----	
MCPA	94-74-6	10	µg/L	<10		<10		----		----		----	
2.4-DP	120-36-5	10	µg/L	<10		<10		----		----		----	
2.4-D	94-75-7	10	µg/L	<10		<10		----		----		----	
Triclopyr	55335-06-3	10	µg/L	<10		<10		----		----		----	
Silvex (2.4.5-TP/Fenoprop)	93-72-1	10	µg/L	<10		<10		----		----		----	
2.4.5-T	93-76-5	10	µg/L	<10		<10		----		----		----	
MCPB	94-81-5	10	µg/L	<10		<10		----		----		----	
Picloram	1918-02-1	10	µg/L	<10		<10		----		----		----	
Clopyralid	1702-17-6	10	µg/L	<10		<10		----		----		----	
Fluroxypyr	69377-81-7	10	µg/L	<10		<10		----		----		----	
2.6-D	575-90-6	10	µg/L	<10		<10		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP202A: Phenoxyacetic Acid Herbicides by LCMS - Continued													
2.4.6-T	575-89-3	10	µg/L	<10		<10		----		----		----	
EP203A: Explosives													
HMX	2691-41-0	20	µg/L	<20		<20		----		----		----	
RDX	----	20	µg/L	<20		<20		----		----		----	
1.3.5-Trinitrobenzene	99-35-4	20	µg/L	<20		<20		----		----		----	
1.3-Dinitrobenzene	99-65-0	20	µg/L	<20		<20		----		----		----	
Tetryl	479-45-8	20	µg/L	<20		<20		----		----		----	
2.4.6-TNT	118-96-7	20	µg/L	<20		<20		----		----		----	
4-Amino.2.6-DNT	19406-51-0	20	µg/L	<20		<20		----		----		----	
2-Amino-4.6-DNT	35572-78-2	20	µg/L	<20		<20		----		----		----	
4-& 2-AM-DNT(Isomeric Mixture)	----	20	µg/L	<20		<20		----		----		----	
2.4-Dinitrotoluene	121-14-2	20	µg/L	<20		<20		----		----		----	
2.6-Dinitrotoluene	606-20-2	20	µg/L	<20		<20		----		----		----	
2.4-& 2.6-DNT(Isomeric Mixture)	51-28-5/606-20-2	20	µg/L	<20		<20		----		----		----	
Nitrobenzene	98-95-3	20	µg/L	<20		<20		----		----		----	
2-Nitrotoluene	88-72-2	20	µg/L	<20		<20		----		----		----	
3-Nitrotoluene	99-08-1	20	µg/L	<20		<20		----		----		----	
4-Nitrotoluene	99-99-0	20	µg/L	<20		<20		----		----		----	
Nitroglycerine	55-63-0	200	µg/L	<200		<200		----		----		----	
PETN	78-11-5	200	µg/L	<200		<200		----		----		----	
EP231: Perfluorinated Compounds													
PFOS	1763-23-1	0.01	µg/L	<0.05		<0.05		----		----		----	
PFOA	335-67-1	0.01	µg/L	<0.05		<0.05		----		----		----	
6:2 Fluorotelomer sulfonate (6:2 FtS)	27619-97-2	0.1	µg/L	<0.5		<0.5		----		----		----	
8:2 Fluorotelomer sulfonate	39108-34-4	0.1	µg/L	<0.5		<0.5		----		----		----	
PFOSA	754-91-6	0.02	µg/L	<0.10		<0.10		----		----		----	
N-Me-FOSA	31506-32-8	0.5	µg/L	<0.5		<0.5		----		----		----	
N-Et-FOSA	4151-50-2	0.05	µg/L	<0.10		<0.10		----		----		----	
N-Me-FOSE	2448-09-7	0.5	µg/L	<0.5		<0.5		----		----		----	
N-Et-FOSE	1691-99-2	0.5	µg/L	<0.5		<0.5		----		----		----	
PFBS	375-73-5	0.02	µg/L	<0.10		<0.10		----		----		----	
PFHxS	355-46-4	0.02	µg/L	<0.10		<0.10		----		----		----	
PFDcS	67906-42-7	0.02	µg/L	<0.10		<0.10		----		----		----	
PFHxA	307-24-4	0.02	µg/L	<0.10		<0.10		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP231: Perfluorinated Compounds - Continued													
PFHpA	375-85-9	0.02	µg/L	<0.10		<0.10		----		----		----	
PFNA	375-95-1	0.02	µg/L	<0.10		<0.10		----		----		----	
PFDcA	335-76-2	0.02	µg/L	<0.10		<0.10		----		----		----	
PFUnA	2058-94-8	0.05	µg/L	<0.10		<0.10		----		----		----	
PFDoA	307-55-1	0.05	µg/L	<0.10		<0.10		----		----		----	
PFTriA	72629-94-8	0.05	µg/L	<0.10		<0.10		----		----		----	
PFTeA	376-06-7	0.5	µg/L	<0.5		<0.5		----		----		----	
EP234A: OP Pesticides													
Azinphos-ethyl	2642-71-9	0.02	µg/L	<0.02		<0.02		----		----		----	
Azinphos-methyl	86-50-0	0.02	µg/L	<0.02		<0.02		----		----		----	
Bromophos-ethyl	4824-78-6	0.1	µg/L	<0.10		<0.10		----		----		----	
Carbofenothion	786-19-6	0.02	µg/L	<0.02		<0.02		----		----		----	
Chlorfenvinphos	470-90-6	0.02	µg/L	<0.02		<0.02		----		----		----	
Chlorpyrifos	2921-88-2	0.02	µg/L	<0.02		<0.02		----		----		----	
Chlorpyrifos-methyl	5598-13-0	0.2	µg/L	<0.2		<0.2		----		----		----	
Coumaphos	56-72-4	0.01	µg/L	<0.01		<0.01		----		----		----	
Demeton-O & Demeton-S	298-03-3/126-75-0	0.02	µg/L	<0.02		<0.02		----		----		----	
Demeton-S-methyl	919-86-8	0.02	µg/L	<0.02		<0.02		----		----		----	
Diazinon	333-41-5	0.01	µg/L	<0.01		<0.01		----		----		----	
Dichlorvos	62-73-7	0.2	µg/L	<0.20		<0.20		----		----		----	
Dimethoate	60-51-5	0.02	µg/L	<0.02		<0.02		----		----		----	
Disulfoton	298-04-4	0.05	µg/L	<0.05		<0.05		----		----		----	
Ethion	563-12-2	0.02	µg/L	<0.02		<0.02		----		----		----	
EPN	2104-64-5	0.05	µg/L	<0.05		<0.05		----		----		----	
Ethoprophos	13194-48-4	0.01	µg/L	<0.01		<0.01		----		----		----	
Fenamiphos	22224-92-6	0.01	µg/L	<0.01		<0.01		----		----		----	
Fenchlorphos (Ronnel)	299-84-3	10	µg/L	<10		<10		----		----		----	
Fenitrothion	122-14-5	2	µg/L	<2		<2		----		----		----	
Fensulfothion	115-90-2	0.01	µg/L	<0.01		<0.01		----		----		----	
Fenthion	55-38-9	0.05	µg/L	<0.05		<0.05		----		----		----	
Malathion	121-75-5	0.02	µg/L	<0.02		<0.02		----		----		----	
Mevinphos	7786-34-7	0.02	µg/L	<0.02		<0.02		----		----		----	
Monocrotophos	6923-22-4	0.02	µg/L	<0.02		<0.02		----		----		----	
Omethoate	1113-02-6	0.01	µg/L	<0.01		<0.01		----		----		----	
Parathion	56-38-2	0.2	µg/L	<0.2		<0.2		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP234A: OP Pesticides - Continued													
Parathion-methyl	298-00-0	2	µg/L	<2.0		<2.0		----		----		----	
Phorate	298-02-2	0.1	µg/L	<0.1		<0.1		----		----		----	
Pirimiphos-ethyl	23505-41-1	0.01	µg/L	<0.01		<0.01		----		----		----	
Pirimiphos-methyl	29232-93-7	0.01	µg/L	<0.01		<0.01		----		----		----	
Profenofos	41198-08-7	0.01	µg/L	<0.01		<0.01		----		----		----	
Prothiofos	34643-46-4	0.1	µg/L	<0.1		<0.1		----		----		----	
Sulfotep	3689-24-5	0.005	µg/L	<0.005		<0.005		----		----		----	
Sulprofos	35400-43-2	0.05	µg/L	<0.05		<0.05		----		----		----	
Terbufos	13071-79-9	0.01	µg/L	<0.01		<0.01		----		----		----	
Temephos	3383-96-8	0.02	µg/L	<0.02		<0.02		----		----		----	
Tetrachlorvinphos	22248-79-9	0.01	µg/L	<0.01		<0.01		----		----		----	
Triazophos	24017-47-8	0.005	µg/L	<0.005		<0.005		----		----		----	
Trichlorfon	52-68-6	0.02	µg/L	<0.02		<0.02		----		----		----	
Trichloronate	327-98-0	0.5	µg/L	<0.5		<0.5		----		----		----	
EP234B: Thiocarbamates and Carbamates													
Aldicarb	116-06-3	0.05	µg/L	<0.05		<0.05		----		----		----	
Bendiocarb	22781-23-3	0.1	µg/L	<0.10		<0.10		----		----		----	
Benomyl	17804-35-2	0.01	µg/L	<0.01		<0.01		----		----		----	
Carbaryl	63-25-2	0.01	µg/L	<0.01		<0.01		----		----		----	
Carbofuran	1563-66-2	0.01	µg/L	<0.01		<0.01		----		----		----	
3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L	<0.02		<0.02		----		----		----	
Methiocarb	2032-65-7	0.01	µg/L	<0.01		<0.01		----		----		----	
Methomyl	16752-77-5	0.01	µg/L	<0.01		<0.01		----		----		----	
Molinate	2212-67-1	0.1	µg/L	<0.1		<0.1		----		----		----	
Oxamyl	23135-22-0	0.01	µg/L	<0.01		<0.01		----		----		----	
Thiobencarb	28249-77-6	0.01	µg/L	<0.01		<0.01		----		----		----	
Thiodicarb	59669-26-0	0.01	µg/L	<0.01		<0.01		----		----		----	
EP234C: Dinitroanilines													
Pendimethalin	40487-42-1	0.05	µg/L	<0.05		<0.05		----		----		----	
Trifluralin	1582-09-8	10	µg/L	<10.0		<10.0		----		----		----	
EP234D: Triazinone Herbicides													
Hexazinone	51235-04-2	0.02	µg/L	<0.02		<0.02		----		----		----	
Metribuzin	21087-64-9	0.02	µg/L	<0.02		<0.02		----		----		----	
EP234E: Conazole and Aminopyrimidine Fungicides													

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP234E: Conazole and Aminopyrimidine Fungicides - Continued													
Cyproconazole	94361-06-5	0.02	µg/L	<0.02		<0.02		----		----		----	
Difenoconazole	119446-68-3	0.02	µg/L	<0.02		<0.02		----		----		----	
Flusilazole	85509-19-9	0.02	µg/L	<0.02		<0.02		----		----		----	
Hexaconazole	79983-71-4	0.02	µg/L	<0.02		<0.02		----		----		----	
Paclobutrazole	76738-62-0	0.05	µg/L	<0.05		<0.05		----		----		----	
Penconazole	66246-88-6	0.01	µg/L	<0.01		<0.01		----		----		----	
Propiconazole	60207-90-1	0.05	µg/L	<0.05		<0.05		----		----		----	
Tebuconazole	107534-96-3	0.01	µg/L	<0.01		<0.01		----		----		----	
Cyprodinil	121552-61-2	0.01	µg/L	<0.01		<0.01		----		----		----	
Pyrimethanil	53112-28-0	0.02	µg/L	<0.02		<0.02		----		----		----	
EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides													
Diuron	330-54-1	0.02	µg/L	<0.02		<0.02		----		----		----	
Fluometuron	2164-17-2	0.01	µg/L	<0.01		<0.01		----		----		----	
Tebuthiuron	34014-18-1	0.02	µg/L	<0.02		<0.02		----		----		----	
Bromacil	314-40-9	0.02	µg/L	<0.02		<0.02		----		----		----	
Chlorsulfuron	64902-72-3	0.2	µg/L	<0.2		<0.2		----		----		----	
EP234G: Chloracetanilides													
Metolachlor	51218-45-2	0.01	µg/L	<0.01		<0.01		----		----		----	
EP234H: Triazine Herbicides													
Ametryn	834-12-8	0.01	µg/L	<0.01		<0.01		----		----		----	
Atrazine	1912-24-9	0.01	µg/L	<0.01		<0.01		----		----		----	
Cyanazine	21725-46-2	0.02	µg/L	<0.02		<0.02		----		----		----	
Cyromazine	66215-27-8	0.05	µg/L	<0.05		<0.05		----		----		----	
Prometryn	7287-19-6	0.01	µg/L	<0.01		<0.01		----		----		----	
Propazine	139-40-2	0.01	µg/L	<0.01		<0.01		----		----		----	
Simazine	122-34-9	0.02	µg/L	<0.02		<0.02		----		----		----	
Terbuthylazine	5915-41-3	0.01	µg/L	<0.01		<0.01		----		----		----	
Terbutryn	886-50-0	0.01	µg/L	<0.01		<0.01		----		----		----	
EP234I: Miscellaneous (ESI Positive Mode) Pesticides													
Diclofop-methyl	51338-27-3	0.05	µg/L	<0.05		<0.05		----		----		----	
Fenarimol	60168-88-9	0.02	µg/L	<0.02		<0.02		----		----		----	
Irgarol	28159-98-0	0.002	µg/L	<0.002		<0.002		----		----		----	
Oxyfluorfen	42874-03-3	1	µg/L	<1.0		<1.0		----		----		----	
Thiamethoxam	153719-23-4	0.02	µg/L	<0.02		<0.02		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP066S: PCB Surrogate													
Decachlorobiphenyl	2051-24-3	1	%	**70.0**		**61.0**		----		----		----	
EP068S: Organochlorine Pesticide Surrogate													
Dibromo-DDE	21655-73-2	0.5	%	**70.6**		**62.6**		----		----		----	
EP068T: Organophosphorus Pesticide Surrogate													
DEF	78-48-8	0.5	%	**68.9**		**62.7**		----		----		----	
EP074S: VOC Surrogates													
1.2-Dichloroethane-D4	17060-07-0	5	%	**104**		**108**		----		----		----	
Toluene-D8	2037-26-5	5	%	**121**		**123**		----		----		----	
4-Bromofluorobenzene	460-00-4	5	%	**107**		**111**		----		----		----	
EP075S: Acid Extractable Surrogates													
2-Fluorophenol	367-12-4	2	%	**27.2**		**19.4**		----		----		----	
Phenol-d6	13127-88-3	2	%	**26.5**		**23.5**		----		----		----	
2-Chlorophenol-D4	93951-73-6	2	%	**18.0**		**32.3**		----		----		----	
2.4.6-Tribromophenol	118-79-6	2	%	**25.3**		**39.1**		----		----		----	
EP075T: Base/Neutral Extractable Surrogates													
Nitrobenzene-D5	4165-60-0	2	%	**53.6**		**38.0**		----		----		----	
1.2-Dichlorobenzene-D4	2199-69-1	2	%	**44.2**		**31.0**		----		----		----	
2-Fluorobiphenyl	321-60-8	2	%	**61.8**		**36.1**		----		----		----	
Anthracene-d10	1719-06-8	2	%	**113**		**76.7**		----		----		----	
4-Terphenyl-d14	1718-51-0	2	%	**70.5**		**47.9**		----		----		----	
EP080S: TPH(V)/BTEX Surrogates													
1.2-Dichloroethane-D4	17060-07-0	2	%	**107**		**111**		----		----		----	
Toluene-D8	2037-26-5	2	%	**112**		**114**		----		----		----	
4-Bromofluorobenzene	460-00-4	2	%	**107**		**112**		----		----		----	
EP090S: Organotin Surrogate													
Tripropyltin	----	5	%	**67.1**		**83.9**		----		----		----	
EP132S: Acid Extractable Surrogates													
2-Fluorophenol	367-12-4	0.1	%	**34.4**		**54.1**		----		----		----	
Phenol-d6	13127-88-3	0.1	%	**76.8**		**58.4**		----		----		----	
2-Chlorophenol-D4	93951-73-6	0.1	%	**62.6**		**58.4**		----		----		----	
2.4.6-Tribromophenol	118-79-6	0.1	%	**57.0**		**69.8**		----		----		----	
EP132T: Base/Neutral Extractable Surrogates													
2-Fluorobiphenyl	321-60-8	0.1	%	**93.2**		**53.5**		----		----		----	
Anthracene-d10	1719-06-8	0.1	%	**116**		**63.6**		----		----		----	

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW206		MW202		----		----		----	
			Client sampling date / time	[11-Nov-2015]		[11-Nov-2015]		----		----		----	
Compound	CAS Number	LOR	Unit	ES1535966-001		ES1535966-002		--------		--------		--------	
				Result	MU	Result	MU	Result	MU	Result	MU	Result	MU
EP132T: Base/Neutral Extractable Surrogates - Continued													
4-Terphenyl-d14	1718-51-0	0.1	%	**107**		**56.8**		----		----		----	
EP202S: Phenoxyacetic Acid Herbicide Surrogate													
2.4-Dichlorophenyl Acetic Acid	19719-28-9	10	%	**72.4**		**69.9**		----		----		----	
EP203S: Explosives Surrogate													
o-Dinitrobenzene	528-29-0	20	%	**97.2**		**114**		----		----		----	

Environmental

QUALITY CONTROL REPORT

Work Order	: **ES1535966**	Page	: 1 of 39
Amendment	: **1**		
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR DAVE BARRETT	Contact	:
Address	: PO BOX 5403 NEWCASTLE WEST NSW, AUSTRALIA 2302	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: dave.barrett@ghd.com.au	E-mail	:
Telephone	: +61 07 4972 6377	Telephone	: +61-2-8784 8555
Facsimile	: +61 07 4972 6236	Facsimile	: +61-2-8784 8500
Project	: LEACHATE ASSESSMENT	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: 2218015	Date Samples Received	: 11-Nov-2015
C-O-C number	: ----	Date Analysis Commenced	: 11-Nov-2015
Sampler	: JESSE SIMKUS	Issue Date	: 04-Dec-2015
Site	: ----	No. of samples received	: 2
Quote number	: ----	No. of samples analysed	: 2

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key :

- Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot
- CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
- LOR = Limit of reporting
- RPD = Relative Percentage Difference
- # = Indicates failed QC

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Dian Dao		Sydney Inorganics
Dianne Blane	Laboratory Coordinator (2IC)	Newcastle - Inorganics
Matt Frost	Senior Organic Chemist	Brisbane Organics
Pabi Subba	Senior Organic Chemist	Sydney Organics
Phalak Inthakesone	Laboratory Manager - Organics	Sydney Organics
Titus Vimalasiri	Senior Scientist	Radionuclides

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EA005: pH (QC Lot: 275594)									
EN1513842-001	Anonymous	EA005: pH Value	----	0.01	pH Unit	7.77	7.79	0.257	0% - 20%
EN1513850-001	Anonymous	EA005: pH Value	----	0.01	pH Unit	7.09	7.11	0.282	0% - 20%
EA010P: Conductivity by PC Titrator (QC Lot: 275166)									
ES1535895-001	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	6230	6230	0.00	0% - 20%
ES1535912-002	Anonymous	EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	1050	1040	0.291	0% - 20%
EA025: Total Suspended Solids dried at 104 ± 2°C (QC Lot: 279024)									
ES1536075-012	Anonymous	EA025H: Suspended Solids (SS)	----	5	mg/L	13	12	8.16	No Limit
ES1535966-001	MW206	EA025H: Suspended Solids (SS)	----	5	mg/L	375	396	5.45	0% - 20%
EA036: Fixed/Volatile Suspended Solids (QC Lot: 279026)									
ES1535966-001	MW206	EA036H: Fixed Suspended Solids @ 550 C (Fraction of Suspended S)	----	1	%	87	90	3.39	0% - 20%
		EA036H: Volatile Suspended Solids @ 550 C (Fraction of Suspended S)	----	1	%	13	10	26.1	0% - 50%
		EA036H: Volatile Suspended Solids @ 550°C	----	5	mg/L	50	41	19.8	0% - 50%
EA040: Colour (Apparent) (QC Lot: 277282)									
ES1535966-001	MW206	EA040: Colour (Apparent)	----	1	PCU	5000	5000	0.00	0% - 20%
EA041: Colour (True) (QC Lot: 277283)									
ES1535966-001	MW206	EA041: Colour (True)	----	1	PCU	4500	4500	0.00	0% - 20%
		EA041: pH Colour	----	0.01	pH Unit	11.1	11.1	0.00	0% - 20%
EA250: Gross Alpha and Beta Activity (QC Lot: 278277)									
EB1532684-001	Anonymous	EA250-LSC: Gross alpha	----	0.05	Bq/L	<0.05	<0.05	0.00	No Limit
		EA250-LSC: Gross beta activity - 40K	----	0.1	Bq/L	<0.10	<0.10	0.00	No Limit
ED037P: Alkalinity by PC Titrator (QC Lot: 275164)									
ES1535895-001	Anonymous	ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	607	602	0.731	0% - 20%
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	29	31	6.56	0% - 20%
		ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	636	633	0.388	0% - 20%
ES1535912-002	Anonymous	ED037-P: Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	426	419	1.61	0% - 20%
		ED037-P: Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	24	24	0.00	0% - 20%
		ED037-P: Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	0.00	No Limit
		ED037-P: Total Alkalinity as CaCO3	----	1	mg/L	449	443	1.44	0% - 20%
ED040F: Dissolved Major Anions (QC Lot: 275139)									
ES1535912-001	Anonymous	ED040F: Silicon as SiO2	14464-46-1	0.1	mg/L	41.5	41.5	0.00	0% - 20%
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 275135)									

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QC Lot: 275135) - continued									
ES1535912-002	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	<1	0.00	No Limit
ES1535912-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	32	35	7.50	0% - 20%
ED045G: Chloride by Discrete Analyser (QC Lot: 275136)									
ES1535912-002	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	46	45	0.00	0% - 20%
ES1535912-001	Anonymous	ED045G: Chloride	16887-00-6	1	mg/L	47	47	0.00	0% - 20%
ED093F: Dissolved Major Cations (QC Lot: 277441)									
ES1535933-016	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	33	33	0.00	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	32	32	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	7	7	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	459	460	0.00	0% - 20%
ES1535912-001	Anonymous	ED093F: Calcium	7440-70-2	1	mg/L	44	47	6.71	0% - 20%
		ED093F: Magnesium	7439-95-4	1	mg/L	23	24	0.00	0% - 20%
		ED093F: Potassium	7440-09-7	1	mg/L	2	2	0.00	No Limit
		ED093F: Sodium	7440-23-5	1	mg/L	34	35	0.00	0% - 20%
EG020F: Dissolved Metals by ICP-MS (QC Lot: 277437)									
ES1535912-001	Anonymous	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-F: Strontium	7440-24-6	0.001	mg/L	0.423	0.429	1.46	0% - 20%
		EG020B-F: Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 277439)									
ES1536010-003	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	0.0004	0.0004	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.028	0.028	0.00	0% - 20%
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	0.007	0.007	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	0.216	0.219	1.65	0% - 20%
		EG020A-F: Copper	7440-50-8	0.001	mg/L	0.005	0.005	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-F: Lithium	7439-93-2	0.001	mg/L	0.028	0.028	0.00	0% - 20%
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	6.09	6.05	0.638	0% - 20%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.272	0.276	1.07	0% - 20%
		EG020A-F: Thallium	7440-28-0	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.960	0.996	3.69	0% - 20%
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	8.44	8.67	2.76	0% - 20%
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EG020F: Dissolved Metals by ICP-MS (QC Lot: 277439) - continued									
ES1536010-003	Anonymous	EG020A-F: Iron	7439-89-6	0.05	mg/L	47.8	48.9	2.22	0% - 20%
		EG020A-F: Bromine	7726-95-6	0.1	mg/L	0.6	0.6	0.00	No Limit
		EG020A-F: Iodine	7553-56-2	0.1	mg/L	0.2	0.2	0.00	No Limit
ES1535912-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.005	0.005	0.00	No Limit
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lithium	7439-93-2	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Bromine	7726-95-6	0.1	mg/L	0.3	0.3	0.00	No Limit
		EG020A-F: Iodine	7553-56-2	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 277693)									
ES1535987-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.002	<0.001	74.7	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.210	0.213	1.01	0% - 20%
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.002	0.00	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lithium	7439-93-2	0.001	mg/L	0.250	0.257	2.59	0% - 20%
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.015	0.016	7.40	0% - 50%
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	0.014	0.011	22.2	0% - 50%
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020T: Total Metals by ICP-MS (QC Lot: 277693) - continued									
ES1535987-001	Anonymous	EG020A-T: Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.010	0.014	39.8	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.10	0.09	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	0.07	0.07	0.00	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	0.25	0.18	31.3	No Limit
EP1515744-024	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.003	<0.001	92.4	No Limit
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lithium	7439-93-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Tin	7440-31-5	0.001	mg/L	0.002	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	0.00	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.01	<0.01	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 277694)									
EP1515744-024	Anonymous	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-T: Strontium	7440-24-6	0.001	mg/L	0.002	<0.001	0.00	No Limit
		EG020B-T: Titanium	7440-32-6	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EG020U: Unfiltered Metals by ICP-MS (QC Lot: 280184)									
ES1535966-001	MW206	EG020A-U: Bromine	7726-95-6	0.05	mg/L	4.19	4.85	14.6	0% - 20%
		EG020A-U: Iodine	7553-56-2	0.05	mg/L	2.56	2.63	2.58	0% - 20%
EG032: Arsenic Speciation by LC-ICPMS (QC Lot: 276684)									
EB1533734-001	Anonymous	EG032: Arsenic Acid, As (V)	----	0.5	µg/L	<1.0	<1.0	0.00	No Limit
		EG032: Arsenious Acid, As (III)	----	0.5	µg/L	<1.0	<1.0	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory Duplicate (DUP) Report

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG035F: Dissolved Mercury by FIMS (QC Lot: 277438)									
ES1535912-002	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
ES1536156-003	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 279772)									
ES1535904-034	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
ES1535942-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG050F: Dissolved Hexavalent Chromium (QC Lot: 277273)									
ES1535705-014	Anonymous	EG050G-F: Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.01	<0.01	0.00	No Limit
ES1536061-001	Anonymous	EG050G-F: Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK010/011: Chlorine (QC Lot: 276830)									
ES1536055-001	Anonymous	EK010: Chlorine - Free	----	0.2	mg/L	1.0	1.0	0.00	No Limit
		EK010: Chlorine - Total Residual	----	0.2	mg/L	1.0	1.0	0.00	No Limit
ME1510760-001	Anonymous	EK010: Chlorine - Free	----	0.2	mg/L	<0.2	<0.2	0.00	No Limit
		EK010: Chlorine - Total Residual	----	0.2	mg/L	<0.2	<0.2	0.00	No Limit
EK026SF: Total CN by Segmented Flow Analyser (QC Lot: 275210)									
ES1535924-001	Anonymous	EK026SF: Total Cyanide	57-12-5	0.004	mg/L	20.5	20.8	1.59	0% - 20%
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser (QC Lot: 275209)									
ES1535924-001	Anonymous	EK028SF: Weak Acid Dissociable Cyanide	----	0.004	mg/L	2.06	2.09	1.52	0% - 20%
EK040P: Fluoride by PC Titrator (QC Lot: 275163)									
ES1535895-001	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.9	0.8	0.00	No Limit
ES1535912-002	Anonymous	EK040P: Fluoride	16984-48-8	0.1	mg/L	0.7	0.8	0.00	No Limit
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 276957)									
ES1535918-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.04	0.03	0.00	No Limit
ES1535966-001	MW206	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	529	516	2.56	0% - 20%
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 275137)									
ES1535912-002	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
ES1535912-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 276958)									
ES1535918-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.06	0.06	0.00	No Limit
ES1535966-001	MW206	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.55	0.58	5.31	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 276935)									
ES1535918-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	2.0	1.8	12.4	0% - 20%
ES1535966-001	MW206	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	593	622	4.77	0% - 20%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 276934)									
ES1535918-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.10	0.12	21.8	0% - 50%
ES1535966-001	MW206	EK067G: Total Phosphorus as P	----	0.01	mg/L	8.60	7.07	19.5	0% - 20%
EK071G: Reactive Phosphorus as P by discrete analyser (QC Lot: 275138)									
ES1535912-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	0.12	0.12	0.00	0% - 50%
EK085M: Sulfide as S2- (QC Lot: 279129)									

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EK085M: Sulfide as S2- (QC Lot: 279129) - continued									
ES1535966-001	MW206	EK085: Sulfide as S2-	18496-25-8	0.1	mg/L	1.5	1.6	8.41	No Limit
ES1536197-001	Anonymous	EK085: Sulfide as S2-	18496-25-8	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EK086: Sulfite as SO3 2- (QC Lot: 277284)									
ES1535966-001	MW206	EK086: Sulfite as SO3 2-	14265-45-3	2	mg/L	<2	<2	0.00	No Limit
EK087: Thiosulfate as S2O3 2- (QC Lot: 277285)									
ES1535966-001	MW206	EK087: Thiosulfate as S2O3 2-	----	2	mg/L	<20	<20	0.00	No Limit
EP005: Total Organic Carbon (TOC) (QC Lot: 274591)									
ES1535878-001	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	12	12	0.00	0% - 50%
ES1535893-002	Anonymous	EP005: Total Organic Carbon	----	1	mg/L	3	3	0.00	No Limit
EP010: Formaldehyde (QC Lot: 277026)									
ES1535925-001	Anonymous	EP010: Formaldehyde	50-00-0	0.1	mg/L	0.4	0.4	0.00	No Limit
EP026SP: Chemical Oxygen Demand (Spectrophotometric) (QC Lot: 279509)									
EP1515806-001	Anonymous	EP026SP: Chemical Oxygen Demand	----	10	mg/L	<10	<10	0.00	No Limit
ES1535904-038	Anonymous	EP026SP: Chemical Oxygen Demand	----	10	mg/L	94	81	14.8	No Limit
EP041A: Nonionic Surfactants (QC Lot: 275763)									
ES1535966-001	MW206	EP041A: Nonionic Surfactants as CTAS	----	5	mg/L	<5	<5	0.00	No Limit
EP050: Anionic Surfactants as MBAS (QC Lot: 277603)									
ES1535966-001	MW206	EP050: Anionic Surfactants as MBAS		0.1	mg/L	0.1	<0.1	0.00	No Limit
EP074A: Monocyclic Aromatic Hydrocarbons (QC Lot: 274938)									
ES1535986-001	Anonymous	EP074: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP074: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP074: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP074: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP074: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP074: 1.2.4-Trimethylbenzene	95-63-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.3.5-Trimethylbenzene	108-67-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: Isopropylbenzene	98-82-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: n-Butylbenzene	104-51-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: n-Propylbenzene	103-65-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: p-Isopropyltoluene	99-87-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: sec-Butylbenzene	135-98-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: Styrene	100-42-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: tert-Butylbenzene	98-06-6	5	µg/L	<5	<5	0.00	No Limit
ES1535912-001	Anonymous	EP074: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP074: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP074: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP074: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory Duplicate (DUP) Report

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP074A: Monocyclic Aromatic Hydrocarbons (QC Lot: 274938) - continued									
ES1535912-001	Anonymous	EP074: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP074: 1.2.4-Trimethylbenzene	95-63-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.3.5-Trimethylbenzene	108-67-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: Isopropylbenzene	98-82-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: n-Butylbenzene	104-51-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: n-Propylbenzene	103-65-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: p-Isopropyltoluene	99-87-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: sec-Butylbenzene	135-98-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: Styrene	100-42-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: tert-Butylbenzene	98-06-6	5	µg/L	<5	<5	0.00	No Limit
EP074B: Oxygenated Compounds (QC Lot: 274938)									
ES1535986-001	Anonymous	EP074: 2-Butanone (MEK)	78-93-3	50	µg/L	<50	<50	0.00	No Limit
		EP074: 2-Hexanone (MBK)	591-78-6	50	µg/L	<50	<50	0.00	No Limit
		EP074: 2-Propanone (Acetone)	67-64-1	50	µg/L	<50	<50	0.00	No Limit
		EP074: 4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L	<50	<50	0.00	No Limit
		EP074: Vinyl Acetate	108-05-4	50	µg/L	<50	<50	0.00	No Limit
ES1535912-001	Anonymous	EP074: 2-Butanone (MEK)	78-93-3	50	µg/L	<50	<50	0.00	No Limit
		EP074: 2-Hexanone (MBK)	591-78-6	50	µg/L	<50	<50	0.00	No Limit
		EP074: 2-Propanone (Acetone)	67-64-1	50	µg/L	<50	<50	0.00	No Limit
		EP074: 4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L	<50	<50	0.00	No Limit
		EP074: Vinyl Acetate	108-05-4	50	µg/L	<50	<50	0.00	No Limit
EP074C: Sulfonated Compounds (QC Lot: 274938)									
ES1535986-001	Anonymous	EP074: Carbon disulfide	75-15-0	5	µg/L	<5	<5	0.00	No Limit
ES1535912-001	Anonymous	EP074: Carbon disulfide	75-15-0	5	µg/L	<5	<5	0.00	No Limit
EP074D: Fumigants (QC Lot: 274938)									
ES1535986-001	Anonymous	EP074: 1.2-Dibromoethane (EDB)	106-93-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dichloropropane	78-87-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: 2.2-Dichloropropane	594-20-7	5	µg/L	<5	<5	0.00	No Limit
		EP074: cis-1.3-Dichloropropylene	10061-01-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: trans-1.3-Dichloropropylene	10061-02-6	5	µg/L	<5	<5	0.00	No Limit
ES1535912-001	Anonymous	EP074: 1.2-Dibromoethane (EDB)	106-93-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dichloropropane	78-87-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: 2.2-Dichloropropane	594-20-7	5	µg/L	<5	<5	0.00	No Limit
		EP074: cis-1.3-Dichloropropylene	10061-01-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: trans-1.3-Dichloropropylene	10061-02-6	5	µg/L	<5	<5	0.00	No Limit
EP074E: Halogenated Aliphatic Compounds (QC Lot: 274938)									
ES1535986-001	Anonymous	EP074: 1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1.1-Trichloroethane	71-55-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L	<5	<5	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP074E: Halogenated Aliphatic Compounds (QC Lot: 274938) - continued									
ES1535986-001	Anonymous	EP074: 1.1.2-Trichloroethane	79-00-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1-Dichloroethane	75-34-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1-Dichloroethene	75-35-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1-Dichloropropylene	563-58-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2.3-Trichloropropane	96-18-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dichloroethane	107-06-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.3-Dichloropropane	142-28-9	5	µg/L	<5	<5	0.00	No Limit
		EP074: Carbon Tetrachloride	56-23-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: cis-1.2-Dichloroethene	156-59-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: Dibromomethane	74-95-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: Hexachlorobutadiene	87-68-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: Iodomethane	74-88-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: Methylene chloride	75-09-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: Pentachloroethane	76-01-7	5	µg/L	<5	<5	0.00	No Limit
		EP074: Tetrachloroethene	127-18-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: trans-1.2-Dichloroethene	156-60-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: Trichloroethene	79-01-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: Bromomethane	74-83-9	50	µg/L	<50	<50	0.00	No Limit
		EP074: Chloroethane	75-00-3	50	µg/L	<50	<50	0.00	No Limit
		EP074: Chloromethane	74-87-3	50	µg/L	<50	<50	0.00	No Limit
		EP074: Dichlorodifluoromethane	75-71-8	50	µg/L	<50	<50	0.00	No Limit
		EP074: Trichlorofluoromethane	75-69-4	50	µg/L	<50	<50	0.00	No Limit
		EP074: Vinyl chloride	75-01-4	50	µg/L	<50	<50	0.00	No Limit
ES1535912-001	Anonymous	EP074: 1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1.1-Trichloroethane	71-55-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1.2-Trichloroethane	79-00-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1-Dichloroethane	75-34-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1-Dichloroethene	75-35-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.1-Dichloropropylene	563-58-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2.3-Trichloropropane	96-18-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dichloroethane	107-06-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.3-Dichloropropane	142-28-9	5	µg/L	<5	<5	0.00	No Limit
		EP074: Carbon Tetrachloride	56-23-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: cis-1.2-Dichloroethene	156-59-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L	<5	<5	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP074E: Halogenated Aliphatic Compounds (QC Lot: 274938) - continued									
ES1535912-001	Anonymous	EP074: Dibromomethane	74-95-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: Hexachlorobutadiene	87-68-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: Iodomethane	74-88-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: Methylene chloride	75-09-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: Pentachloroethane	76-01-7	5	µg/L	<5	<5	0.00	No Limit
		EP074: Tetrachloroethene	127-18-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: trans-1.2-Dichloroethene	156-60-5	5	µg/L	<5	<5	0.00	No Limit
		EP074: trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: Trichloroethene	79-01-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: Bromomethane	74-83-9	50	µg/L	<50	<50	0.00	No Limit
		EP074: Chloroethane	75-00-3	50	µg/L	<50	<50	0.00	No Limit
		EP074: Chloromethane	74-87-3	50	µg/L	<50	<50	0.00	No Limit
		EP074: Dichlorodifluoromethane	75-71-8	50	µg/L	<50	<50	0.00	No Limit
		EP074: Trichlorofluoromethane	75-69-4	50	µg/L	<50	<50	0.00	No Limit
		EP074: Vinyl chloride	75-01-4	50	µg/L	<50	<50	0.00	No Limit
EP074F: Halogenated Aromatic Compounds (QC Lot: 274938)									
ES1535986-001	Anonymous	EP074: 1.2.3-Trichlorobenzene	87-61-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2.4-Trichlorobenzene	120-82-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dichlorobenzene	95-50-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.3-Dichlorobenzene	541-73-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.4-Dichlorobenzene	106-46-7	5	µg/L	<5	<5	0.00	No Limit
		EP074: 2-Chlorotoluene	95-49-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: 4-Chlorotoluene	106-43-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: Bromobenzene	108-86-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: Chlorobenzene	108-90-7	5	µg/L	<5	<5	0.00	No Limit
ES1535912-001	Anonymous	EP074: 1.2.3-Trichlorobenzene	87-61-6	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2.4-Trichlorobenzene	120-82-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.2-Dichlorobenzene	95-50-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.3-Dichlorobenzene	541-73-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: 1.4-Dichlorobenzene	106-46-7	5	µg/L	<5	<5	0.00	No Limit
		EP074: 2-Chlorotoluene	95-49-8	5	µg/L	<5	<5	0.00	No Limit
		EP074: 4-Chlorotoluene	106-43-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: Bromobenzene	108-86-1	5	µg/L	<5	<5	0.00	No Limit
		EP074: Chlorobenzene	108-90-7	5	µg/L	<5	<5	0.00	No Limit
EP074G: Trihalomethanes (QC Lot: 274938)									
ES1535986-001	Anonymous	EP074: Bromodichloromethane	75-27-4	5	µg/L	<5	<5	0.00	No Limit
		EP074: Bromoform	75-25-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: Chloroform	67-66-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: Dibromochloromethane	124-48-1	5	µg/L	<5	<5	0.00	No Limit
ES1535912-001	Anonymous	EP074: Bromodichloromethane	75-27-4	5	µg/L	<5	<5	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP074G: Trihalomethanes (QC Lot: 274938) - continued									
ES1535912-001	Anonymous	EP074: Bromoform	75-25-2	5	µg/L	<5	<5	0.00	No Limit
		EP074: Chloroform	67-66-3	5	µg/L	<5	<5	0.00	No Limit
		EP074: Dibromochloromethane	124-48-1	5	µg/L	<5	<5	0.00	No Limit
EP080/071: Total Petroleum Hydrocarbons (QC Lot: 274940)									
ES1535912-001	Anonymous	EP080: C6 - C9 Fraction	----	20	µg/L	<20	<20	0.00	No Limit
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QC Lot: 274940)									
ES1535912-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	0.00	No Limit
EP080: BTEXN (QC Lot: 274940)									
ES1535912-001	Anonymous	EP080: Benzene	71-43-2	1	µg/L	<1	<1	0.00	No Limit
		EP080: Ethylbenzene	100-41-4	2	µg/L	<2	<2	0.00	No Limit
		EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: ortho-Xylene	95-47-6	2	µg/L	<2	<2	0.00	No Limit
		EP080: Toluene	108-88-3	2	µg/L	<2	<2	0.00	No Limit
		EP080: Naphthalene	91-20-3	5	µg/L	<5	<5	0.00	No Limit
EP118: Nitrogenated Compounds (QC Lot: 275422)									
ES1535966-001	MW206	EP118-1: Acrylonitrile	107-13-1	1	µg/L	<1	<1	0.00	No Limit
EP121: Aldehydes (QC Lot: 275068)									
ES1535966-001	MW206	EP121: Acetaldehyde	75-07-0	2	µg/L	19.0	18.2	4.00	No Limit
		EP121: Acrolein (Propenal)	107-02-8	2	µg/L	<2.0	<2.0	0.00	No Limit
		EP121: Butyraldehyde	123-72-8	2	µg/L	2.7	3.0	9.35	No Limit
		EP121: Formaldehyde	50-00-0	2	µg/L	423	413	2.51	0% - 20%
		EP121: Propionaldehyde	123-38-6	2	µg/L	<2.0	<2.0	0.00	No Limit
EP202A: Phenoxyacetic Acid Herbicides by LCMS (QC Lot: 277738)									
EB1534277-001	Anonymous	EP202-SL: 2.4.5-T	93-76-5	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 2.4-D	94-75-7	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 2.4-DB	94-82-6	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 2.4-DP	120-36-5	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: 4-Chlorophenoxy acetic acid	122-88-3	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Clopyralid	1702-17-6	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Dicamba	1918-00-9	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Fluroxypyr	69377-81-7	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: MCPA	94-74-6	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: MCPB	94-81-5	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Mecoprop	93-65-2	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Picloram	1918-02-1	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Silvex (2.4.5-TP/Fenoprop)	93-72-1	10	µg/L	<10	<10	0.00	No Limit
		EP202-SL: Triclopyr	55335-06-3	10	µg/L	<10	<10	0.00	No Limit
EP203A: Explosives (QC Lot: 274448)									

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP203A: Explosives (QC Lot: 274448) - continued									
ES1535966-001	MW206	EP203-SL: 1.3.5-Trinitrobenzene	99-35-4	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 1.3-Dinitrobenzene	99-65-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2.4.6-TNT	118-96-7	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2.4-Dinitrotoluene	121-14-2	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2.6-Dinitrotoluene	606-20-2	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2-Amino-4.6-DNT	35572-78-2	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 2-Nitrotoluene	88-72-2	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 3-Nitrotoluene	99-08-1	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 4-Amino.2.6-DNT	19406-51-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: 4-Nitrotoluene	99-99-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: HMX	2691-41-0	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: Nitrobenzene	98-95-3	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: RDX	----	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: Tetryl	479-45-8	20	µg/L	<20	<20	0.00	No Limit
		EP203-SL: Nitroglycerine	55-63-0	200	µg/L	<200	<200	0.00	No Limit
		EP203-SL: PETN	78-11-5	200	µg/L	<200	<200	0.00	No Limit
EP231: Perfluorinated Compounds (QC Lot: 274411)									
EB1534037-003	Anonymous	EP231: PFOA	335-67-1	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP231: PFOS	1763-23-1	0.01	µg/L	0.07	0.07	0.00	No Limit
		EP231: 6:2 Fluorotelomer sulfonate (6:2 FtS)	27619-97-2	0.1	µg/L	<0.1	<0.1	0.00	No Limit
		EP231: 8:2 Fluorotelomer sulfonate	39108-34-4	0.1	µg/L	<0.1	<0.1	0.00	No Limit
EP231: Perfluorinated Compounds (QC Lot: 274412)									
EB1534037-003	Anonymous	EP231PFC: PFBS	375-73-5	0.02	µg/L	0.03	0.03	0.00	No Limit
		EP231PFC: PFDcA	335-76-2	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP231PFC: PFHpA	375-85-9	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP231PFC: PFHxA	307-24-4	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP231PFC: PFHxS	355-46-4	0.02	µg/L	0.11	0.11	0.00	No Limit
		EP231PFC: PFNA	375-95-1	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP231PFC: PFOSA	754-91-6	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP231PFC: N-Et-FOSA	4151-50-2	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP231PFC: PFDcS	67906-42-7	0.05	µg/L	<0.02	<0.02	85.7	No Limit
		EP231PFC: PFDoA	307-55-1	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP231PFC: PFTriA	72629-94-8	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP231PFC: PFUnA	2058-94-8	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP231PFC: N-Me-FOSA	31506-32-8	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP231PFC: PFTeA	376-06-7	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP231PFC: N-Et-FOSE	1691-99-2	1	µg/L	<0.5	<0.5	66.7	No Limit
		EP231PFC: N-Me-FOSE	2448-09-7	1	µg/L	<0.5	<0.5	66.7	No Limit
EP234A: OP Pesticides (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Sulfotep	3689-24-5	0.005	µg/L	<0.005	<0.005	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EP234A: OP Pesticides (QC Lot: 276928) - continued									
ES1535894-016	Anonymous	EP234-1: Triazophos	24017-47-8	0.005	µg/L	<0.005	<0.005	0.00	No Limit
		EP234-1: Coumaphos	56-72-4	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Diazinon	333-41-5	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Ethoprophos	13194-48-4	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Fenamiphos	22224-92-6	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Fensulfothion	115-90-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Omethoate	1113-02-6	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Pirimiphos-ethyl	23505-41-1	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Pirimiphos-methyl	29232-93-7	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Profenofos	41198-08-7	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Terbufos	13071-79-9	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Tetrachlorvinphos	22248-79-9	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Azinphos-ethyl	2642-71-9	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Azinphos-methyl	86-50-0	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Carbofenothion	786-19-6	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Chlorfenvinphos	470-90-6	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Chlorpyrifos	2921-88-2	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Demeton-O & Demeton-S	298-03-3/126-75-0	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Demeton-S-methyl	919-86-8	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Dimethoate	60-51-5	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Ethion	563-12-2	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Malathion	121-75-5	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Mevinphos	7786-34-7	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Monocrotophos	6923-22-4	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Temephos	3383-96-8	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Trichlorfon	52-68-6	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Disulfoton	298-04-4	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: EPN	2104-64-5	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Fenthion	55-38-9	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Sulprofos	35400-43-2	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Bromophos-ethyl	4824-78-6	0.1	µg/L	<0.10	<0.10	0.00	No Limit
		EP234-1: Phorate	298-02-2	0.1	µg/L	<0.1	<0.1	0.00	No Limit
		EP234-1: Prothiofos	34643-46-4	0.1	µg/L	<0.1	<0.1	0.00	No Limit
		EP234-1: Chlorpyrifos-methyl	5598-13-0	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EP234-1: Dichlorvos	62-73-7	0.2	µg/L	<0.20	<0.20	0.00	No Limit
		EP234-1: Parathion	56-38-2	0.2	µg/L	<0.2	<0.2	0.00	No Limit
		EP234-1: Parathion-methyl	298-00-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP234-1: Trichloronate	327-98-0	0.5	µg/L	<0.5	<0.5	0.00	No Limit
		EP234-1: Fenchlorphos (Ronnel)	299-84-3	10	µg/L	<10	<10	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP234A: OP Pesticides (QC Lot: 276928) - continued									
ES1535894-016	Anonymous	EP234-1: Fenitrothion	122-14-5	2	µg/L	<2	<2	0.00	No Limit
EP234B: Thiocarbamates and Carbamates (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Benomyl	17804-35-2	0.01	µg/L	0.06	0.06	0.00	No Limit
		EP234-1: Carbaryl	63-25-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Carbofuran	1563-66-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Methiocarb	2032-65-7	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Methomyl	16752-77-5	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Oxamyl	23135-22-0	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Thiobencarb	28249-77-6	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Thiodicarb	59669-26-0	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: 3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Aldicarb	116-06-3	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Bendiocarb	22781-23-3	0.1	µg/L	<0.10	<0.10	0.00	No Limit
		EP234-1: Molinate	2212-67-1	0.1	µg/L	<0.1	<0.1	0.00	No Limit
EP234C: Dinitroanilines (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Pendimethalin	40487-42-1	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Trifluralin	1582-09-8	10	µg/L	<10.0	<10.0	0.00	No Limit
EP234D: Triazinone Herbicides (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Hexazinone	51235-04-2	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Metribuzin	21087-64-9	0.02	µg/L	<0.02	<0.02	0.00	No Limit
EP234E: Conazole and Aminopyrimidine Fungicides (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Cyprodinil	121552-61-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Penconazole	66246-88-6	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Tebuconazole	107534-96-3	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Cyproconazole	94361-06-5	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Difenoconazole	119446-68-3	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Flusilazole	85509-19-9	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Hexaconazole	79983-71-4	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Pyrimethanil	53112-28-0	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Paclobutrazole	76738-62-0	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Propiconazole	60207-90-1	0.05	µg/L	<0.05	<0.05	0.00	No Limit
EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Fluometuron	2164-17-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Bromacil	314-40-9	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Diuron	330-54-1	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Tebuthiuron	34014-18-1	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Chlorsulfuron	64902-72-3	0.2	µg/L	<0.2	<0.2	0.00	No Limit
EP234G: Chloracetanilides (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Metolachlor	51218-45-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EP234H: Triazine Herbicides (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Ametryn	834-12-8	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Atrazine	1912-24-9	0.01	µg/L	0.06	0.06	0.00	No Limit
		EP234-1: Prometryn	7287-19-6	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Propazine	139-40-2	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Terbuthylazine	5915-41-3	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Terbutryn	886-50-0	0.01	µg/L	<0.01	<0.01	0.00	No Limit
		EP234-1: Cyanazine	21725-46-2	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Simazine	122-34-9	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Cyromazine	66215-27-8	0.05	µg/L	<0.05	<0.05	0.00	No Limit
EP234I: Miscellaneous (ESI Positive Mode) Pesticides (QC Lot: 276928)									
ES1535894-016	Anonymous	EP234-1: Irgarol	28159-98-0	0.002	µg/L	<0.002	<0.002	0.00	No Limit
		EP234-1: Fenarimol	60168-88-9	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Thiamethoxam	153719-23-4	0.02	µg/L	<0.02	<0.02	0.00	No Limit
		EP234-1: Diclofop-methyl	51338-27-3	0.05	µg/L	<0.05	<0.05	0.00	No Limit
		EP234-1: Oxyfluorfen	42874-03-3	1	µg/L	<1.0	<1.0	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EA010P: Conductivity by PC Titrator (QCLot: 275166)								
EA010-P: Electrical Conductivity @ 25°C	----	1	µS/cm	<1	2000 µS/cm	108	95	113
EA025: Total Suspended Solids dried at 104 ± 2°C (QCLot: 279024)								
EA025H: Suspended Solids (SS)	----	5	mg/L	<5	150 mg/L	103	83	129
				<5	1000 mg/L	104	82	110
EA036: Fixed/Volatile Suspended Solids (QCLot: 279026)								
EA036H: Fixed Suspended Solids @ 550 C (Fraction of Suspended S)	----	1	%	<1	----	----	----	----
EA036H: Volatile Suspended Solids @ 550 C (Fraction of Suspended S)	----	1	%	<1	----	----	----	----
EA036H: Volatile Suspended Solids @ 550°C	----	5	mg/L	<5	----	----	----	----
EA040: Colour (Apparent) (QCLot: 277282)								
EA040: Colour (Apparent)	----	1	PCU	<1	20 PCU	100	90	110
EA041: Colour (True) (QCLot: 277283)								
EA041: Colour (True)	----	1	PCU	<1	20 PCU	100	90	110
EA250: Gross Alpha and Beta Activity (QCLot: 278277)								
EA250-LSC: Gross alpha	----	0.05	Bq/L	<0.05	1751 Bq/L	98.7	70	130
EA250-LSC: Gross beta activity - 40K	----	0.1	Bq/L	<0.10	3342 Bq/L	99.3	70	130
ED037P: Alkalinity by PC Titrator (QCLot: 275164)								
ED037-P: Total Alkalinity as CaCO3	----	----	mg/L	----	200 mg/L	92.9	81	111
ED040F: Dissolved Major Anions (QCLot: 275139)								
ED040F: Silicon as SiO2	14464-46-1	0.1	mg/L	<0.1	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 275135)								
ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	<1	25 mg/L	99.8	82	122
ED045G: Chloride by Discrete Analyser (QCLot: 275136)								
ED045G: Chloride	16887-00-6	1	mg/L	<1	10 mg/L	95.4	75	123
				<1	1000 mg/L	97.3	78	128
ED093F: Dissolved Major Cations (QCLot: 277441)								
ED093F: Calcium	7440-70-2	1	mg/L	<1	50 mg/L	95.5	80	114
ED093F: Magnesium	7439-95-4	1	mg/L	<1	50 mg/L	99.0	90	116
ED093F: Potassium	7440-09-7	1	mg/L	<1	50 mg/L	96.5	85	113
ED093F: Sodium	7440-23-5	1	mg/L	<1	50 mg/L	93.5	82	120
EG020F: Dissolved Metals by ICP-MS (QCLot: 277437)								
EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 277437) - continued								
EG020B-F: Strontium	7440-24-6	0.001	mg/L	<0.001	0.1 mg/L	86.8	81	113
EG020B-F: Titanium	7440-32-6	0.01	mg/L	<0.01	0.1 mg/L	78.5	77	119
EG020F: Dissolved Metals by ICP-MS (QCLot: 277439)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	91.9	80	116
EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	0.01 mg/L	102	85	115
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	99.8	85	114
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	93.1	82	110
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	98.1	85	115
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.1 mg/L	96.3	85	115
EG020A-F: Bromine	7726-95-6	0.1	mg/L	<0.1	----	----	----	----
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	94.7	84	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	85.3	85	111
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	89.2	82	112
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	91.2	81	111
EG020A-F: Iodine	7553-56-2	0.1	mg/L	<0.1	----	----	----	----
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	90.2	82	112
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	92.9	83	111
EG020A-F: Lithium	7439-93-2	0.001	mg/L	<0.001	0.1 mg/L	98.6	79	117
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	93.4	82	110
EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	90.7	79	113
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	86.4	82	112
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	87.2	85	115
EG020A-F: Thallium	7440-28-0	0.001	mg/L	<0.001	0.1 mg/L	90.9	85	111
EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	96.3	77	115
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	90.7	83	109
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	88.5	81	117
EG020T: Total Metals by ICP-MS (QCLot: 277693)								
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	104	82	120
EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	97.9	82	114
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	95.3	84	116
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	93.7	79	119
EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	0.1 mg/L	95.5	75	129
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	96.1	84	112
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	100	86	116
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	99.8	84	116
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	97.2	83	118
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	103	85	117
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	100	85	115

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 277693) - continued								
EG020A-T: Lithium	7439-93-2	0.001	mg/L	<0.001	0.1 mg/L	98.9	82	122
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	96.4	85	113
EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	105	83	121
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	96.4	84	116
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	105	68	126
EG020A-T: Thallium	7440-28-0	0.001	mg/L	<0.001	0.1 mg/L	99.6	87	117
EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	110	83	123
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	100	85	113
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	94.2	79	117
EG020T: Total Metals by ICP-MS (QCLot: 277694)								
EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----
EG020B-T: Strontium	7440-24-6	0.001	mg/L	<0.001	0.1 mg/L	94.7	84	118
EG020B-T: Titanium	7440-32-6	0.01	mg/L	<0.01	0.1 mg/L	88.5	80	124
EG020U: Unfiltered Metals by ICP-MS (QCLot: 280184)								
EG020A-U: Bromine	7726-95-6	0.05	mg/L	<0.05	----	----	----	----
EG020A-U: Iodine	7553-56-2	0.05	mg/L	<0.05	----	----	----	----
EG032: Arsenic Speciation by LC-ICPMS (QCLot: 276684)								
EG032: Arsenic Acid, As (V)	----	0.5	µg/L	<0.5	10 µg/L	99.1	79	121
EG032: Arsenious Acid, As (III)	----	0.5	µg/L	<0.5	10 µg/L	109	79	125
EG035F: Dissolved Mercury by FIMS (QCLot: 277438)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	95.2	83	105
EG035T: Total Recoverable Mercury by FIMS (QCLot: 279772)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	91.5	77	111
EG050F: Dissolved Hexavalent Chromium (QCLot: 277273)								
EG050G-F: Hexavalent Chromium	18540-29-9	0.01	mg/L	<0.01	0.5 mg/L	108	86	112
EK010/011: Chlorine (QCLot: 276830)								
EK010: Chlorine - Free	----	0.2	mg/L	<0.2	----	----	----	----
EK010: Chlorine - Total Residual	----	0.2	mg/L	<0.2	----	----	----	----
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 275210)								
EK026SF: Total Cyanide	57-12-5	0.004	mg/L	<0.004	0.2 mg/L	112	73	133
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser (QCLot: 275209)								
EK028SF: Weak Acid Dissociable Cyanide	----	0.004	mg/L	<0.004	0.2 mg/L	105	93	127
EK040P: Fluoride by PC Titrator (QCLot: 275163)								
EK040P: Fluoride	16984-48-8	0.1	mg/L	<0.1	5 mg/L	101	82	116
EK055G: Ammonia as N by Discrete Analyser (QCLot: 276957)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	97.9	90	114
EK057G: Nitrite as N by Discrete Analyser (QCLot: 275137)								

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	Recovery Limits (%) High
EK057G: Nitrite as N by Discrete Analyser (QCLot: 275137) - continued								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	97.4	82	114
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 276958)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	101	91	113
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 276935)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	90.4	69	101
				<0.1	1 mg/L	90.2	70	118
				<0.1	5 mg/L	93.3	74	118
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 276934)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	87.8	71	101
				<0.01	0.442 mg/L	90.6	72	108
				<0.01	1 mg/L	91.3	78	118
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 275138)								
EK071G: Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	0.5 mg/L	99.1	85	117
EK085M: Sulfide as S2- (QCLot: 279129)								
EK085: Sulfide as S2-	18496-25-8	0.1	mg/L	<0.1	0.5 mg/L	95.8	76	116
EK086: Sulfite as SO3 2- (QCLot: 277284)								
EK086: Sulfite as SO3 2-	14265-45-3	2	mg/L	<2	50 mg/L	102	80	108
EK087: Thiosulfate as S2O3 2- (QCLot: 277285)								
EK087: Thiosulfate as S2O3 2-	----	2	mg/L	<2	50 mg/L	95.2	88	120
EP005: Total Organic Carbon (TOC) (QCLot: 274591)								
EP005: Total Organic Carbon	----	1	mg/L	<1	10 mg/L	106	72	120
EP010: Formaldehyde (QCLot: 277026)								
EP010: Formaldehyde	50-00-0	0.1	mg/L	<0.1	2 mg/L	103	83	111
EP020: Oil and Grease (O&G) (QCLot: 280242)								
EP020: Oil & Grease	----	5	mg/L	<5	5000 mg/L	98.2	81	121
EP026SP: Chemical Oxygen Demand (Spectrophotometric) (QCLot: 279509)								
EP026SP: Chemical Oxygen Demand	----	10	mg/L	<10	50 mg/L	100	82	112
				<10	500 mg/L	97.2	83	113
EP041A: Nonionic Surfactants (QCLot: 275763)								
EP041A: Nonionic Surfactants as CTAS	----	5	mg/L	<5	5 mg/L	117	78	124
EP050: Anionic Surfactants as MBAS (QCLot: 277603)								
EP050: Anionic Surfactants as MBAS		0.1	mg/L	<0.1	2 mg/L	90.0	74	118
EP066: Polychlorinated Biphenyls (PCB) (QCLot: 276810)								
EP066: Total Polychlorinated biphenyls	----	1	µg/L	<1	10 µg/L	102	62	107
EP068A: Organochlorine Pesticides (OC) (QCLot: 276811)								
EP068: 4.4`-DDD	72-54-8	0.5	µg/L	<0.5	5 µg/L	78.8	72	122
EP068: 4.4`-DDE	72-55-9	0.5	µg/L	<0.5	5 µg/L	80.8	67	119

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP068A: Organochlorine Pesticides (OC) (QCLot: 276811) - continued								
EP068: 4.4`-DDT	50-29-3	2	µg/L	<2.0	5 µg/L	81.1	60	122
EP068: Aldrin	309-00-2	0.5	µg/L	<0.5	5 µg/L	85.8	66	116
EP068: alpha-BHC	319-84-6	0.5	µg/L	<0.5	5 µg/L	85.2	65	113
EP068: alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	5 µg/L	89.6	66	120
EP068: beta-BHC	319-85-7	0.5	µg/L	<0.5	5 µg/L	87.7	69	117
EP068: beta-Endosulfan	33213-65-9	0.5	µg/L	<0.5	5 µg/L	99.8	71	119
EP068: cis-Chlordane	5103-71-9	0.5	µg/L	<0.5	5 µg/L	85.8	64	120
EP068: delta-BHC	319-86-8	0.5	µg/L	<0.5	5 µg/L	93.6	67	117
EP068: Dieldrin	60-57-1	0.5	µg/L	<0.5	5 µg/L	97.0	66	120
EP068: Endosulfan sulfate	1031-07-8	0.5	µg/L	<0.5	5 µg/L	74.9	60	126
EP068: Endrin	72-20-8	0.5	µg/L	<0.5	5 µg/L	87.6	66	122
EP068: Endrin aldehyde	7421-93-4	0.5	µg/L	<0.5	5 µg/L	97.4	64	116
EP068: Endrin ketone	53494-70-5	0.5	µg/L	<0.5	5 µg/L	74.6	62	124
EP068: gamma-BHC	58-89-9	0.5	µg/L	<0.5	5 µg/L	87.2	70	112
EP068: Heptachlor	76-44-8	0.5	µg/L	<0.5	5 µg/L	81.0	63	113
EP068: Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	5 µg/L	87.6	59	123
EP068: Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	5 µg/L	75.5	54	114
EP068: Methoxychlor	72-43-5	2	µg/L	<2.0	5 µg/L	83.2	53	127
EP068: trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	5 µg/L	75.9	61	121
EP068B: Organophosphorus Pesticides (OP) (QCLot: 276811)								
EP068: Azinphos Methyl	86-50-0	0.5	µg/L	<0.5	5 µg/L	77.9	44	130
EP068: Bromophos-ethyl	4824-78-6	0.5	µg/L	<0.5	5 µg/L	80.0	63	125
EP068: Carbophenothion	786-19-6	0.5	µg/L	<0.5	5 µg/L	85.8	68	124
EP068: Chlorfenvinphos	470-90-6	0.5	µg/L	<0.5	5 µg/L	84.3	69	119
EP068: Chlorpyrifos	2921-88-2	0.5	µg/L	<0.5	5 µg/L	92.8	75	1196
EP068: Chlorpyrifos-methyl	5598-13-0	0.5	µg/L	<0.5	5 µg/L	82.8	77	119
EP068: Demeton-S-methyl	919-86-8	0.5	µg/L	<0.5	5 µg/L	85.5	62	124
EP068: Diazinon	333-41-5	0.5	µg/L	<0.5	5 µg/L	90.6	70	120
EP068: Dichlorvos	62-73-7	0.5	µg/L	<0.5	5 µg/L	91.4	69	119
EP068: Dimethoate	60-51-5	0.5	µg/L	<0.5	5 µg/L	103	65	121
EP068: Ethion	563-12-2	0.5	µg/L	<0.5	5 µg/L	87.4	74	120
EP068: Fenamiphos	22224-92-6	0.5	µg/L	<0.5	5 µg/L	82.5	69	125
EP068: Fenthion	55-38-9	0.5	µg/L	<0.5	5 µg/L	79.6	68	122
EP068: Malathion	121-75-5	0.5	µg/L	<0.5	5 µg/L	91.6	70	124
EP068: Monocrotophos	6923-22-4	2	µg/L	<2.0	5 µg/L	26.2	20	48
EP068: Parathion	56-38-2	2	µg/L	<2.0	5 µg/L	78.8	67	121
EP068: Parathion-methyl	298-00-0	2	µg/L	<2.0	5 µg/L	78.9	70	124
EP068: Pirimphos-ethyl	23505-41-1	0.5	µg/L	<0.5	5 µg/L	90.7	69	121
EP068: Prothiofos	34643-46-4	0.5	µg/L	<0.5	5 µg/L	82.9	61	111231

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	Recovery Limits (%) High
EP074A: Monocyclic Aromatic Hydrocarbons (QCLot: 274938)								
EP074: 1.2.4-Trimethylbenzene	95-63-6	5	µg/L	<5	10 µg/L	103	74	116
EP074: 1.3.5-Trimethylbenzene	108-67-8	5	µg/L	<5	10 µg/L	101	74	116
EP074: Benzene	71-43-2	1	µg/L	<1	10 µg/L	104	77	119
EP074: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	102	76	118
EP074: Isopropylbenzene	98-82-8	5	µg/L	<5	10 µg/L	104	76	118
EP074: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	20 µg/L	108	77	119
EP074: n-Butylbenzene	104-51-8	5	µg/L	<5	10 µg/L	97.0	65	123
EP074: n-Propylbenzene	103-65-1	5	µg/L	<5	10 µg/L	98.9	69	119
EP074: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	110	79	117
EP074: p-Isopropyltoluene	99-87-6	5	µg/L	<5	10 µg/L	100	71	119
EP074: sec-Butylbenzene	135-98-8	5	µg/L	<5	10 µg/L	102	73	119
EP074: Styrene	100-42-5	5	µg/L	<5	10 µg/L	106	73	119
EP074: tert-Butylbenzene	98-06-6	5	µg/L	<5	10 µg/L	101	72	116
EP074: Toluene	108-88-3	2	µg/L	<2	10 µg/L	103	69	129
EP074B: Oxygenated Compounds (QCLot: 274938)								
EP074: 2-Butanone (MEK)	78-93-3	50	µg/L	<50	100 µg/L	74.0	74	130
EP074: 2-Hexanone (MBK)	591-78-6	50	µg/L	<50	100 µg/L	84.5	65	137
EP074: 2-Propanone (Acetone)	67-64-1	50	µg/L	<50	100 µg/L	66.3	65	137
EP074: 4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L	<50	100 µg/L	106	66	132
EP074: Vinyl Acetate	108-05-4	50	µg/L	<50	100 µg/L	99.3	61	134
EP074C: Sulfonated Compounds (QCLot: 274938)								
EP074: Carbon disulfide	75-15-0	5	µg/L	<5	10 µg/L	116	73	127
EP074D: Fumigants (QCLot: 274938)								
EP074: 1.2-Dibromoethane (EDB)	106-93-4	5	µg/L	<5	10 µg/L	96.0	69	117
EP074: 1.2-Dichloropropane	78-87-5	5	µg/L	<5	10 µg/L	102	76	118
EP074: 2.2-Dichloropropane	594-20-7	5	µg/L	<5	10 µg/L	88.0	68	122
EP074: cis-1.3-Dichloropropylene	10061-01-5	5	µg/L	<5	10 µg/L	116	62	120
EP074: trans-1.3-Dichloropropylene	10061-02-6	5	µg/L	<5	10 µg/L	94.3	60	114
EP074E: Halogenated Aliphatic Compounds (QCLot: 274938)								
EP074: 1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L	<5	10 µg/L	98.1	66	114
EP074: 1.1.1-Trichloroethane	71-55-6	5	µg/L	<5	10 µg/L	89.0	67	119
EP074: 1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L	<5	10 µg/L	106	70	124
EP074: 1.1.2-Trichloroethane	79-00-5	5	µg/L	<5	10 µg/L	105	72	126
EP074: 1.1-Dichloroethane	75-34-3	5	µg/L	<5	10 µg/L	102	74	120
EP074: 1.1-Dichloroethene	75-35-4	5	µg/L	<5	10 µg/L	101	70	124
EP074: 1.1-Dichloropropylene	563-58-6	5	µg/L	<5	10 µg/L	100	73	119
EP074: 1.2.3-Trichloropropane	96-18-4	5	µg/L	<5	10 µg/L	105	74	126

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	Recovery Limits (%) High
EP074E: Halogenated Aliphatic Compounds (QCLot: 274938) - continued								
EP074: 1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L	<5	10 µg/L	114	66	136
EP074: 1.2-Dichloroethane	107-06-2	5	µg/L	<5	10 µg/L	105	73	123
EP074: 1.3-Dichloropropane	142-28-9	5	µg/L	<5	10 µg/L	104	71	129
EP074: Bromomethane	74-83-9	50	µg/L	<50	100 µg/L	102	56	140
EP074: Carbon Tetrachloride	56-23-5	5	µg/L	<5	10 µg/L	107	62	120
EP074: Chloroethane	75-00-3	50	µg/L	<50	100 µg/L	108	61	139
EP074: Chloromethane	74-87-3	50	µg/L	<50	100 µg/L	83.9	67	130
EP074: cis-1.2-Dichloroethene	156-59-2	5	µg/L	<5	10 µg/L	104	77	119
EP074: cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L	<5	10 µg/L	93.5	71	128
EP074: Dibromomethane	74-95-3	5	µg/L	<5	10 µg/L	99.2	73	119
EP074: Dichlorodifluoromethane	75-71-8	50	µg/L	<50	100 µg/L	73.6	61	138
EP074: Hexachlorobutadiene	87-68-3	5	µg/L	<5	10 µg/L	96.5	58	130
EP074: Iodomethane	74-88-4	5	µg/L	<5	10 µg/L	92.4	70	128
EP074: Methylene chloride	75-09-2	5	µg/L	<5	10 µg/L	98.9	69	133
EP074: Pentachloroethane	76-01-7	5	µg/L	<5	10 µg/L	112	72	126
EP074: Tetrachloroethene	127-18-4	5	µg/L	<5	10 µg/L	101	72	124
EP074: trans-1.2-Dichloroethene	156-60-5	5	µg/L	<5	10 µg/L	102	74	118
EP074: trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L	<5	10 µg/L	95.5	60	120
EP074: Trichloroethene	79-01-6	5	µg/L	<5	10 µg/L	104	76	118
EP074: Trichlorofluoromethane	75-69-4	50	µg/L	<50	100 µg/L	106	69	131
EP074: Vinyl chloride	75-01-4	50	µg/L	<50	100 µg/L	108	69	129
EP074F: Halogenated Aromatic Compounds (QCLot: 274938)								
EP074: 1.2.3-Trichlorobenzene	87-61-6	5	µg/L	<5	10 µg/L	100	67	123
EP074: 1.2.4-Trichlorobenzene	120-82-1	5	µg/L	<5	10 µg/L	95.1	61	125
EP074: 1.2-Dichlorobenzene	95-50-1	5	µg/L	<5	10 µg/L	102	75	117
EP074: 1.3-Dichlorobenzene	541-73-1	5	µg/L	<5	10 µg/L	102	75	117
EP074: 1.4-Dichlorobenzene	106-46-7	5	µg/L	<5	10 µg/L	102	74	118
EP074: 2-Chlorotoluene	95-49-8	5	µg/L	<5	10 µg/L	102	73	119
EP074: 4-Chlorotoluene	106-43-4	5	µg/L	<5	10 µg/L	102	73	119
EP074: Bromobenzene	108-86-1	5	µg/L	<5	10 µg/L	104	76	116
EP074: Chlorobenzene	108-90-7	5	µg/L	<5	10 µg/L	105	79	117
EP074G: Trihalomethanes (QCLot: 274938)								
EP074: Bromodichloromethane	75-27-4	5	µg/L	<5	10 µg/L	97.6	64	118
EP074: Bromoform	75-25-2	5	µg/L	<5	10 µg/L	107	74	126
EP074: Chloroform	67-66-3	5	µg/L	<5	10 µg/L	106	72	120
EP074: Dibromochloromethane	124-48-1	5	µg/L	<5	10 µg/L	109	65	115
EP075A: Phenolic Compounds (QCLot: 276812)								
EP075: 2.4.5-Trichlorophenol	95-95-4	2	µg/L	<2	5 µg/L	78.0	58	110

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	High
EP075A: Phenolic Compounds (QCLot: 276812) - continued								
EP075: 2.4.6-Trichlorophenol	88-06-2	2	µg/L	<2	5 µg/L	68.6	58	112
EP075: 2.4-Dichlorophenol	120-83-2	2	µg/L	<2	5 µg/L	69.1	62	109
EP075: 2.4-Dimethylphenol	105-67-9	2	µg/L	<2	5 µg/L	65.1	50	94
EP075: 2.6-Dichlorophenol	87-65-0	2	µg/L	<2	5 µg/L	70.6	62	108
EP075: 2-Chlorophenol	95-57-8	2	µg/L	<2	5 µg/L	63.6	52	88
EP075: 2-Methylphenol	95-48-7	2	µg/L	<2	5 µg/L	62.2	50	94
EP075: 2-Nitrophenol	88-75-5	2	µg/L	<2	5 µg/L	67.3	48	98
EP075: 3- & 4-Methylphenol	1319-77-3	4	µg/L	<4	10 µg/L	48.9	45	96
EP075: 4-Chloro-3-methylphenol	59-50-7	2	µg/L	<2	5 µg/L	71.3	61	107
EP075: Pentachlorophenol	87-86-5	4	µg/L	<4	10 µg/L	45.2	13	95
EP075: Phenol	108-95-2	2	µg/L	<2	5 µg/L	47.2	26	64
EP075B: Polynuclear Aromatic Hydrocarbons (QCLot: 276812)								
EP075: 2-Chloronaphthalene	91-58-7	2	µg/L	<2	5 µg/L	69.4	61	106
EP075: 2-Methylnaphthalene	91-57-6	2	µg/L	<2	5 µg/L	68.6	59	108
EP075: 3-Methylcholanthrene	56-49-5	2	µg/L	<2	5 µg/L	87.7	60	110
EP075: 7.12-Dimethylbenz(a)anthracene	57-97-6	2	µg/L	<2	5 µg/L	92.1	50	108
EP075: Acenaphthene	83-32-9	2	µg/L	<2	5 µg/L	75.7	65	108
EP075: Acenaphthylene	208-96-8	2	µg/L	<2	5 µg/L	75.8	64	108
EP075: Anthracene	120-12-7	2	µg/L	<2	5 µg/L	82.7	66	108
EP075: Benz(a)anthracene	56-55-3	2	µg/L	<2	5 µg/L	82.2	62	112
EP075: Benzo(a)pyrene	50-32-8	2	µg/L	<2	5 µg/L	89.8	59	112
EP075: Benzo(a)pyrene TEQ (zero)	----	2	µg/L	<2	----	----	----	----
EP075: Benzo(b+j) & Benzo(k)fluoranthene	205-99-2 207-08-9	4	µg/L	<4	10 µg/L	89.1	60	111
EP075: Benzo(g.h.i)perylene	191-24-2	2	µg/L	<2	5 µg/L	86.0	61	110
EP075: Chrysene	218-01-9	2	µg/L	<2	5 µg/L	86.2	59	114
EP075: Dibenz(a.h)anthracene	53-70-3	2	µg/L	<2	5 µg/L	82.1	57	109
EP075: Fluoranthene	206-44-0	2	µg/L	<2	5 µg/L	86.3	65	109
EP075: Fluorene	86-73-7	2	µg/L	<2	5 µg/L	77.9	65	107
EP075: Indeno(1.2.3.cd)pyrene	193-39-5	2	µg/L	<2	5 µg/L	84.2	60	110
EP075: N-2-Fluorenyl Acetamide	53-96-3	2	µg/L	<2	5 µg/L	82.8	60	110
EP075: Naphthalene	91-20-3	2	µg/L	<2	5 µg/L	66.6	51	95
EP075: Phenanthrene	85-01-8	2	µg/L	<2	5 µg/L	82.2	67	108
EP075: Pyrene	129-00-0	2	µg/L	<2	5 µg/L	83.9	60	111
EP075C: Phthalate Esters (QCLot: 276812)								
EP075: bis(2-ethylhexyl) phthalate	117-81-7	----	µg/L	----	5 µg/L	96.1	60	132
EP075: Butyl benzyl phthalate	85-68-7	2	µg/L	<2	5 µg/L	88.3	61	114
EP075: Diethyl phthalate	84-66-2	2	µg/L	<2	5 µg/L	89.5	67	111
EP075: Dimethyl phthalate	131-11-3	2	µg/L	<2	5 µg/L	85.5	64	112

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report Result	Laboratory Control Spike (LCS) Report Spike Concentration	Spike Recovery (%) LCS	Recovery Limits (%) Low	Recovery Limits (%) High
EP075C: Phthalate Esters (QCLot: 276812) - continued								
EP075: Di-n-butyl phthalate	84-74-2	2	µg/L	<2	5 µg/L	91.0	68	122
EP075: Di-n-octylphthalate	117-84-0	2	µg/L	<2	5 µg/L	92.6	62	115
EP075D: Nitrosamines (QCLot: 276812)								
EP075: Methapyrilene	91-80-5	2	µg/L	<2	5 µg/L	92.2	23	125
EP075: N-Nitrosodibutylamine	924-16-3	2	µg/L	<2	5 µg/L	72.5	63	108
EP075: N-Nitrosodiethylamine	55-18-5	2	µg/L	<2	5 µg/L	87.1	61	113
EP075: N-Nitrosodi-n-propylamine	621-64-7	2	µg/L	<2	5 µg/L	76.3	64	108
EP075: N-Nitrosodiphenyl & Diphenylamine	86-30-6 122-39-4	4	µg/L	<4	10 µg/L	84.2	65	112
EP075: N-Nitrosomethylethylamine	10595-95-6	2	µg/L	<2	5 µg/L	95.8	46	110
EP075: N-Nitrosomorpholine	59-89-2	2	µg/L	<2	5 µg/L	64.0	42	100
EP075: N-Nitrosopiperidine	100-75-4	2	µg/L	<2	5 µg/L	66.4	62	107
EP075: N-Nitrosopyrrolidine	930-55-2	4	µg/L	<4	5 µg/L	74.4	45	91
EP075E: Nitroaromatics and Ketones (QCLot: 276812)								
EP075: 1.3.5-Trinitrobenzene	99-35-4	2	µg/L	<2	5 µg/L	62.9	46	108
EP075: 1-Naphthylamine	134-32-7	2	µg/L	<2	5 µg/L	59.4	47	102
EP075: 2.4-Dinitrotoluene	121-14-2	4	µg/L	<4	5 µg/L	81.9	60	109
EP075: 2.6-Dinitrotoluene	606-20-2	4	µg/L	<4	5 µg/L	80.0	64	113
EP075: 2-Picoline	109-06-8	2	µg/L	<2	5 µg/L	51.4	41	109
EP075: 4-Aminobiphenyl	92-67-1	2	µg/L	<2	5 µg/L	64.9	60	112
EP075: 4-Nitroquinoline-N-oxide	56-57-5	2	µg/L	<2	5 µg/L	45.6	40	96
EP075: 5-Nitro-o-toluidine	99-55-8	2	µg/L	<2	5 µg/L	78.4	58	106
EP075: Acetophenone	98-86-2	2	µg/L	<2	5 µg/L	# 67.2	68	112
EP075: Azobenzene	103-33-3	2	µg/L	<2	5 µg/L	83.3	66	112
EP075: Chlorobenzilate	510-15-6	2	µg/L	<2	5 µg/L	92.5	58	110
EP075: Dimethylaminoazobenzene	60-11-7	2	µg/L	<2	5 µg/L	79.1	59	108
EP075: Isophorone	78-59-1	2	µg/L	<2	5 µg/L	76.2	68	111
EP075: Nitrobenzene	98-95-3	2	µg/L	<2	5 µg/L	# 66.3	68	112
EP075: Pentachloronitrobenzene	82-68-8	2	µg/L	<2	5 µg/L	81.8	59	109
EP075: Phenacetin	62-44-2	2	µg/L	<2	5 µg/L	74.0	58	101
EP075: Pronamide	23950-58-5	2	µg/L	<2	5 µg/L	89.0	63	109
EP075F: Haloethers (QCLot: 276812)								
EP075: 4-Bromophenyl phenyl ether	101-55-3	2	µg/L	<2	5 µg/L	83.7	62	108
EP075: 4-Chlorophenyl phenyl ether	7005-72-3	2	µg/L	<2	5 µg/L	75.3	65	109
EP075: Bis(2-chloroethoxy) methane	111-91-1	2	µg/L	<2	5 µg/L	72.5	66	111
EP075: Bis(2-chloroethyl) ether	111-44-4	2	µg/L	<2	5 µg/L	# 68.4	69	112
EP075G: Chlorinated Hydrocarbons (QCLot: 276812)								
EP075: 1.2.4-Trichlorobenzene	120-82-1	2	µg/L	<2	5 µg/L	61.0	46	96

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP075G: Chlorinated Hydrocarbons (QCLot: 276812) - continued								
EP075: 1.2-Dichlorobenzene	95-50-1	2	µg/L	<2	5 µg/L	56.0	41	95
EP075: 1.3-Dichlorobenzene	541-73-1	2	µg/L	<2	5 µg/L	57.1	40	96
EP075: 1.4-Dichlorobenzene	106-46-7	2	µg/L	<2	5 µg/L	57.1	41	97
EP075: Hexachlorobenzene (HCB)	118-74-1	4	µg/L	<4	5 µg/L	79.9	66	110
EP075: Hexachlorobutadiene	87-68-3	2	µg/L	<2	5 µg/L	61.5	37	100
EP075: Hexachlorocyclopentadiene	77-47-4	10	µg/L	<10	5 µg/L	# 19.3	24	107
EP075: Hexachloroethane	67-72-1	2	µg/L	<2	5 µg/L	59.2	46	88
EP075: Hexachloropropylene	1888-71-7	2	µg/L	<2	5 µg/L	60.6	34	96
EP075: Pentachlorobenzene	608-93-5	2	µg/L	<2	5 µg/L	74.4	65	107
EP075H: Anilines and Benzidines (QCLot: 276812)								
EP075: 2-Nitroaniline	88-74-4	4	µg/L	<4	5 µg/L	72.4	61	110
EP075: 3.3`-Dichlorobenzidine	91-94-1	2	µg/L	<2	5 µg/L	90.6	60	119
EP075: 3-Nitroaniline	99-09-2	4	µg/L	<4	5 µg/L	71.9	52	97
EP075: 4-Chloroaniline	106-47-8	2	µg/L	<2	5 µg/L	70.3	42	106
EP075: 4-Nitroaniline	100-01-6	2	µg/L	<2	5 µg/L	84.2	49	100
EP075: Aniline	62-53-3	2	µg/L	<2	5 µg/L	69.0	50	104
EP075: Carbazole	86-74-8	2	µg/L	<2	5 µg/L	84.1	64	107
EP075: Dibenzofuran	132-64-9	2	µg/L	<2	5 µg/L	76.4	65	108
EP075I: Organochlorine Pesticides (QCLot: 276812)								
EP075: 4.4`-DDD	72-54-8	2	µg/L	<2	5 µg/L	88.4	55	115
EP075: 4.4`-DDE	72-55-9	2	µg/L	<2	5 µg/L	89.1	53	115
EP075: 4.4`-DDT	50-29-3	4	µg/L	<4	5 µg/L	84.7	56	114
EP075: Aldrin	309-00-2	2	µg/L	<2	5 µg/L	83.6	56	112
EP075: alpha-BHC	319-84-6	2	µg/L	<2	5 µg/L	84.3	64	110
EP075: alpha-Endosulfan	959-98-8	2	µg/L	<2	5 µg/L	91.0	59	111
EP075: beta-BHC	319-85-7	2	µg/L	<2	5 µg/L	76.7	53	107
EP075: beta-Endosulfan	33213-65-9	2	µg/L	<2	5 µg/L	96.6	54	116
EP075: delta-BHC	319-86-8	2	µg/L	<2	5 µg/L	87.2	57	111
EP075: Dieldrin	60-57-1	2	µg/L	<2	5 µg/L	84.8	59	115
EP075: Endosulfan sulfate	1031-07-8	2	µg/L	<2	5 µg/L	94.6	53	114
EP075: Endrin	72-20-8	2	µg/L	<2	5 µg/L	88.5	58	114
EP075: gamma-BHC	58-89-9	2	µg/L	<2	5 µg/L	82.4	51	111
EP075: Heptachlor	76-44-8	2	µg/L	<2	5 µg/L	81.3	58	108
EP075: Heptachlor epoxide	1024-57-3	2	µg/L	<2	5 µg/L	83.6	50	118
EP075: Sum of Aldrin + Dieldrin	309-00-2/60-57-1	4	µg/L	<4	----	----	----	----
EP075: Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	4	µg/L	<4	----	----	----	----
EP075J: Organophosphorus Pesticides (QCLot: 276812)								

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EP075J: Organophosphorus Pesticides (QCLot: 276812) - continued								
EP075: Chlorfenvinphos	470-90-6	2	µg/L	<2	5 µg/L	82.4	50	116
EP075: Chlorpyrifos	2921-88-2	2	µg/L	<2	5 µg/L	91.3	53	109
EP075: Chlorpyrifos-methyl	5598-13-0	2	µg/L	<2	5 µg/L	82.7	54	116
EP075: Diazinon	333-41-5	2	µg/L	<2	5 µg/L	90.4	49	113
EP075: Dichlorvos	62-73-7	2	µg/L	<2	5 µg/L	82.0	51	113
EP075: Dimethoate	60-51-5	2	µg/L	<2	5 µg/L	80.2	43	109
EP075: Ethion	563-12-2	2	µg/L	<2	5 µg/L	92.6	51	117
EP075: Fenthion	55-38-9	2	µg/L	<2	5 µg/L	86.6	57	115
EP075: Malathion	121-75-5	2	µg/L	<2	5 µg/L	106	54	1254
EP075: Pirimphos-ethyl	23505-41-1	2	µg/L	<2	5 µg/L	87.8	55	111
EP075: Prothiofos	34643-46-4	2	µg/L	<2	5 µg/L	87.5	54	118
EP080/071: Total Petroleum Hydrocarbons (QCLot: 274940)								
EP080: C6 - C9 Fraction	----	20	µg/L	<20	260 µg/L	88.3	75	127
EP080/071: Total Petroleum Hydrocarbons (QCLot: 276813)								
EP071: C10 - C14 Fraction	----	50	µg/L	<50	2000 µg/L	99.0	76	116
EP071: C15 - C28 Fraction	----	100	µg/L	<100	3000 µg/L	99.2	83	109
EP071: C29 - C36 Fraction	----	50	µg/L	<50	2000 µg/L	91.3	75	113
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 274940)								
EP080: C6 - C10 Fraction	C6_C10	20	µg/L	<20	310 µg/L	89.0	75	127
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 276813)								
EP071: >C10 - C16 Fraction	----	100	µg/L	<100	2500 µg/L	93.5	76	114
EP071: >C16 - C34 Fraction	----	100	µg/L	<100	3500 µg/L	94.8	81	111
EP071: >C34 - C40 Fraction	----	100	µg/L	<100	1500 µg/L	100	77	119
EP080: BTEXN (QCLot: 274940)								
EP080: Benzene	71-43-2	1	µg/L	<1	10 µg/L	100	70	122
EP080: Ethylbenzene	100-41-4	2	µg/L	<2	10 µg/L	91.8	70	120
EP080: meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	10 µg/L	92.1	69	121
EP080: Naphthalene	91-20-3	5	µg/L	<5	10 µg/L	95.3	70	120
EP080: ortho-Xylene	95-47-6	2	µg/L	<2	10 µg/L	94.8	72	122
EP080: Toluene	108-88-3	2	µg/L	<2	10 µg/L	91.8	69	123
EP090: Organotin Compounds (Soluble) (QCLot: 277897)								
EP090S: Tributyltin	56573-85-4	2	ngSn/L	<2	147 ngSn/L	77.0	20	125
EP118: Nitrogenated Compounds (QCLot: 275422)								
EP118-1: Acrylonitrile	107-13-1	1	µg/L	<1	10 µg/L	107	72	130
EP121: Aldehydes (QCLot: 275068)								
EP121: Acetaldehyde	75-07-0	2	µg/L	<2.0	20 µg/L	103	79	117
EP121: Acrolein (Propenal)	107-02-8	2	µg/L	<2.0	20 µg/L	81.0	70	130

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP121: Aldehydes (QCLot: 275068) - continued								
EP121: Butyraldehyde	123-72-8	2	µg/L	<2.0	20 µg/L	97.1	72	118
EP121: Formaldehyde	50-00-0	2	µg/L	<2.0	20 µg/L	103	80	116
EP121: Propionaldehyde	123-38-6	2	µg/L	<2.0	20 µg/L	96.5	77	111
EP132A: Phenolic Compounds (QCLot: 276717)								
EP132: 2.3.4.6-Tetrachlorophenol	58-90-2	0.1	µg/L	<0.1	2 µg/L	106	52	132
EP132: 2.4.5-Trichlorophenol	95-95-4	0.1	µg/L	<0.1	2 µg/L	98.6	68	130
EP132: 2.4.6-Trichlorophenol	88-06-2	0.1	µg/L	<0.1	2 µg/L	86.6	63	129
EP132: 2.4-Dichlorophenol	120-83-2	0.1	µg/L	<0.1	2 µg/L	72.3	64	128
EP132: 2.4-Dimethylphenol	105-67-9	0.1	µg/L	<0.1	2 µg/L	77.3	55	131
EP132: 2.6-Dichlorophenol	87-65-0	0.1	µg/L	<0.1	2 µg/L	70.1	63	127
EP132: 2-Chlorophenol	95-57-8	0.05	µg/L	<0.05	2 µg/L	70.9	61	125
EP132: 2-Nitrophenol	88-75-5	0.1	µg/L	<0.1	2 µg/L	106	50	154
EP132: 4-Chloro-3-methylphenol	59-50-7	0.05	µg/L	<0.05	2 µg/L	69.4	61	125
EP132: 4-Nitrophenol	100-02-7	0.1	µg/L	<0.1	2 µg/L	87.7	22	142
EP132: Hexachlorophene	70-30-4	0.1	µg/L	<0.1	2 µg/L	90.4	34	138
EP132: m-Cresol	108-39-4	0.1	µg/L	<0.1	2 µg/L	51.1	42	118
EP132: o-Cresol	95-48-7	0.1	µg/L	<0.1	2 µg/L	55.3	50	122
EP132: p-Cresol	106-44-5	0.1	µg/L	<0.1	2 µg/L	44.0	38	124
EP132: Pentachlorophenol	87-86-5	0.05	µg/L	<0.05	2 µg/L	51.5	32	138
EP132: Phenol	108-95-2	0.1	µg/L	<0.1	2 µg/L	36.0	26	74
EP202A: Phenoxyacetic Acid Herbicides by LCMS (QCLot: 277738)								
EP202-SL: 2.4.5-T	93-76-5	10	µg/L	<10	100 µg/L	97.6	78	140
EP202-SL: 2.4-D	94-75-7	10	µg/L	<10	100 µg/L	99.5	77	139
EP202-SL: 2.4-DB	94-82-6	10	µg/L	<10	100 µg/L	101	65	147
EP202-SL: 2.4-DP	120-36-5	10	µg/L	<10	100 µg/L	99.7	76	144
EP202-SL: 4-Chlorophenoxy acetic acid	122-88-3	10	µg/L	<10	100 µg/L	102	82	136
EP202-SL: Clopyralid	1702-17-6	10	µg/L	<10	100 µg/L	85.5	70	145
EP202-SL: Dicamba	1918-00-9	10	µg/L	<10	100 µg/L	106	83	137
EP202-SL: Fluroxypyr	69377-81-7	10	µg/L	<10	100 µg/L	99.8	77	145
EP202-SL: MCPA	94-74-6	10	µg/L	<10	100 µg/L	95.6	76	140
EP202-SL: MCPB	94-81-5	10	µg/L	<10	100 µg/L	107	69	139
EP202-SL: Mecoprop	93-65-2	10	µg/L	<10	100 µg/L	97.3	75	143
EP202-SL: Picloram	1918-02-1	10	µg/L	<10	100 µg/L	103	70	144
EP202-SL: Silvex (2.4.5-TP/Fenoprop)	93-72-1	10	µg/L	<10	100 µg/L	102	75	143
EP202-SL: Triclopyr	55335-06-3	10	µg/L	<10	100 µg/L	99.4	77	141
EP203A: Explosives (QCLot: 274448)								
EP203-SL: 1.3.5-Trinitrobenzene	99-35-4	20	µg/L	<20	----	----	----	----
EP203-SL: 1.3-Dinitrobenzene	99-65-0	20	µg/L	<20	----	----	----	----

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP203A: Explosives (QCLot: 274448) - continued								
EP203-SL: 2.4.6-TNT	118-96-7	20	µg/L	<20	200 µg/L	112	63	145
EP203-SL: 2.4-Dinitrotoluene	121-14-2	20	µg/L	<20	200 µg/L	108	59	131
EP203-SL: 2.6-Dinitrotoluene	606-20-2	20	µg/L	<20	----	----	----	----
EP203-SL: 2-Amino-4.6-DNT	35572-78-2	20	µg/L	<20	----	----	----	----
EP203-SL: 2-Nitrotoluene	88-72-2	20	µg/L	<20	----	----	----	----
EP203-SL: 3-Nitrotoluene	99-08-1	20	µg/L	<20	----	----	----	----
EP203-SL: 4-Amino.2.6-DNT	19406-51-0	20	µg/L	<20	200 µg/L	100	59	135
EP203-SL: 4-Nitrotoluene	99-99-0	20	µg/L	<20	----	----	----	----
EP203-SL: HMX	2691-41-0	20	µg/L	<20	200 µg/L	98.6	53	147
EP203-SL: Nitrobenzene	98-95-3	20	µg/L	<20	200 µg/L	110	52	140
EP203-SL: Nitroglycerine	55-63-0	200	µg/L	<200	----	----	----	----
EP203-SL: PETN	78-11-5	200	µg/L	<200	200 µg/L	109	75	143
EP203-SL: RDX	----	20	µg/L	<20	----	----	----	----
EP203-SL: Tetryl	479-45-8	20	µg/L	<20	----	----	----	----
EP231: Perfluorinated Compounds (QCLot: 274411)								
EP231: 6:2 Fluorotelomer sulfonate (6:2 FtS)	27619-97-2	0.1	µg/L	<0.1	2.5 µg/L	112	61	145
EP231: 8:2 Fluorotelomer sulfonate	39108-34-4	0.1	µg/L	<0.1	2.5 µg/L	96.0	70	130
EP231: PFOA	335-67-1	0.01	µg/L	<0.01	0.5 µg/L	119	72	134
EP231: PFOS	1763-23-1	0.01	µg/L	<0.01	0.5 µg/L	89.2	70	136
EP231: Perfluorinated Compounds (QCLot: 274412)								
EP231PFC: N-Et-FOSA	4151-50-2	0.05	µg/L	<0.05	2.5 µg/L	96.0	56	130
EP231PFC: N-Et-FOSE	1691-99-2	1	µg/L	<1.0	2.5 µg/L	110	64	130
EP231PFC: N-Me-FOSA	31506-32-8	0.5	µg/L	<0.5	2.5 µg/L	118	53	130
EP231PFC: N-Me-FOSE	2448-09-7	1	µg/L	<1.0	2.5 µg/L	97.5	63	130
EP231PFC: PFBS	375-73-5	0.02	µg/L	<0.02	0.5 µg/L	122	54	130
EP231PFC: PFDcA	335-76-2	0.02	µg/L	<0.02	0.5 µg/L	72.8	50	130
EP231PFC: PFDcS	67906-42-7	0.05	µg/L	<0.05	0.5 µg/L	79.8	50	130
EP231PFC: PFDoA	307-55-1	0.05	µg/L	<0.05	0.5 µg/L	117	50	130
EP231PFC: PFHpA	375-85-9	0.02	µg/L	<0.02	0.5 µg/L	118	50	130
EP231PFC: PFHxA	307-24-4	0.02	µg/L	<0.02	0.5 µg/L	112	52	130
EP231PFC: PFHxS	355-46-4	0.02	µg/L	<0.02	0.5 µg/L	88.6	54	130
EP231PFC: PFNA	375-95-1	0.02	µg/L	<0.02	0.5 µg/L	86.4	51	130
EP231PFC: PFOSA	754-91-6	0.02	µg/L	<0.02	0.5 µg/L	122	57	130
EP231PFC: PFTeA	376-06-7	0.5	µg/L	<0.5	2.5 µg/L	85.3	30	130
EP231PFC: PFTriA	72629-94-8	0.05	µg/L	<0.05	0.5 µg/L	87.4	30	130
EP231PFC: PFUnA	2058-94-8	0.05	µg/L	<0.05	0.5 µg/L	73.6	50	130
EP234A: OP Pesticides (QCLot: 276928)								
EP234-1: Azinphos-ethyl	2642-71-9	0.02	µg/L	<0.02	0.2 µg/L	91.0	75	135

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP234A: OP Pesticides (QCLot: 276928) - continued								
EP234-1: Azinphos-methyl	86-50-0	0.02	µg/L	<0.02	0.2 µg/L	92.5	77	129
EP234-1: Bromophos-ethyl	4824-78-6	0.1	µg/L	<0.10	1 µg/L	97.7	70	130
EP234-1: Carbofenothion	786-19-6	0.02	µg/L	<0.02	0.2 µg/L	90.5	70	130
EP234-1: Chlorfenvinphos	470-90-6	0.02	µg/L	<0.02	0.4 µg/L	89.5	74	134
EP234-1: Chlorpyrifos	2921-88-2	0.02	µg/L	<0.02	0.2 µg/L	89.0	70	130
EP234-1: Chlorpyrifos-methyl	5598-13-0	0.2	µg/L	<0.2	2 µg/L	95.8	70	130
EP234-1: Coumaphos	56-72-4	0.01	µg/L	<0.01	0.1 µg/L	91.0	70	130
EP234-1: Demeton-O & Demeton-S	298-03-3/12 6-75-0	0.02	µg/L	<0.02	0.2 µg/L	90.5	79	127
EP234-1: Demeton-S-methyl	919-86-8	0.02	µg/L	<0.02	0.2 µg/L	99.0	70	128
EP234-1: Diazinon	333-41-5	0.01	µg/L	<0.01	0.1 µg/L	91.0	68	138
EP234-1: Dichlorvos	62-73-7	0.2	µg/L	<0.20	2 µg/L	102	76	128
EP234-1: Dimethoate	60-51-5	0.02	µg/L	<0.02	0.2 µg/L	101	75	127
EP234-1: Disulfoton	298-04-4	0.05	µg/L	<0.05	0.5 µg/L	89.2	72	134
EP234-1: EPN	2104-64-5	0.05	µg/L	<0.05	0.5 µg/L	103	70	130
EP234-1: Ethion	563-12-2	0.02	µg/L	<0.02	0.2 µg/L	95.0	70	130
EP234-1: Ethoprophos	13194-48-4	0.01	µg/L	<0.01	0.1 µg/L	96.0	78	128
EP234-1: Fenamiphos	22224-92-6	0.01	µg/L	<0.01	0.1 µg/L	94.0	71	135
EP234-1: Fenchlorphos (Ronnel)	299-84-3	10	µg/L	<10	100 µg/L	90.1	70	130
EP234-1: Fenitrothion	122-14-5	2	µg/L	<2	20 µg/L	90.2	64	136
EP234-1: Fensulfothion	115-90-2	0.01	µg/L	<0.01	0.1 µg/L	93.0	79	125
EP234-1: Fenthion	55-38-9	0.05	µg/L	<0.05	0.5 µg/L	90.8	70	130
EP234-1: Malathion	121-75-5	0.02	µg/L	<0.02	0.2 µg/L	110	70	130
EP234-1: Mevinphos	7786-34-7	0.02	µg/L	<0.02	0.4 µg/L	97.5	77	123
EP234-1: Monocrotophos	6923-22-4	0.02	µg/L	<0.02	0.2 µg/L	97.5	75	129
EP234-1: Omethoate	1113-02-6	0.01	µg/L	<0.01	0.1 µg/L	97.0	74	130
EP234-1: Parathion	56-38-2	0.2	µg/L	<0.2	2 µg/L	87.4	69	139
EP234-1: Parathion-methyl	298-00-0	0.5	µg/L	<0.5	20 µg/L	89.3	66	140
EP234-1: Phorate	298-02-2	0.1	µg/L	<0.1	1 µg/L	103	68	136
EP234-1: Pirimiphos-ethyl	23505-41-1	0.01	µg/L	<0.01	0.1 µg/L	86.0	70	130
EP234-1: Pirimiphos-methyl	29232-93-7	0.01	µg/L	<0.01	0.1 µg/L	106	71	137
EP234-1: Profenofos	41198-08-7	0.01	µg/L	<0.01	0.1 µg/L	90.0	70	130
EP234-1: Prothiofos	34643-46-4	0.1	µg/L	<0.1	1 µg/L	91.8	70	130
EP234-1: Sulfotep	3689-24-5	0.005	µg/L	<0.005	0.05 µg/L	90.0	71	137
EP234-1: Sulprofos	35400-43-2	0.05	µg/L	<0.05	0.5 µg/L	92.2	70	130
EP234-1: Temephos	3383-96-8	0.02	µg/L	<0.02	0.2 µg/L	82.5	70	130
EP234-1: Terbufos	13071-79-9	0.01	µg/L	<0.01	0.1 µg/L	95.0	70	130
EP234-1: Tetrachlorvinphos	22248-79-9	0.01	µg/L	<0.01	0.1 µg/L	92.0	74	128
EP234-1: Triazophos	24017-47-8	0.005	µg/L	<0.005	0.05 µg/L	90.0	77	131

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP234A: OP Pesticides (QCLot: 276928) - continued								
EP234-1: Trichlorfon	52-68-6	0.02	µg/L	<0.02	0.2 µg/L	94.5	70	130
EP234-1: Trichloronate	327-98-0	0.5	µg/L	<0.5	5 µg/L	99.2	63	139
EP234B: Thiocarbamates and Carbamates (QCLot: 276928)								
EP234-1: 3-Hydroxy Carbofuran	16655-82-6	0.02	µg/L	<0.02	0.2 µg/L	99.0	68	134
EP234-1: Aldicarb	116-06-3	0.05	µg/L	<0.05	0.5 µg/L	89.0	75	123
EP234-1: Bendiocarb	22781-23-3	0.1	µg/L	<0.10	1 µg/L	95.0	70	130
EP234-1: Benomyl	17804-35-2	0.01	µg/L	<0.01	0.1 µg/L	93.0	73	129
EP234-1: Carbaryl	63-25-2	0.01	µg/L	<0.01	0.1 µg/L	108	68	134
EP234-1: Carbofuran	1563-66-2	0.01	µg/L	<0.01	0.1 µg/L	106	77	127
EP234-1: Methiocarb	2032-65-7	0.01	µg/L	<0.01	0.1 µg/L	97.0	70	130
EP234-1: Methomyl	16752-77-5	0.01	µg/L	<0.01	0.1 µg/L	94.0	79	127
EP234-1: Molinate	2212-67-1	0.1	µg/L	<0.1	1 µg/L	93.3	75	127
EP234-1: Oxamyl	23135-22-0	0.01	µg/L	<0.01	0.1 µg/L	100	70	130
EP234-1: Thiobencarb	28249-77-6	0.01	µg/L	<0.01	0.1 µg/L	84.0	79	131
EP234-1: Thiodicarb	59669-26-0	0.01	µg/L	<0.01	0.1 µg/L	104	74	132
EP234C: Dinitroanilines (QCLot: 276928)								
EP234-1: Pendimethalin	40487-42-1	0.05	µg/L	<0.05	0.5 µg/L	92.0	70	130
EP234-1: Trifluralin	1582-09-8	10	µg/L	<10.0	100 µg/L	85.3	70	130
EP234D: Triazinone Herbicides (QCLot: 276928)								
EP234-1: Hexazinone	51235-04-2	0.02	µg/L	<0.02	0.2 µg/L	91.5	73	127
EP234-1: Metribuzin	21087-64-9	0.02	µg/L	<0.02	0.2 µg/L	89.0	65	133
EP234E: Conazole and Aminopyrimidine Fungicides (QCLot: 276928)								
EP234-1: Cyproconazole	94361-06-5	0.02	µg/L	<0.02	0.4 µg/L	103	78	128
EP234-1: Cyprodinil	121552-61-2	0.01	µg/L	<0.01	0.1 µg/L	94.0	77	131
EP234-1: Difenoconazole	119446-68-3	0.02	µg/L	<0.02	0.2 µg/L	87.5	76	144
EP234-1: Flusilazole	85509-19-9	0.02	µg/L	<0.02	0.2 µg/L	94.5	76	140
EP234-1: Hexaconazole	79983-71-4	0.02	µg/L	<0.02	0.2 µg/L	96.5	78	130
EP234-1: Paclobutrazole	76738-62-0	0.05	µg/L	<0.05	0.5 µg/L	96.6	78	130
EP234-1: Penconazole	66246-88-6	0.01	µg/L	<0.01	0.1 µg/L	92.0	75	133
EP234-1: Propiconazole	60207-90-1	0.05	µg/L	<0.05	0.5 µg/L	86.0	66	138
EP234-1: Pyrimethanil	53112-28-0	0.02	µg/L	<0.02	0.2 µg/L	92.0	79	123
EP234-1: Tebuconazole	107534-96-3	0.01	µg/L	<0.01	0.1 µg/L	92.0	69	135
EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides (QCLot: 276928)								
EP234-1: Bromacil	314-40-9	0.02	µg/L	<0.02	0.2 µg/L	90.5	71	129
EP234-1: Chlorsulfuron	64902-72-3	0.2	µg/L	<0.2	2 µg/L	88.2	66	136
EP234-1: Diuron	330-54-1	0.02	µg/L	<0.02	0.2 µg/L	97.0	65	137
EP234-1: Fluometuron	2164-17-2	0.01	µg/L	<0.01	0.2 µg/L	102	80	124
EP234-1: Tebuthiuron	34014-18-1	0.02	µg/L	<0.02	0.2 µg/L	95.0	75	127

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EP234G: Chloracetanilides (QCLot: 276928)								
EP234-1: Metolachlor	51218-45-2	0.01	µg/L	<0.01	0.1 µg/L	86.0	76	128
EP234H: Triazine Herbicides (QCLot: 276928)								
EP234-1: Ametryn	834-12-8	0.01	µg/L	<0.01	0.1 µg/L	95.0	81	125
EP234-1: Atrazine	1912-24-9	0.01	µg/L	<0.01	0.1 µg/L	98.0	75	123
EP234-1: Cyanazine	21725-46-2	0.02	µg/L	<0.02	0.2 µg/L	90.5	76	130
EP234-1: Cyromazine	66215-27-8	0.05	µg/L	<0.05	0.5 µg/L	95.8	79	123
EP234-1: Prometryn	7287-19-6	0.01	µg/L	<0.01	0.1 µg/L	92.0	81	123
EP234-1: Propazine	139-40-2	0.01	µg/L	<0.01	0.1 µg/L	92.0	84	124
EP234-1: Simazine	122-34-9	0.02	µg/L	<0.02	0.2 µg/L	90.0	73	127
EP234-1: Terbuthylazine	5915-41-3	0.01	µg/L	<0.01	0.1 µg/L	93.0	79	125
EP234-1: Terbutryn	886-50-0	0.01	µg/L	<0.01	0.1 µg/L	96.0	76	130
EP234I: Miscellaneous (ESI Positive Mode) Pesticides (QCLot: 276928)								
EP234-1: Diclofop-methyl	51338-27-3	0.05	µg/L	<0.05	0.5 µg/L	111	70	130
EP234-1: Fenarimol	60168-88-9	0.02	µg/L	<0.02	0.2 µg/L	92.5	68	138
EP234-1: Irgarol	28159-98-0	0.002	µg/L	<0.002	0.02 µg/L	95.0	73	129
EP234-1: Oxyfluorfen	42874-03-3	1	µg/L	<1.0	10 µg/L	89.5	66	144
EP234-1: Thiamethoxam	153719-23-4	0.02	µg/L	<0.02	0.2 µg/L	93.5	71	127

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
				Concentration	MS	Low	High
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA (QCLot: 275135)							
ES1535912-001	Anonymous	ED041G: Sulfate as SO4 - Turbidimetric	14808-79-8	10 mg/L	125	70	130
ED045G: Chloride by Discrete Analyser (QCLot: 275136)							
ES1535912-001	Anonymous	ED045G: Chloride	16887-00-6	250 mg/L	117	70	130
EG020F: Dissolved Metals by ICP-MS (QCLot: 277439)							
ES1535912-002	Anonymous	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	101	70	130
		EG020A-F: Barium	7440-39-3	0.2 mg/L	100	70	130
		EG020A-F: Beryllium	7440-41-7	0.2 mg/L	103	70	130
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	106	70	130
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	91.0	70	130
		EG020A-F: Cobalt	7440-48-4	0.2 mg/L	93.5	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	93.8	70	130
		EG020A-F: Lead	7439-92-1	0.2 mg/L	97.2	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 277439) - continued							
ES1535912-002	Anonymous	EG020A-F: Manganese	7439-96-5	0.2 mg/L	97.6	70	130
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	90.9	70	130
		EG020A-F: Vanadium	7440-62-2	0.2 mg/L	97.8	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	95.0	70	130
EG020T: Total Metals by ICP-MS (QCLot: 277693)							
EP1515746-001	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	103	70	130
		EG020A-T: Barium	7440-39-3	1 mg/L	94.6	70	130
		EG020A-T: Beryllium	7440-41-7	1 mg/L	94.3	70	130
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	96.6	70	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	97.8	70	130
		EG020A-T: Cobalt	7440-48-4	1 mg/L	97.6	70	130
		EG020A-T: Copper	7440-50-8	1 mg/L	102	70	130
		EG020A-T: Lead	7439-92-1	1 mg/L	96.1	70	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	89.6	70	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	98.0	70	130
		EG020A-T: Vanadium	7440-62-2	1 mg/L	99.4	70	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	# Not Determined	70	130
EG032: Arsenic Speciation by LC-ICPMS (QCLot: 276684)							
EB1533734-001	Anonymous	EG032: Arsenic Acid, As (V)	----	10 µg/L	105	70	130
		EG032: Arsenious Acid, As (III)	----	10 µg/L	102	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 277438)							
ES1535912-001	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	92.7	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 279772)							
ES1535904-038	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	78.9	70	130
EG050F: Dissolved Hexavalent Chromium (QCLot: 277273)							
ES1535705-014	Anonymous	EG050G-F: Hexavalent Chromium	18540-29-9	0.5 mg/L	101	70	130
EK026SF: Total CN by Segmented Flow Analyser (QCLot: 275210)							
ES1535924-001	Anonymous	EK026SF: Total Cyanide	57-12-5	0.2 mg/L	# Not Determined	70	130
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser (QCLot: 275209)							
ES1535924-001	Anonymous	EK028SF: Weak Acid Dissociable Cyanide	----	0.2 mg/L	# Not Determined	70	130
EK040P: Fluoride by PC Titrator (QCLot: 275163)							
ES1535895-001	Anonymous	EK040P: Fluoride	16984-48-8	5 mg/L	108	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 276957)							

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	Recovery Limits (%) High
EK055G: Ammonia as N by Discrete Analyser (QCLot: 276957) - continued							
ES1535918-001	Anonymous	EK055G: Ammonia as N	7664-41-7	1 mg/L	83.6	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 275137)							
ES1535912-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	106	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 276958)							
ES1535918-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	94.2	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 276935)							
ES1535918-002	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	93.9	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 276934)							
ES1535918-002	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	94.3	70	130
EK071G: Reactive Phosphorus as P by discrete analyser (QCLot: 275138)							
ES1535912-001	Anonymous	EK071G: Reactive Phosphorus as P	14265-44-2	0.5 mg/L	103	70	130
EK085M: Sulfide as S2- (QCLot: 279129)							
ES1535966-001	MW206	EK085: Sulfide as S2-	18496-25-8	0.33 mg/L	# Not Determined	70	130
EP005: Total Organic Carbon (TOC) (QCLot: 274591)							
ES1535878-002	Anonymous	EP005: Total Organic Carbon	----	100 mg/L	92.4	70	130
EP010: Formaldehyde (QCLot: 277026)							
ES1535925-001	Anonymous	EP010: Formaldehyde	50-00-0	2.5 mg/L	98.8	70	130
EP026SP: Chemical Oxygen Demand (Spectrophotometric) (QCLot: 279509)							
EP1515806-001	Anonymous	EP026SP: Chemical Oxygen Demand	----	47.6 mg/L	113	70	130
EP041A: Nonionic Surfactants (QCLot: 275763)							
ES1535966-001	MW206	EP041A: Nonionic Surfactants as CTAS	----	5 mg/L	93.0	70	130
EP050: Anionic Surfactants as MBAS (QCLot: 277603)							
ES1535933-018	Anonymous	EP050: Anionic Surfactants as MBAS		1 mg/L	80.0	70	130
EP074A: Monocyclic Aromatic Hydrocarbons (QCLot: 274938)							
ES1535912-001	Anonymous	EP074: Benzene	71-43-2	25 µg/L	91.0	70	130
		EP074: Toluene	108-88-3	25 µg/L	97.7	70	130
EP074E: Halogenated Aliphatic Compounds (QCLot: 274938)							
ES1535912-001	Anonymous	EP074: 1.1-Dichloroethene	75-35-4	25 µg/L	84.5	70	130
		EP074: Trichloroethene	79-01-6	25 µg/L	89.0	70	130
EP074F: Halogenated Aromatic Compounds (QCLot: 274938)							
ES1535912-001	Anonymous	EP074: Chlorobenzene	108-90-7	25 µg/L	100	70	130
EP080/071: Total Petroleum Hydrocarbons (QCLot: 274940)							
ES1535912-001	Anonymous						

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	High
EP080/071: Total Petroleum Hydrocarbons (QCLot: 274940) - continued							
ES1535912-001	Anonymous	EP080: C6 - C9 Fraction	----	325 µg/L	98.4	70	130
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions (QCLot: 274940)							
ES1535912-001	Anonymous	EP080: C6 - C10 Fraction	C6_C10	375 µg/L	95.8	70	130
EP080: BTEXN (QCLot: 274940)							
ES1535912-001	Anonymous	EP080: Benzene	71-43-2	25 µg/L	83.5	70	130
		EP080: Ethylbenzene	100-41-4	25 µg/L	86.7	70	130
		EP080: meta- & para-Xylene	108-38-3 106-42-3	25 µg/L	87.5	70	130
		EP080: Naphthalene	91-20-3	25 µg/L	88.7	70	130
		EP080: ortho-Xylene	95-47-6	25 µg/L	89.5	70	130
		EP080: Toluene	108-88-3	25 µg/L	85.1	70	130
EP118: Nitrogenated Compounds (QCLot: 275422)							
ES1535966-002	MW202	EP118-1: Acrylonitrile	107-13-1	10 µg/L	82.5	80	120
EP121: Aldehydes (QCLot: 275068)							
ES1535966-002	MW202	EP121: Acetaldehyde	75-07-0	20 µg/L	117	70	130
		EP121: Acrolein (Propenal)	107-02-8	20 µg/L	# 43.4	70	130
		EP121: Butyraldehyde	123-72-8	20 µg/L	89.2	70	130
		EP121: Formaldehyde	50-00-0	20 µg/L	# Not Determined	70	130
		EP121: Propionaldehyde	123-38-6	20 µg/L	117	70	130
EP202A: Phenoxyacetic Acid Herbicides by LCMS (QCLot: 277738)							
EB1534277-001	Anonymous	EP202-SL: 2.4.5-T	93-76-5	100 µg/L	98.2	78	140
		EP202-SL: 2.4-D	94-75-7	100 µg/L	117	77	139
		EP202-SL: Clopyralid	1702-17-6	100 µg/L	# 36.1	70	145
		EP202-SL: MCPA	94-74-6	100 µg/L	106	76	140
		EP202-SL: Mecoprop	93-65-2	100 µg/L	106	75	143
		EP202-SL: Picloram	1918-02-1	100 µg/L	81.0	70	144
		EP202-SL: Triclopyr	55335-06-3	100 µg/L	119	77	141
EP203A: Explosives (QCLot: 274448)							
ES1535966-002	MW202	EP203-SL: 2.4.6-TNT	118-96-7	200 µg/L	101	66	138
		EP203-SL: 2.4-Dinitrotoluene	121-14-2	200 µg/L	108	69	133
		EP203-SL: 4-Amino.2.6-DNT	19406-51-0	200 µg/L	116	63	131
		EP203-SL: HMX	2691-41-0	200 µg/L	103	57	143
		EP203-SL: Nitrobenzene	98-95-3	200 µg/L	108	57	127
		EP203-SL: PETN	78-11-5	200 µg/L	102	51	145
EP231: Perfluorinated Compounds (QCLot: 274411)							
EB1534037-003	Anonymous	EP231: 6:2 Fluorotelomer sulfonate (6:2 FtS)	27619-97-2	2.5 µg/L	106	60	145

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	Recovery Limits (%) High
EP231: Perfluorinated Compounds (QCLot: 274411) - continued							
EB1534037-003	Anonymous	EP231: 8:2 Fluorotelomer sulfonate	39108-34-4	2.5 µg/L	76.4	70	130
		EP231: PFOA	335-67-1	0.5 µg/L	118	60	134
		EP231: PFOS	1763-23-1	0.5 µg/L	89.8	60	136
EP231: Perfluorinated Compounds (QCLot: 274412)							
EB1534037-003	Anonymous	EP231PFC: N-Et-FOSA	4151-50-2	2.5 µg/L	93.9	50	130
		EP231PFC: N-Et-FOSE	1691-99-2	2.5 µg/L	108	30	130
		EP231PFC: N-Me-FOSA	31506-32-8	2.5 µg/L	115	50	130
		EP231PFC: N-Me-FOSE	2448-09-7	2.5 µg/L	75.7	30	130
		EP231PFC: PFBS	375-73-5	0.5 µg/L	122	50	130
		EP231PFC: PFDcA	335-76-2	0.5 µg/L	79.6	50	130
		EP231PFC: PFDcS	67906-42-7	0.5 µg/L	80.8	30	130
		EP231PFC: PFDoA	307-55-1	0.5 µg/L	79.0	50	130
		EP231PFC: PFHpA	375-85-9	0.5 µg/L	120	50	130
		EP231PFC: PFHxA	307-24-4	0.5 µg/L	106	50	130
		EP231PFC: PFHxS	355-46-4	0.5 µg/L	91.0	50	130
		EP231PFC: PFNA	375-95-1	0.5 µg/L	118	50	130
		EP231PFC: PFOSA	754-91-6	0.5 µg/L	120	50	130
		EP231PFC: PFTeA	376-06-7	2.5 µg/L	37.0	30	130
		EP231PFC: PFTriA	72629-94-8	0.5 µg/L	40.8	30	130
		EP231PFC: PFUnA	2058-94-8	0.5 µg/L	66.4	30	130
EP234A: OP Pesticides (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Azinphos-ethyl	2642-71-9	0.2 µg/L	91.5	70	130
		EP234-1: Azinphos-methyl	86-50-0	0.2 µg/L	96.5	70	130
		EP234-1: Bromophos-ethyl	4824-78-6	1 µg/L	91.2	70	130
		EP234-1: Carbofenothion	786-19-6	0.2 µg/L	82.5	70	130
		EP234-1: Chlorfenvinphos	470-90-6	0.4 µg/L	86.5	70	130
		EP234-1: Chlorpyrifos	2921-88-2	0.2 µg/L	90.5	70	130
		EP234-1: Chlorpyrifos-methyl	5598-13-0	2 µg/L	85.0	58	136
		EP234-1: Coumaphos	56-72-4	0.1 µg/L	91.0	70	130
		EP234-1: Demeton-O & Demeton-S	298-03-3/126-75-0	0.2 µg/L	96.5	69	129
		EP234-1: Demeton-S-methyl	919-86-8	0.2 µg/L	90.0	70	130
		EP234-1: Diazinon	333-41-5	0.1 µg/L	89.0	70	130
		EP234-1: Dichlorvos	62-73-7	2 µg/L	82.6	70	130
		EP234-1: Dimethoate	60-51-5	0.2 µg/L	110	69	131
		EP234-1: Disulfoton	298-04-4	0.5 µg/L	91.4	70	130
		EP234-1: EPN	2104-64-5	0.5 µg/L	92.2	70	130
		EP234-1: Ethion	563-12-2	0.2 µg/L	89.5	70	130
		EP234-1: Ethoprophos	13194-48-4	0.1 µg/L	93.0	70	132

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EP234A: OP Pesticides (QCLot: 276928) - continued							
ES1535894-016	Anonymous	EP234-1: Fenamiphos	22224-92-6	0.1 µg/L	93.0	70	130
		EP234-1: Fenchlorphos (Ronnel)	299-84-3	100 µg/L	95.4	71	133
		EP234-1: Fenitrothion	122-14-5	20 µg/L	84.4	64	136
		EP234-1: Fensulfothion	115-90-2	0.1 µg/L	89.0	83	123
		EP234-1: Fenthion	55-38-9	0.5 µg/L	82.0	70	130
		EP234-1: Malathion	121-75-5	0.2 µg/L	107	70	130
		EP234-1: Mevinphos	7786-34-7	0.4 µg/L	104	69	125
		EP234-1: Monocrotophos	6923-22-4	0.2 µg/L	102	70	128
		EP234-1: Omethoate	1113-02-6	0.1 µg/L	91.0	70	130
		EP234-1: Parathion	56-38-2	2 µg/L	86.2	70	130
		EP234-1: Parathion-methyl	298-00-0	20 µg/L	96.7	70	140
		EP234-1: Phorate	298-02-2	1 µg/L	100	70	130
		EP234-1: Pirimiphos-ethyl	23505-41-1	0.1 µg/L	90.0	70	130
		EP234-1: Pirimiphos-methyl	29232-93-7	0.1 µg/L	104	70	130
		EP234-1: Profenofos	41198-08-7	0.1 µg/L	93.0	70	130
		EP234-1: Prothiofos	34643-46-4	1 µg/L	96.0	70	130
		EP234-1: Sulfotep	3689-24-5	0.05 µg/L	100	63	135
		EP234-1: Sulprofos	35400-43-2	0.5 µg/L	92.2	70	130
		EP234-1: Temephos	3383-96-8	0.2 µg/L	84.0	70	130
		EP234-1: Terbufos	13071-79-9	0.1 µg/L	93.0	70	130
		EP234-1: Tetrachlorvinphos	22248-79-9	0.1 µg/L	87.0	77	125
		EP234-1: Triazophos	24017-47-8	0.05 µg/L	92.0	74	132
		EP234-1: Trichlorfon	52-68-6	0.2 µg/L	95.0	70	130
		EP234-1: Trichloronate	327-98-0	5 µg/L	98.2	63	139
EP234B: Thiocarbamates and Carbamates (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: 3-Hydroxy Carbofuran	16655-82-6	0.2 µg/L	99.0	70	130
		EP234-1: Aldicarb	116-06-3	0.5 µg/L	91.2	70	130
		EP234-1: Bendiocarb	22781-23-3	1 µg/L	99.3	70	130
		EP234-1: Benomyl	17804-35-2	0.1 µg/L	93.0	62	136
		EP234-1: Carbaryl	63-25-2	0.1 µg/L	103	70	130
		EP234-1: Carbofuran	1563-66-2	0.1 µg/L	97.0	70	130
		EP234-1: Methiocarb	2032-65-7	0.1 µg/L	94.0	70	130
		EP234-1: Methomyl	16752-77-5	0.1 µg/L	97.0	70	130
		EP234-1: Molinate	2212-67-1	1 µg/L	91.8	66	128
		EP234-1: Oxamyl	23135-22-0	0.1 µg/L	100	70	130
		EP234-1: Thiobencarb	28249-77-6	0.1 µg/L	85.0	70	130
		EP234-1: Thiodicarb	59669-26-0	0.1 µg/L	100	70	130
EP234C: Dinitroanilines (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Pendimethalin	40487-42-1	0.5 µg/L	110	70	130

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report: Spike Concentration	SpikeRecovery(%) MS	Recovery Limits (%) Low	Recovery Limits (%) High
EP234C: Dinitroanilines (QCLot: 276928) - continued							
ES1535894-016	Anonymous	EP234-1: Trifluralin	1582-09-8	100 µg/L	102	70	130
EP234D: Triazinone Herbicides (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Hexazinone	51235-04-2	0.2 µg/L	88.0	75	125
		EP234-1: Metribuzin	21087-64-9	0.2 µg/L	86.5	70	130
EP234E: Conazole and Aminopyrimidine Fungicides (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Cyproconazole	94361-06-5	0.4 µg/L	102	73	127
		EP234-1: Cyprodinil	121552-61-2	0.1 µg/L	90.0	74	130
		EP234-1: Difenoconazole	119446-68-3	0.2 µg/L	89.5	74	146
		EP234-1: Flusilazole	85509-19-9	0.2 µg/L	91.0	74	138
		EP234-1: Hexaconazole	79983-71-4	0.2 µg/L	93.0	69	135
		EP234-1: Paclobutrazole	76738-62-0	0.5 µg/L	88.0	73	137
		EP234-1: Penconazole	66246-88-6	0.1 µg/L	89.0	78	132
		EP234-1: Propiconazole	60207-90-1	0.5 µg/L	82.4	70	142
		EP234-1: Pyrimethanil	53112-28-0	0.2 µg/L	92.5	73	127
		EP234-1: Tebuconazole	107534-96-3	0.1 µg/L	99.0	69	135
EP234F: Phenylurea, Thizdiazolurea, Uracil and Sulfonylurea Herbicides (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Bromacil	314-40-9	0.2 µg/L	84.5	67	129
		EP234-1: Chlorsulfuron	64902-72-3	2 µg/L	92.1	66	134
		EP234-1: Diuron	330-54-1	0.2 µg/L	100	70	130
		EP234-1: Fluometuron	2164-17-2	0.2 µg/L	104	69	125
		EP234-1: Tebuthiuron	34014-18-1	0.2 µg/L	95.0	71	129
EP234G: Chloracetanilides (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Metolachlor	51218-45-2	0.1 µg/L	93.0	76	130
EP234H: Triazine Herbicides (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Ametryn	834-12-8	0.1 µg/L	97.0	74	126
		EP234-1: Atrazine	1912-24-9	0.1 µg/L	80.0	68	130
		EP234-1: Cyanazine	21725-46-2	0.2 µg/L	89.5	72	126
		EP234-1: Cyromazine	66215-27-8	0.5 µg/L	105	69	137
		EP234-1: Prometryn	7287-19-6	0.1 µg/L	89.0	72	130
		EP234-1: Propazine	139-40-2	0.1 µg/L	82.0	67	133
		EP234-1: Simazine	122-34-9	0.2 µg/L	96.0	70	132
		EP234-1: Terbuthylazine	5915-41-3	0.1 µg/L	97.0	70	126
		EP234-1: Terbutryn	886-50-0	0.1 µg/L	92.0	71	129
EP234I: Miscellaneous (ESI Positive Mode) Pesticides (QCLot: 276928)							
ES1535894-016	Anonymous	EP234-1: Diclofop-methyl	51338-27-3	0.5 µg/L	112	70	130
		EP234-1: Fenarimol	60168-88-9	0.2 µg/L	90.5	60	136
		EP234-1: Irgarol	28159-98-0	0.02 µg/L	100	69	127

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EP234I: Miscellaneous (ESI Positive Mode) Pesticides (QCLot: 276928) - continued							
ES1535894-016	Anonymous	EP234-1: Oxyfluorfen	42874-03-3	10 µg/L	85.2	66	144
		EP234-1: Thiamethoxam	153719-23-4	0.2 µg/L	104	67	133

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1535966**	Page	
Amendment	: **1**		
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR DAVE BARRETT	Telephone	: +61-2-8784 8555
Project	: LEACHATE ASSESSMENT	Date Samples Received	: 11-Nov-2015
Site	: ----	Issue Date	: 04-Dec-2015
Sampler	: JESSE SIMKUS	No. of samples received	: 2
Order number	: 2218015	No. of samples analysed	: 2

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **Laboratory Control outliers exist - please see following pages for full details.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **Surrogate recovery outliers exist for all regular sample matrices - please see following pages for full details.**

Outliers : Analysis Holding Time Compliance

- **Analysis Holding Time Outliers exist - please see following pages for full details.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Laboratory Control Spike (LCS) Recoveries							
EP075E: Nitroaromatics and Ketones	QC-276812-002	----	**Acetophenone**	98-86-2	67.2 %	68-112%	**Recovery less than lower control limit**
EP075E: Nitroaromatics and Ketones	QC-276812-002	----	**Nitrobenzene**	98-95-3	66.3 %	68-112%	**Recovery less than lower control limit**
EP075F: Haloethers	QC-276812-002	----	**Bis(2-chloroethyl) ether**	111-44-4	68.4 %	69-112%	**Recovery less than lower control limit**
EP075G: Chlorinated Hydrocarbons	QC-276812-002	----	**Hexachlorocyclopentadiene**	77-47-4	19.3 %	24-107%	**Recovery less than lower control limit**
Matrix Spike (MS) Recoveries							
EG020T: Total Metals by ICP-MS	EP1515746--001	Anonymous	**Zinc**	7440-66-6	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK026SF: Total CN by Segmented Flow Analyser	ES1535924--001	Anonymous	**Total Cyanide**	57-12-5	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK028SF: Weak Acid Dissociable CN by Segmented F	ES1535924--001	Anonymous	**Weak Acid Dissociable Cyanide**	----	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK085M: Sulfide as S2-	ES1535966--001	MW206	**Sulfide as S2-**	18496-25-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EP121: Aldehydes	ES1535966--002	MW202	**Acrolein (Propenal)**	107-02-8	43.4 %	70-130%	**Recovery less than lower data quality objective**
EP121: Aldehydes	ES1535966--002	MW202	**Formaldehyde**	50-00-0	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EP202A: Phenoxyacetic Acid Herbicides by LCMS	EB1534277--001	Anonymous	**Clopyralid**	1702-17-6	36.1 %	70-145%	**Recovery less than lower data quality objective**

Regular Sample Surrogates

Sub-Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Samples Submitted							
EP075S: Acid Extractable Surrogates	ES1535966-001	MW206	**2-Chlorophenol-D4**	93951-73-6	18.0 %	21-130 %	**Recovery less than lower data quality objective**
EP132S: Acid Extractable Surrogates	ES1535966-001	MW206	**Phenol-d6**	13127-88-3	76.8 %	10-65 %	**Recovery greater than upper data quality objective**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)	*Date extracted*	*Due for extraction*	***Days overdue***	*Date analysed*	*Due for analysis*	***Days overdue***

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation: Date extracted	Due for extraction	Days overdue	Analysis: Date analysed	Due for analysis	Days overdue
EK010/011: Chlorine						
Clear Plastic Bottle - Natural						
MW206	----	----	----	13-Nov-2015	11-Nov-2015	**2**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count: QC	Count: Regular	Rate (%): Actual	Rate (%): Expected	Quality Control Specification
Laboratory Duplicates (DUP)					
Gross Alpha and Beta Activity	1	11	9.09	10.00	NEPM 2013 B3 & ALS QC Standard
Organotin Compounds (Soluble)	0	9	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	0	4	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	0	3	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	0	3	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Semivolatile Organic Compounds	0	2	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	0	3	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)					
Major Anions - Dissolved	0	4	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	0	2	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
Organotin Compounds (Soluble)	0	9	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	0	4	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	0	3	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	0	3	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Semivolatile Organic Compounds	0	2	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	0	3	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	0	2	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005: pH							
Clear Plastic Bottle - Natural (EA005) MW206	**11-Nov-2015**	**----**	----	----	**11-Nov-2015**	11-Nov-2015	✓
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P) MW206	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	09-Dec-2015	✓
EA025: Total Suspended Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA025H) MW206	**11-Nov-2015**	**----**	----	----	**16-Nov-2015**	18-Nov-2015	✓
EA030: Total Solids dried at 104 ± 2°C							
Clear Plastic Bottle - Natural (EA030H) MW206	**11-Nov-2015**	**----**	----	----	**16-Nov-2015**	18-Nov-2015	✓
EA036: Fixed/Volatile Suspended Solids							
Clear Plastic Bottle - Natural (EA036H) MW206	**11-Nov-2015**	**----**	----	----	**16-Nov-2015**	18-Nov-2015	✓
EA040: Colour (Apparent)							
Clear Plastic Bottle - Natural (EA040) MW206	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	13-Nov-2015	✓
EA041: Colour (True)							
Clear Plastic Bottle - Natural (EA041) MW206	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	13-Nov-2015	✓
EA250: Gross Alpha and Beta Activity							
Clear Plastic Bottle - Unspecified; Lab-acidified (EA250-LSC) MW206, MW202	**11-Nov-2015**	**16-Nov-2015**	09-May-2016	✓	**16-Nov-2015**	14-May-2016	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P) MW206	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	25-Nov-2015	✓
ED040F: Dissolved Major Anions							
Clear Plastic Bottle - Natural (ED040F) MW206	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	09-Dec-2015	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G) MW206	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	09-Dec-2015	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G) MW206	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	09-Dec-2015	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F) MW206	**11-Nov-2015**	**----**	----	----	**14-Nov-2015**	09-Dec-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
MW206	**11-Nov-2015**	**----**	----	----	**14-Nov-2015**	09-May-2016	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T)							
MW206	**11-Nov-2015**	**16-Nov-2015**	09-May-2016	✓	**16-Nov-2015**	09-May-2016	✓
EG020U: Unfiltered Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-U)							
MW206	**11-Nov-2015**	**----**	----	----	**18-Nov-2015**	09-May-2016	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020B-F)							
MW206	**11-Nov-2015**	**----**	----	----	**14-Nov-2015**	09-May-2016	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020B-T)							
MW206	**11-Nov-2015**	**16-Nov-2015**	09-May-2016	✓	**16-Nov-2015**	09-May-2016	✓
EG032: Arsenic Speciation by LC-ICPMS							
Opaque Plastic Bottle - HCl Preserved (Speciation) (EG032)							
MW206, MW202	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	09-Dec-2015	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
MW206	**11-Nov-2015**	**----**	----	----	**17-Nov-2015**	09-Dec-2015	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035T)							
MW206	**11-Nov-2015**	**----**	----	----	**18-Nov-2015**	09-Dec-2015	✓
EG050F: Dissolved Hexavalent Chromium							
Clear Plastic Bottle - NaOH Filtered (EG050G-F)							
MW206, MW202	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	09-Dec-2015	✓
EK010/011: Chlorine							
Clear Plastic Bottle - Natural (EK010)							
MW206	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	11-Nov-2015	×
EK026SF: Total CN by Segmented Flow Analyser							
White Plastic Bottle-NaOH (EK026SF)							
MW206	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	25-Nov-2015	✓
EK028SF: Weak Acid Dissociable CN by Segmented Flow Analyser							
White Plastic Bottle-NaOH (EK028SF)							
MW206	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	25-Nov-2015	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P)							
MW206	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	09-Dec-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / *Container / Client Sample ID(s)*	*Sample Date*	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) MW206	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	09-Dec-2015	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) MW206	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	13-Nov-2015	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) MW206	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	09-Dec-2015	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) MW206	**11-Nov-2015**	**13-Nov-2015**	09-Dec-2015	✓	**13-Nov-2015**	09-Dec-2015	✓
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) MW206	**11-Nov-2015**	**13-Nov-2015**	09-Dec-2015	✓	**13-Nov-2015**	09-Dec-2015	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G) MW206	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	13-Nov-2015	✓
EK085M: Sulfide as S2-							
Clear Plastic Bottle - Zinc Acetate/NaOH (EK085) MW206, MW202	**11-Nov-2015**	**----**	----	----	**16-Nov-2015**	18-Nov-2015	✓
EK086: Sulfite as SO3 2-							
Clear Plastic Bottle - EDTA/Zinc Acetate (EK086) MW206, MW202	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	13-Nov-2015	✓
EK087: Thiosulfate as S2O3 2-							
Clear Plastic Bottle - EDTA/Zinc Acetate (EK087) MW206, MW202	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	13-Nov-2015	✓
EP005: Total Organic Carbon (TOC)							
Amber TOC Vial - Sulfuric Acid (EP005) MW206	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	09-Dec-2015	✓
Amber VOC Vial - Sulfuric Acid (EP005) MW202	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	09-Dec-2015	✓
EP010: Formaldehyde							
Clear Plastic Bottle - Natural (EP010) MW206	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	13-Nov-2015	✓
EP020: Oil and Grease (O&G)							
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020) MW206, MW202	**11-Nov-2015**	**----**	----	----	**17-Nov-2015**	09-Dec-2015	✓
EP026SP: Chemical Oxygen Demand (Spectrophotometric)							
Clear Plastic Bottle - Sulfuric Acid (EP026SP) MW206	**11-Nov-2015**	**----**	----	----	**17-Nov-2015**	09-Dec-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation: Date extracted	Due for extraction	Evaluation	Analysis: Date analysed	Due for analysis	Evaluation
EP041A: Nonionic Surfactants							
Pres. with Formaldehyde on receipt (EP041A)							
MW206	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	09-Dec-2015	✓
EP050: Anionic Surfactants as MBAS							
Pres. with Formaldehyde on receipt (EP050)							
MW206	**11-Nov-2015**	**----**	----	----	**14-Nov-2015**	15-Nov-2015	✓
EP066: Polychlorinated Biphenyls (PCB)							
Amber Glass Bottle - Unpreserved (EP066)							
MW202	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
Clear Plastic Bottle - Natural (EP066)							
MW206	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
EP068A: Organochlorine Pesticides (OC)							
Amber Glass Bottle - Unpreserved (EP068)							
MW202	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
Clear Plastic Bottle - Natural (EP068)							
MW206	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071)							
MW202	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
Clear Plastic Bottle - Natural (EP071)							
MW206	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
EP074A: Monocyclic Aromatic Hydrocarbons							
Amber TOC Vial - Sulfuric Acid (EP074)							
MW206	**11-Nov-2015**	**12-Nov-2015**	25-Nov-2015	✓	**12-Nov-2015**	25-Nov-2015	✓
Amber VOC Vial - Sulfuric Acid (EP074)							
MW202	**11-Nov-2015**	**12-Nov-2015**	25-Nov-2015	✓	**12-Nov-2015**	25-Nov-2015	✓
EP075B: Polynuclear Aromatic Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP075)							
MW202	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
Clear Plastic Bottle - Natural (EP075)							
MW206	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**16-Nov-2015**	26-Dec-2015	✓
EP080S: TPH(V)/BTEX Surrogates							
Amber TOC Vial - Sulfuric Acid (EP080)							
MW206	**11-Nov-2015**	**12-Nov-2015**	25-Nov-2015	✓	**12-Nov-2015**	25-Nov-2015	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
MW202	**11-Nov-2015**	**12-Nov-2015**	25-Nov-2015	✓	**12-Nov-2015**	25-Nov-2015	✓
EP090: Organotin Compounds (Soluble)							
Amber Glass Bottle - Unpreserved (EP090S)							
MW206, MW202	**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**17-Nov-2015**	26-Dec-2015	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP118: Nitrogenated Compounds								
Amber VOC Vial - Sulfuric Acid (EP118-1)								
MW202		**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	25-Nov-2015	✓
VOC Vial - unpreserved (EP118-1)								
MW206		**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	18-Nov-2015	✓
EP121: Aldehydes								
VOC Vial - unpreserved (EP121)								
MW206,	MW202	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	16-Nov-2015	✓
EP132A: Phenolic Compounds								
Amber Glass Bottle - Unpreserved (EP132)								
MW202		**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**18-Nov-2015**	26-Dec-2015	✓
Clear Plastic Bottle - Natural (EP132)								
MW206		**11-Nov-2015**	**16-Nov-2015**	18-Nov-2015	✓	**18-Nov-2015**	26-Dec-2015	✓
EP202A: Phenoxyacetic Acid Herbicides by LCMS								
Amber Glass Bottle - Unpreserved (EP202-SL)								
MW206,	MW202	**11-Nov-2015**	**----**	----	----	**16-Nov-2015**	18-Nov-2015	✓
EP203A: Explosives								
Amber Glass Bottle - Unpreserved (EP203-SL)								
MW202		**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	18-Nov-2015	✓
Clear Plastic Bottle - Natural (EP203-SL)								
MW206		**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	18-Nov-2015	✓
EP231: Perfluorinated Compounds								
HDPE (no PTFE) (EP231)								
MW206,	MW202	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	09-May-2016	✓
EP231: Perfluorinated Compounds								
HDPE (no PTFE) (EP231PFC)								
MW206,	MW202	**11-Nov-2015**	**----**	----	----	**12-Nov-2015**	09-May-2016	✓
EP234I: Miscellaneous (ESI Positive Mode) Pesticides								
Amber Glass Bottle - Unpreserved (EP234-1)								
MW206,	MW202	**11-Nov-2015**	**----**	----	----	**13-Nov-2015**	18-Nov-2015	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Acrylonitrile by HS-GC-MS	EP118-1	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Aldehydes by Derivitization Headspace GCMS	EP121	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Anionic Surfactants as MBAS	EP050	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Arsenic Speciation by LC-ICPMS	EG032	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chemical Oxygen Demand (COD) (Spectrophotometric)	EP026SP	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorine	EK010	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Colour (Apparent)	EA040	1	1	**100.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Colour (True)	EA041	1	5	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Explosives (Standard Level)	EP203-SL	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fixed and/or Volatile Suspended Solids (High Level)	EA036H	1	1	**100.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Formaldehyde	EP010	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Gross Alpha and Beta Activity	EA250-LSC	1	11	**9.09**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium by Discrete Analyser - Dissolved	EG050G-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Dissolved	ED040F	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	9	**22.22**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	1	**100.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Compounds (Soluble)	EP090S	0	9	**0.00**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
Perfluorinated Compounds by LCMSMS	EP231PFC	1	9	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	0	4	**0.00**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
PFOS and PFOA	EP231	1	9	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH	EA005	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	10	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	EP066	0	3	**0.00**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	0	3	**0.00**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type / Analytical Methods	Method	Count QC	Count Regular	Rate (%) Actual	Rate (%) Expected	Evaluation	Quality Control Specification
Laboratory Duplicates (DUP) - Continued							
Semivolatile Organic Compounds	EP075	0	2	**0.00**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfide as S2-	EK085	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfite as SO3 2-	EK086	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	20	**10.00**	**9.52**	✓	NEPM 2013 B3 & ALS QC Standard
Thiosulfate as S2O3 2-	EK087	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	3	**0.00**	**10.00**	✗	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Volatile Organic Compounds	EP074	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Weak Acid Dissociable Cyanide by Segmented Flow Analyser	EK028SF	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Acrylonitrile by HS-GC-MS	EP118-1	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Aldehydes by Derivitization Headspace GCMS	EP121	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Alkalinity by PC Titrator	ED037-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Anionic Surfactants as MBAS	EP050	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Arsenic Speciation by LC-ICPMS	EG032	2	3	**66.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chemical Oxygen Demand (COD) (Spectrophotometric)	EP026SP	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Colour (Apparent)	EA040	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Colour (True)	EA041	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Explosives (Standard Level)	EP203-SL	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Formaldehyde	EP010	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Gross Alpha and Beta Activity	EA250-LSC	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium by Discrete Analyser - Dissolved	EG050G-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Dissolved	ED040F	0	4	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Control Samples (LCS) - Continued							
Major Cations - Dissolved	ED093F	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Compounds (Soluble)	EP090S	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Perfluorinated Compounds by LCMSMS	EP231PFC	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PFOS and PFOA	EP231	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	EP066	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Semivolatile Organic Compounds	EP075	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfide as S2-	EK085	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfite as SO3 2-	EK086	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	2	20	**10.00**	**9.52**	✓	NEPM 2013 B3 & ALS QC Standard
Thiosulfate as S2O3 2-	EK087	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	7	**28.57**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	3	20	**15.00**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	3	20	**15.00**	**15.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	0	2	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
Volatile Organic Compounds	EP074	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Weak Acid Dissociable Cyanide by Segmented Flow Analyser	EK028SF	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Acrylonitrile by HS-GC-MS	EP118-1	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Aldehydes by Derivitization Headspace GCMS	EP121	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Anionic Surfactants as MBAS	EP050	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Arsenic Speciation by LC-ICPMS	EG032	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chemical Oxygen Demand (COD) (Spectrophotometric)	EP026SP	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type / *Analytical Methods*	*Method*	*Count* QC	*Count* Regular	*Rate (%)* Actual	*Rate (%)* Expected	Evaluation	*Quality Control Specification*
Method Blanks (MB) - Continued							
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chlorine	EK010	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Colour (Apparent)	EA040	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Colour (True)	EA041	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Explosives (Standard Level)	EP203-SL	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fixed and/or Volatile Suspended Solids (High Level)	EA036H	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Formaldehyde	EP010	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Gross Alpha and Beta Activity	EA250-LSC	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium by Discrete Analyser - Dissolved	EG050G-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Anions - Dissolved	ED040F	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Compounds (Soluble)	EP090S	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Perfluorinated Compounds by LCMSMS	EP231PFC	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PFOS and PFOA	EP231	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	EP066	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Semivolatile Organic Compounds	EP075	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfide as S2-	EK085	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfite as SO3 2-	EK086	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Suspended Solids (High Level)	EA025H	1	20	**5.00**	**4.76**	✓	NEPM 2013 B3 & ALS QC Standard
Thiosulfate as S2O3 2-	EK087	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Total Organic Carbon	EP005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Volatile Organic Compounds	EP074	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Weak Acid Dissociable Cyanide by Segmented Flow Analyser	EK028SF	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Acrylonitrile by HS-GC-MS	EP118-1	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Aldehydes by Derivitization Headspace GCMS	EP121	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Anionic Surfactants as MBAS	EP050	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Arsenic Speciation by LC-ICPMS	EG032	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chemical Oxygen Demand (COD) (Spectrophotometric)	EP026SP	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Explosives (Standard Level)	EP203-SL	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Formaldehyde	EP010	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium by Discrete Analyser - Dissolved	EG050G-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Organotin Compounds (Soluble)	EP090S	0	9	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
Perfluorinated Compounds by LCMSMS	EP231PFC	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	0	4	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PFOS and PFOA	EP231	1	9	**11.11**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	EP066	0	3	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	0	3	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
Semivolatile Organic Compounds	EP075	0	2	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfide as S2-	EK085	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Matrix Spikes (MS) - Continued							
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	3	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	0	2	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
Volatile Organic Compounds	EP074	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Weak Acid Dissociable Cyanide by Segmented Flow Analyser	EK028SF	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
pH	EA005	WATER	In house: Referenced to APHA 4500 H+ B. pH of water samples is determined by ISE either manually or by automated pH meter. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (Calculated)	EA017PGG	WATER	In house: Referenced to APHA 1030 E. Calculated as the sum of quantified major anions and cations This method is compliant with NEPM (2013) Schedule B(3)
Suspended Solids (High Level)	EA025H	WATER	In house: Referenced to APHA 2540D. A gravimetric procedure employed to determine the amount of \`non-filterable\` residue in a aqueous sample. The prescribed GFC (1.2um) filter is rinsed with deionised water, oven dried and weighed prior to analysis. A well-mixed sample is filtered through a glass fibre filter (1.2um). The residue on the filter paper is dried at 104+/-2C . This method is compliant with NEPM (2013) Schedule B(3)
Total Solids	EA030H	WATER	In house: Referenced to APHA 2540 B. A gravimetric procedure employed to determine the amount of residue in a aqueous sample. The sample is evaporated to dryness and dried to constant weight at 104+/-2C. This method is compliant with NEPM (2013) Schedule B(3)
Fixed and/or Volatile Suspended Solids (High Level)	EA036H	WATER	In house: Referenced to APHA 2540 E.This method is compliant with NEPM (2013) Schedule B(3)
Colour (Apparent)	EA040	WATER	In house: Referenced to APHA 2120 B. Apparent colour is determined on the original sample without filtration. This method is compliant with NEPM (2013) Schedule B(3)
Colour (True)	EA041	WATER	In house: Referenced to APHA 2120 B. This method is compliant with NEPM (2013) Schedule B(3)
Gross Alpha and Beta Activity	EA250-LSC	WATER	In house: Referenced to ASTM D7283-06: Determination of gross alpha and gross beta radioactivity in water samples by Liquid Scintillation Counting (LSC).
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Major Anions - Dissolved	ED040F	WATER	In house: Referenced to APHA 3120. The 0.45um filtered samples are determined by ICP/AES for Sulfur and/or Silcon content and reported as Sulfate and/or Silica after conversion by gravimetric factor.
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocyanate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003

Analytical Methods	Method	Matrix	Method Descriptions
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Metals by ICP-MS - Suite B	EG020B-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite B	EG020B-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Arsenic Speciation by LC-ICPMS	EG032	WATER	In house. The arsenic species are separated by HPLC with an anion exchange column and each species is quantified by ICPMS using a single ion at m/z 75
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45 um filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Hexavalent Chromium by Discrete Analyser - Dissolved	EG050G-F	WATER	In house: Referenced to APHA 3500 Cr-A & B. Samples are 0.45 um filtered prior to analysis. Hexavalent chromium is determined directly on water sample by Descrete Analyser as received by pH adjustment and colour development using dephenylcarbazide. Each run of samples is measured against a five-point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Chlorine	EK010	WATER	In-house (DPD colourimetry)
Total Cyanide by Segmented Flow Analyser	EK026SF	WATER	In house: Referenced to APHA 4500-CN O. Sodium hydroxide preserved samples are introduced into an automated segmented flow analyser. Complex bound cyanide is decomposed in a continuously flowing stream, at a pH of 3.8, by the effect of UV light. A UV-B lamp (312 nm) and a decomposition spiral of borosilicate glass are used to filter out UV light with a wavelength of less than 290 nm thus preventing the conversion of thiocyanate into cyanide. The hydrogen cyanide present at a pH of 3.8 is separated by gas dialysis. The hydrogen cyanide is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. This then reacts with 4-pyridine carboxylic acid and 1,3-dimethylbarbituric acid to give a red colour which is measured at 600 nm. This method is compliant with NEPM (2013) Schedule B(3)
Weak Acid Dissociable Cyanide by Segmented Flow Analyser	EK028SF	WATER	In house: Referenced to APHA 4500-CN-O. Samples preserved with sodium hydroxide are introduced into an automated segmented flow analyser. Hydrogen cyanide is liberated from a slightly acidified (pH 4.5) and is dialysed. Tight cyanide complexes that would not be amenable to oxidation by chlorine are not converted. Iron cyanide complexes are precipitated with zinc acetate. Liberated HCN diffuses through a membrane into a stream of sodium hydroxide where it is carried as CN- The cyanide in caustic solution is buffered to pH 5.2 and further converted to cyanogen chloride by reaction with chloramine-T. Cyanogen chloride subsequently reacts with 4 ¿pyridine carboxylic and 1,3 - dimethylbarbituric acids to give a red colour complex. This colour is measured at 600 nm. This method is compliant with NEPM (2013) Schedule B(3)
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500 F--C CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	WATER	In house: Referenced to APHA 4500-Norg D (In house). An aliquot of sample is digested using a high temperature Kjeldahl digestion to convert nitrogenous compounds to ammonia. Ammonia is determined colorimetrically by discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Total Nitrogen as N (TKN + Nox) By Discrete Analyser	EK062G	WATER	In house: Referenced to APHA 4500-Norg / 4500-NO3-. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	*Method*	*Matrix*	*Method Descriptions*
Total Phosphorus as P By Discrete Analyser	EK067G	WATER	In house: Referenced to APHA 4500-P H, Jirka et al (1976), Zhang et al (2006). This procedure involves sulphuric acid digestion of a sample aliquot to break phosphorus down to orthophosphate. The orthophosphate reacts with ammonium molybdate and antimony potassium tartrate to form a complex which is then reduced and its concentration measured at 880nm using discrete analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Sulfide as S2-	EK085	WATER	In house: Referenced to APHA 4500-S2- D. Sulfide species present in water samples are immediately precipitated when collected in pretreated caustic/zinc acetate preserved sample containers. After the supernatant is discarded, the resultant precipitate is then coloured using methylene blue indicator and measured using UV-VIS detection at 664nm. This method is compliant with NEPM (2013) Schedule B(3)
Sulfite as SO3 2-	EK086	WATER	In house: Referenced to APHA 4500-SO32- B. Sulfite is determined by standardised Iodate / Iodide titration.
Thiosulfate as S2O3 2-	EK087	WATER	In-house. Thiosulfate is determined by standardised Iodate / Iodide titration following formaledyde pretreatment.
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM (2013) Schedule B(3)
Formaldehyde	EP010	WATER	In house: Referenced to ASTM D 6303-98. Determined by colourimetry using NASH reagent. The Hantszch reaction method is based on the reaction of acetylacetone with formaldehyde in the presence of excess ammonium acetate to form a coloured compound.
Oil and Grease	EP020	WATER	In house: Referenced to APHA 5520 B. Oil & grease is a gravimetric procedure to determine the amount of oil & grease residue in an aqueous sample. The sample is serially extracted three times n-hexane. The resultant extracts are combined, dehydrated and concentrated prior to gravimetric determination. This method is compliant with NEPM (2013) Schedule B(3)
Chemical Oxygen Demand (COD) (Spectrophotometric)	EP026SP	WATER	In house: Referenced to APHA 5220 D. Samples are digested with a known excess of an acidic potassium dichromate solution using silver sulfate as a catalyst. The chromium is reduced from the Cr (VI) oxidation state to the Cr (III) state by the oxygen present in the organic material. Both of these chromium species are coloued and absorb in the visible region of (400nm & 600nm) the spectrum. The oxidisable organic matter can be calculated in terms of oxygen equivalents.
Nonionic Surfactants as CTAS	EP041A	WATER	In house: Referenced to APHA 5540 B&D. This method estimates the non-ionic surfactant content of waters. Sublation transfers all surfactants into a solvent matrix. Cationic and Anionic surfactants are removed by an ion exchange resin column. The remaining surfactant is coloured up with Cobalt Thiocyanate solution and quantified by UV-vis against LAS standards. This method is compliant with NEPM (2013) Schedule B(3)
Anionic Surfactants as MBAS	EP050	WATER	In house: Referenced to APHA 5540 B&C. This method comprises three successive extractions from acid aqueous medium containing excess methylene blue, into chloroform, followed by an aqueous backwash and measurement of the colour by spectrophotometry at 652nm. This method is compliant with NEPM (2013) Schedule B(3)
Polychlorinated Biphenyls (PCB)	EP066	WATER	USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Arochlors by GCMS	EP066-AR	WATER	Calculation based on ALS method EP066 for total PCB by GCMS. Identification of the Aroclor product based on the chromatography of Aroclors under EP066 method conditions.
Pesticides by GCMS	EP068	WATER	USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
Volatile Organic Compounds	EP074	WATER	USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Semivolatile Organic Compounds	EP075	WATER	USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
Organotin Compounds (Soluble)	EP090S	WATER	USEPA SW 846 - 8270D Sample extracts are analysed by GC/MS coupled with high volume injection and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Acrylonitrile by HS-GC-MS	EP118-1	WATER	In House. A 10 mL aliquot of sample is mixed with 4 g of sodium chloride, equilibrated at 80 degrees C for 10 minutes and the headspace analysed by GCMS in the selected ion monitoring mode.
Aldehydes by Derivitization Headspace GCMS	EP121	WATER	In-house. Aqueous aldehydes are derivatised with o-(2,3,4,5,6-pentafluorobenzyl)-hydroxylamine (PFBOA) in a sealed vial at 70°C. After a programmed heating time with gentle shaking, a reproducible headspace gas is extracted from the vial and injected into GC-MS.
Semivolatile Compounds by GCMS(SIM - Ultra-trace)	EP132	WATER	USEPA 3640 (GPC Cleanup), 8270 GCMS Capiliary column, SIM mode. This method is compliant with NEPM (2013) Schedule B(3)
Phenoxyacetic Acid Herbicides (LCMS - Standard DL)	EP202-SL	WATER	In-House, LCMS (Electrospray in negative mode). After adding surrogate and acetic acid, water samples are injected on a C18 column for LC/MS determination.
Explosives (Standard Level)	EP203-SL	WATER	USEPA 8330, Modified In-House, UV-DAD, LCMS (APCI in negative mode). Samples are diluted with acetonitrile and subjected to LC/MS for quantification.
PFOS and PFOA	EP231	WATER	In-house: Direct injection analysis of fresh and diluted saline waters. Analysis by LC-Electrospray-MS-MS, Negative Mode using MRM.
Perfluorinated Compounds by LCMSMS	EP231PFC	WATER	In-house: Direct injection analysis of fresh and diluted saline waters. In order to meet standard reporting limits, saline waters may be adsorped onto a solid phase extraction medium, the salt washed out and the sample eluted for analysis. Analysis by LC-Electrospray-MS-MS, Negative Mode using MRM.
Pesticides by LCMSMS (Positive Ion Mode)	EP234-1	WATER	In-House, LC-MSMS, direct injection. A sample is filtered and injected directly onto the LC-MSMS. Analysis is by LC/MSMS, ESI Positive Mode.

Preparation Methods	Method	Matrix	Method Descriptions
Preparation method for Radionuclides	EA250-PR	WATER	Preparation method for Radionuclides
TKN/TP Digestion	EK061/EK067	WATER	APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
Digestion for Total Recoverable Metals	EN25	WATER	USEPA SW846-3005 Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **ES1538298**	Page	: 1 of 4
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR PAUL MCFADYEN	Contact	:
Address	: PO BOX 5403 NEWCASTLE WEST NSW, AUSTRALIA 2302	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: paul.mcfadyen@ghd.com	E-mail	:
Telephone	: +61 07 4771 5645	Telephone	: +61-2-8784 8555
Facsimile	: +61 07 4772 6514	Facsimile	: +61-2-8784 8500
Project	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: ----	Date Samples Received	: 09-Dec-2015 13:34
C-O-C number	: ----	Date Analysis Commenced	: 10-Dec-2015
Sampler	: ----	Issue Date	: 21-Dec-2015 10:53
Site	: ----		
		No. of samples received	: 1
Quote number	: ----	No. of samples analysed	: 1

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

WORLD RECOGNISED ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Hoa Nguyen	Senior Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Shobhna Chandra	Metals Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting
ø = ALS is not NATA accredited for these tests.

- EG020: Bromine & Iodine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.
- EG020: LOR's for some samples have been raised due to matrix interference
- Metals Analysis : Filtered concentration for some analytes may be greater than total concentration, but within experimental variation of the methods.
- EP050, LOR raised for MBAS due to sample matrix. (very dirty sample).
- EP041A, LOR has been raised for NIS due to sample matrix (dirty sample).
- MBAS is calculated as LAS, molecular weight 342

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	MW202	----	----	----	----
			Client sampling date / time	[09-Dec-2015]	----	----	----	----
Compound	CAS Number	LOR	Unit	ES1538298-001	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.26**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.010	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.251**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.010	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.239**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0010	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	**0.144**	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.340**	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.023**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.010	----	----	----	----
Lithium	7439-93-2	0.001	mg/L	<0.010	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.540**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**1.26**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.288**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.10	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.010	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.199**	----	----	----	----
Thallium	7440-28-0	0.001	mg/L	<0.010	----	----	----	----
Tin	7440-31-5	0.001	mg/L	<0.010	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L	**1.76**	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.075**	----	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.10	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**14.6**	----	----	----	----
Bromine	7726-95-6	0.1	mg/L	**6.8**	----	----	----	----
Iodine	7553-56-2	0.1	mg/L	**9.1**	----	----	----	----
EG020T: Total Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**9.02**	----	----	----	----
Antimony	7440-36-0	0.001	mg/L	<0.010	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.249**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.010	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.293**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0010	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	**0.150**	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.375**	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.032**	----	----	----	----

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

Compound	CAS Number	LOR	Unit	MW202	----	----	----	----
			Client sampling date / time	[09-Dec-2015]	----	----	----	----
				ES1538298-001	--------	--------	--------	--------
				Result	Result	Result	Result	Result
EG020T: Total Metals by ICP-MS - Continued								
Lead	7439-92-1	0.001	mg/L	**0.016**	----	----	----	----
Lithium	7439-93-2	0.001	mg/L	**0.015**	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.581**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**1.41**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.314**	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.10	----	----	----	----
Silver	7440-22-4	0.001	mg/L	<0.010	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.227**	----	----	----	----
Thallium	7440-28-0	0.001	mg/L	<0.010	----	----	----	----
Tin	7440-31-5	0.001	mg/L	<0.010	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L	**1.92**	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.129**	----	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.10	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**19.4**	----	----	----	----
EG020U: Unfiltered Metals by ICP-MS								
Bromine	7726-95-6	0.05	mg/L	**6.08**	----	----	----	----
Iodine	7553-56-2	0.05	mg/L	**7.49**	----	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	**0.0122**	----	----	----	----
EP041A: Nonionic Surfactants								
Nonionic Surfactants as CTAS	----	5	mg/L	<10	----	----	----	----
EP050: Anionic Surfactants as MBAS								
Anionic Surfactants as MBAS	----	0.1	mg/L	<0.2	----	----	----	----

QUALITY CONTROL REPORT

Work Order	: **ES1538298**	Page	: 1 of 8
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR PAUL MCFADYEN	Contact	:
Address	: PO BOX 5403 NEWCASTLE WEST NSW, AUSTRALIA 2302	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: paul.mcfadyen@ghd.com	E-mail	:
Telephone	: +61 07 4771 5645	Telephone	: +61-2-8784 8555
Facsimile	: +61 07 4772 6514	Facsimile	: +61-2-8784 8500
Project	: ----	QC Level	: NEPM 2013 B3 & ALS QC Standard
Order number	: ----	Date Samples Received	: 09-Dec-2015
C-O-C number	: ----	Date Analysis Commenced	: 10-Dec-2015
Sampler	: ----	Issue Date	: 21-Dec-2015
Site	: ----	No. of samples received	: 1
Quote number	: ----	No. of samples analysed	: 1

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted.
This Quality Control Report contains the following information:

- Laboratory Duplicate (DUP) Report; Relative Percentage Difference (RPD) and Acceptance Limits
- Method Blank (MB) and Laboratory Control Spike (LCS) Report; Recovery and Acceptance Limits
- Matrix Spike (MS) Report; Recovery and Acceptance Limits

NATA Accredited
Laboratory 825

Accredited for
compliance with
ISO/IEC 17025.

WORLD RECOGNISED
ACCREDITATION

Signatories

This document has been electronically signed by the authorized signatories indicated below. Electronic signing has been carried out in compliance with procedures specified in 21 CFR Part 11.

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics, Smithfield, NSW
Hoa Nguyen	Senior Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Shobhna Chandra	Metals Coordinator	Sydney Inorganics, Smithfield, NSW

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis. Where the LOR of a reported result differs from standard LOR, this may be due to high

Key : Anonymous = Refers to samples which are not specifically part of this work order but formed part of the QC process lot

CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.

LOR = Limit of reporting

RPD = Relative Percentage Difference

= Indicates failed QC

Laboratory Duplicate (DUP) Report

The quality control term Laboratory Duplicate refers to a randomly selected intralaboratory split. Laboratory duplicates provide information regarding method precision and sample heterogeneity. The permitted ranges for the Relative Percent Deviation (RPD) of Laboratory Duplicates are specified in ALS Method QWI-EN/38 and are dependent on the magnitude of results in comparison to the level of reporting: Result < 10 times LOR: No Limit; Result between 10 and 20 times LOR:- 0% - 50%; Result > 20 times LOR:0% - 20%.

Sub-Matrix: **WATER**

				Laboratory Duplicate (DUP) Report					
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020F: Dissolved Metals by ICP-MS (QC Lot: 307176)									
ES1538428-003	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.154	0.154	0.00	0% - 20%
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lithium	7439-93-2	0.001	mg/L	0.066	0.066	0.00	0% - 20%
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.624	0.624	0.00	0% - 20%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	0.009	0.009	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-F: Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.008	0.008	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	0.50	0.50	0.00	0% - 50%
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Bromine	7726-95-6	0.1	mg/L	0.3	0.3	0.00	No Limit
		EG020A-F: Iodine	7553-56-2	0.1	mg/L	<0.1	<0.1	0.00	No Limit
ES1538266-001	Anonymous	EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Arsenic	7440-38-2	0.001	mg/L	0.002	0.001	0.00	No Limit
		EG020A-F: Barium	7440-39-3	0.001	mg/L	0.036	0.036	0.00	0% - 20%
		EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Lithium	7439-93-2	0.001	mg/L	0.047	0.048	0.00	0% - 20%
		EG020A-F: Manganese	7439-96-5	0.001	mg/L	0.212	0.221	4.52	0% - 20%
		EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	0.003	0.003	0.00	No Limit
		EG020A-F: Nickel	7440-02-0	0.001	mg/L	0.006	0.006	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
				Laboratory Duplicate (DUP) Report					
EG020F: Dissolved Metals by ICP-MS (QC Lot: 307176) - continued									
ES1538266-001	Anonymous	EG020A-F: Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-F: Zinc	7440-66-6	0.005	mg/L	0.007	0.007	0.00	No Limit
		EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-F: Boron	7440-42-8	0.05	mg/L	0.17	0.18	0.00	No Limit
		EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-F: Bromine	7726-95-6	0.1	mg/L	0.6	0.7	0.00	No Limit
		EG020A-F: Iodine	7553-56-2	0.1	mg/L	<0.1	<0.1	0.00	No Limit
EG020F: Dissolved Metals by ICP-MS (QC Lot: 307177)									
ES1538266-001	Anonymous	EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-F: Strontium	7440-24-6	0.001	mg/L	0.788	0.784	0.635	0% - 20%
EG020T: Total Metals by ICP-MS (QC Lot: 306362)									
ES1538311-001	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	0.004	0.004	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.153	0.151	1.44	0% - 20%
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.024	0.022	6.83	0% - 20%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Lithium	7439-93-2	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.005	0.005	0.00	No Limit
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	0.001	0.002	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.016	0.017	0.00	No Limit
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
ES1538320-008	Anonymous	EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
		EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Barium	7440-39-3	0.001	mg/L	0.008	0.009	0.00	No Limit
		EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.00	No Limit

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Laboratory Duplicate (DUP) Report					
				LOR	Unit	Original Result	Duplicate Result	RPD (%)	Recovery Limits (%)
EG020T: Total Metals by ICP-MS (QC Lot: 306362) - continued									
ES1538320-008	Anonymous	EG020A-T: Chromium	7440-47-3	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Copper	7440-50-8	0.001	mg/L	0.644	0.702	8.68	0% - 20%
		EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Lithium	7439-93-2	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Manganese	7439-96-5	0.001	mg/L	0.002	0.001	0.00	No Limit
		EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	0.001	0.001	0.00	No Limit
		EG020A-T: Nickel	7440-02-0	0.001	mg/L	0.002	0.002	0.00	No Limit
		EG020A-T: Thallium	7440-28-0	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020A-T: Zinc	7440-66-6	0.005	mg/L	0.062	0.067	9.12	0% - 50%
		EG020A-T: Aluminium	7429-90-5	0.01	mg/L	0.01	0.02	0.00	No Limit
		EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	0.00	No Limit
		EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.00	No Limit
		EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	<0.05	0.00	No Limit
EG020T: Total Metals by ICP-MS (QC Lot: 306363)									
ES1538311-001	Anonymous	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-T: Strontium	7440-24-6	0.001	mg/L	0.643	0.650	1.12	0% - 20%
ES1538320-008	Anonymous	EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	<0.001	0.00	No Limit
		EG020B-T: Strontium	7440-24-6	0.001	mg/L	0.182	0.199	8.99	0% - 20%
EG020U: Unfiltered Metals by ICP-MS (QC Lot: 309312)									
ES1538298-001	MW202	EG020A-U: Bromine	7726-95-6	0.05	mg/L	6.08	6.43	5.56	0% - 50%
		EG020A-U: Iodine	7553-56-2	0.05	mg/L	7.49	7.86	4.84	0% - 50%
EG035F: Dissolved Mercury by FIMS (QC Lot: 307175)									
ES1538298-001	MW202	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
ES1538423-003	Anonymous	EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EG035T: Total Recoverable Mercury by FIMS (QC Lot: 309604)									
ES1538259-001	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
ES1538320-002	Anonymous	EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	0.00	No Limit
EP041A: Nonionic Surfactants (QC Lot: 307440)									
ES1538298-001	MW202	EP041A: Nonionic Surfactants as CTAS	----	5	mg/L	<10	<5	66.7	No Limit
EP050: Anionic Surfactants as MBAS (QC Lot: 305829)									
ES1538313-005	Anonymous	EP050: Anionic Surfactants as MBAS		0.1	mg/L	0.1	0.1	0.00	No Limit

Method Blank (MB) and Laboratory Control Spike (LCS) Report

The quality control term Method / Laboratory Blank refers to an analyte free matrix to which all reagents are added in the same volumes or proportions as used in standard sample preparation. The purpose of this QC parameter is to monitor potential laboratory contamination. The quality control term Laboratory Control Sample (LCS) refers to a certified reference material, or a known interference free matrix spiked with target analytes. The purpose of this QC parameter is to monitor method precision and accuracy independent of sample matrix. Dynamic Recovery Limits are based on statistical evaluation of processed LCS.

Sub-Matrix: **WATER**

				Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
Method: Compound	CAS Number	LOR	Unit	Result	Concentration	LCS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 307176)								
EG020A-F: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	103	80	116
EG020A-F: Antimony	7440-36-0	0.001	mg/L	<0.001	0.01 mg/L	90.7	85	115
EG020A-F: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	101	85	114
EG020A-F: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	98.2	82	110
EG020A-F: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	107	85	115
EG020A-F: Boron	7440-42-8	0.05	mg/L	<0.05	0.1 mg/L	102	85	115
EG020A-F: Bromine	7726-95-6	0.1	mg/L	<0.1	----	----	----	----
EG020A-F: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	103	84	110
EG020A-F: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	102	85	111
EG020A-F: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	99.4	82	112
EG020A-F: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	101	81	111
EG020A-F: Iodine	7553-56-2	0.1	mg/L	<0.1	----	----	----	----
EG020A-F: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	102	82	112
EG020A-F: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	99.4	83	111
EG020A-F: Lithium	7439-93-2	0.001	mg/L	<0.001	0.1 mg/L	109	79	117
EG020A-F: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	102	82	110
EG020A-F: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	94.3	79	113
EG020A-F: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	98.3	82	112
EG020A-F: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	101	85	115
EG020A-F: Thallium	7440-28-0	0.001	mg/L	<0.001	0.1 mg/L	101	85	111
EG020A-F: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	95.8	77	115
EG020A-F: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	102	83	109
EG020A-F: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	104	81	117
EG020F: Dissolved Metals by ICP-MS (QCLot: 307177)								
EG020B-F: Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----
EG020B-F: Strontium	7440-24-6	0.001	mg/L	<0.001	0.1 mg/L	101	81	113
EG020T: Total Metals by ICP-MS (QCLot: 306362)								
EG020A-T: Aluminium	7429-90-5	0.01	mg/L	<0.01	0.5 mg/L	103	82	120
EG020A-T: Antimony	7440-36-0	0.001	mg/L	<0.001	----	----	----	----
EG020A-T: Arsenic	7440-38-2	0.001	mg/L	<0.001	0.1 mg/L	101	82	114
EG020A-T: Barium	7440-39-3	0.001	mg/L	<0.001	0.1 mg/L	102	84	116
EG020A-T: Beryllium	7440-41-7	0.001	mg/L	<0.001	0.1 mg/L	111	79	119
EG020A-T: Boron	7440-42-8	0.05	mg/L	<0.05	0.1 mg/L	101	75	129
EG020A-T: Cadmium	7440-43-9	0.0001	mg/L	<0.0001	0.1 mg/L	103	84	112

Sub-Matrix: **WATER**

Method: Compound	CAS Number	LOR	Unit	Method Blank (MB) Report	Laboratory Control Spike (LCS) Report			
					Spike	Spike Recovery (%)	Recovery Limits (%)	
				Result	Concentration	LCS	Low	High
EG020T: Total Metals by ICP-MS (QCLot: 306362) - continued								
EG020A-T: Chromium	7440-47-3	0.001	mg/L	<0.001	0.1 mg/L	105	86	116
EG020A-T: Cobalt	7440-48-4	0.001	mg/L	<0.001	0.1 mg/L	101	84	116
EG020A-T: Copper	7440-50-8	0.001	mg/L	<0.001	0.1 mg/L	103	83	118
EG020A-T: Iron	7439-89-6	0.05	mg/L	<0.05	0.5 mg/L	106	85	117
EG020A-T: Lead	7439-92-1	0.001	mg/L	<0.001	0.1 mg/L	102	85	115
EG020A-T: Lithium	7439-93-2	0.001	mg/L	<0.001	0.1 mg/L	113	82	122
EG020A-T: Manganese	7439-96-5	0.001	mg/L	<0.001	0.1 mg/L	105	85	113
EG020A-T: Molybdenum	7439-98-7	0.001	mg/L	<0.001	0.1 mg/L	116	83	121
EG020A-T: Nickel	7440-02-0	0.001	mg/L	<0.001	0.1 mg/L	102	84	116
EG020A-T: Selenium	7782-49-2	0.01	mg/L	<0.01	0.1 mg/L	120	68	126
EG020A-T: Thallium	7440-28-0	0.001	mg/L	<0.001	0.1 mg/L	117	87	117
EG020A-T: Tin	7440-31-5	0.001	mg/L	<0.001	0.1 mg/L	121	83	123
EG020A-T: Vanadium	7440-62-2	0.01	mg/L	<0.01	0.1 mg/L	105	85	113
EG020A-T: Zinc	7440-66-6	0.005	mg/L	<0.005	0.1 mg/L	105	79	117
EG020T: Total Metals by ICP-MS (QCLot: 306363)								
EG020B-T: Silver	7440-22-4	0.001	mg/L	<0.001	----	----	----	----
EG020B-T: Strontium	7440-24-6	0.001	mg/L	<0.001	0.1 mg/L	102	84	118
EG020U: Unfiltered Metals by ICP-MS (QCLot: 309312)								
EG020A-U: Bromine	7726-95-6	0.05	mg/L	<0.05	----	----	----	----
EG020A-U: Iodine	7553-56-2	0.05	mg/L	<0.05	----	----	----	----
EG035F: Dissolved Mercury by FIMS (QCLot: 307175)								
EG035F: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	94.1	83	105
EG035T: Total Recoverable Mercury by FIMS (QCLot: 309604)								
EG035T: Mercury	7439-97-6	0.0001	mg/L	<0.0001	0.01 mg/L	94.0	77	111
EP041A: Nonionic Surfactants (QCLot: 307440)								
EP041A: Nonionic Surfactants as CTAS	----	5	mg/L	<5	5 mg/L	97.0	78	124
EP050: Anionic Surfactants as MBAS (QCLot: 305829)								
EP050: Anionic Surfactants as MBAS		0.1	mg/L	<0.1	2 mg/L	100	74	118

Matrix Spike (MS) Report

The quality control term Matrix Spike (MS) refers to an intralaboratory split sample spiked with a representative set of target analytes. The purpose of this QC parameter is to monitor potential matrix effects on analyte recoveries. Static Recovery Limits as per laboratory Data Quality Objectives (DQOs). Ideal recovery ranges stated may be waived in the event of sample matrix interference.

Sub-Matrix: **WATER**

Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
				Concentration	MS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 307176)							
ES1538296-001	Anonymous	EG020A-F: Arsenic	7440-38-2	0.2 mg/L	118	70	130

Sub-Matrix: **WATER**

				Matrix Spike (MS) Report			
				Spike	SpikeRecovery(%)	Recovery Limits (%)	
Laboratory sample ID	Client sample ID	Method: Compound	CAS Number	Concentration	MS	Low	High
EG020F: Dissolved Metals by ICP-MS (QCLot: 307176) - continued							
ES1538296-001	Anonymous	EG020A-F: Barium	7440-39-3	0.2 mg/L	126	70	130
		EG020A-F: Beryllium	7440-41-7	0.2 mg/L	87.9	70	130
		EG020A-F: Cadmium	7440-43-9	0.05 mg/L	88.0	70	130
		EG020A-F: Chromium	7440-47-3	0.2 mg/L	92.3	70	130
		EG020A-F: Cobalt	7440-48-4	0.2 mg/L	126	70	130
		EG020A-F: Copper	7440-50-8	0.2 mg/L	# Not Determined	70	130
		EG020A-F: Lead	7439-92-1	0.2 mg/L	# Not Determined	70	130
		EG020A-F: Manganese	7439-96-5	0.2 mg/L	93.1	70	130
		EG020A-F: Nickel	7440-02-0	0.2 mg/L	126	70	130
		EG020A-F: Vanadium	7440-62-2	0.2 mg/L	106	70	130
		EG020A-F: Zinc	7440-66-6	0.2 mg/L	# Not Determined	70	130
EG020T: Total Metals by ICP-MS (QCLot: 306362)							
ES1538291-012	Anonymous	EG020A-T: Arsenic	7440-38-2	1 mg/L	110	70	130
		EG020A-T: Barium	7440-39-3	1 mg/L	112	70	130
		EG020A-T: Beryllium	7440-41-7	1 mg/L	118	70	130
		EG020A-T: Cadmium	7440-43-9	0.25 mg/L	110	70	130
		EG020A-T: Chromium	7440-47-3	1 mg/L	111	70	130
		EG020A-T: Cobalt	7440-48-4	1 mg/L	109	70	130
		EG020A-T: Copper	7440-50-8	1 mg/L	109	70	130
		EG020A-T: Lead	7439-92-1	1 mg/L	108	70	130
		EG020A-T: Manganese	7439-96-5	1 mg/L	110	70	130
		EG020A-T: Nickel	7440-02-0	1 mg/L	108	70	130
		EG020A-T: Vanadium	7440-62-2	1 mg/L	111	70	130
		EG020A-T: Zinc	7440-66-6	1 mg/L	110	70	130
EG035F: Dissolved Mercury by FIMS (QCLot: 307175)							
ES1538266-001	Anonymous	EG035F: Mercury	7439-97-6	0.01 mg/L	97.2	70	130
EG035T: Total Recoverable Mercury by FIMS (QCLot: 309604)							
ES1538259-002	Anonymous	EG035T: Mercury	7439-97-6	0.01 mg/L	89.5	70	130
EP041A: Nonionic Surfactants (QCLot: 307440)							
EP1516895-001	Anonymous	EP041A: Nonionic Surfactants as CTAS	----	5 mg/L	82.0	70	130
EP050: Anionic Surfactants as MBAS (QCLot: 305829)							
ES1538313-005	Anonymous	EP050: Anionic Surfactants as MBAS		1 mg/L	90.0	70	130

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **ES1538298**	Page	: 1 of 7
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Sydney
Contact	: MR PAUL MCFADYEN	Telephone	: +61-2-8784 8555
Project	: ----	Date Samples Received	: 09-Dec-2015
Site	: ----	Issue Date	: 21-Dec-2015
Sampler	: ----	No. of samples received	: 1
Order number	: ----	No. of samples analysed	: 1

This report is automatically generated by the ALS LIMS through interpretation of the ALS Quality Control Report and several Quality Assurance parameters measured by ALS. This automated reporting highlights any non-conformances, facilitates faster and more accurate data validation and is designed to assist internal expert and external Auditor review. Many components of this report contribute to the overall DQO assessment and reporting for guideline compliance.

Brief method summaries and references are also provided to assist in traceability.

Summary of Outliers

Outliers : Quality Control Samples

This report highlights outliers flagged in the Quality Control (QC) Report.

- **NO Method Blank value outliers occur.**
- **NO Duplicate outliers occur.**
- **NO Laboratory Control outliers occur.**
- **Matrix Spike outliers exist - please see following pages for full details.**
- **For all regular sample matrices, NO surrogate recovery outliers occur.**

Outliers : Analysis Holding Time Compliance

- **NO Analysis Holding Time Outliers exist.**

Outliers : Frequency of Quality Control Samples

- **Quality Control Sample Frequency Outliers exist - please see following pages for full details.**

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EG020F: Dissolved Metals by ICP-MS	ES1538296--001	Anonymous	**Copper**	7440-50-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG020F: Dissolved Metals by ICP-MS	ES1538296--001	Anonymous	**Lead**	7439-92-1	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG020F: Dissolved Metals by ICP-MS	ES1538296--001	Anonymous	**Zinc**	7440-66-6	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Control Samples (LCS)					
Unfiltered Metals by ICP-MS - Suite A	0	1	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
Unfiltered Metals by ICP-MS - Suite A	0	1	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

This report summarizes extraction / preparation and analysis times and compares each with ALS recommended holding times (referencing USEPA SW 846, APHA, AS and NEPM) based on the sample container provided. Dates reported represent first date of extraction or analysis and preclude subsequent dilutions and reruns. A listing of breaches (if any) is provided herein.

Holding time for leachate methods (e.g. TCLP) vary according to the analytes reported. Assessment compares the leach date with the shortest analyte holding time for the equivalent soil method. These are: organics 14 days, mercury 28 days & other metals 180 days. A recorded breach does not guarantee a breach for all non-volatile parameters.

Holding times for ***VOC in soils*** vary according to analytes of interest. Vinyl Chloride and Styrene holding time is 7 days; others 14 days. A recorded breach does not guarantee a breach for all VOC analytes and should be verified in case the reported breach is a false positive or Vinyl Chloride and Styrene are not key analytes of interest/concern.

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method	*Sample Date*	*Extraction / Preparation*			*Analysis*		
Container / Client Sample ID(s)		*Date extracted*	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F) MW202	**09-Dec-2015**	**----**	----	----	**17-Dec-2015**	06-Jun-2016	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T) MW202	**09-Dec-2015**	**11-Dec-2015**	06-Jun-2016	✓	**11-Dec-2015**	06-Jun-2016	✓
EG020U: Unfiltered Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-U) MW202	**09-Dec-2015**	**----**	----	----	**17-Dec-2015**	06-Jun-2016	✓

Matrix: **WATER**

Evaluation: × = Holding time breach ; ✓ = Within holding time.

Method / **Container** / Client Sample ID(s)	**Sample Date**	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	**Date analysed**	Due for analysis	Evaluation
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020B-F)							
MW202	**09-Dec-2015**	**----**	----	----	**17-Dec-2015**	06-Jun-2016	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020B-T)							
MW202	**09-Dec-2015**	**11-Dec-2015**	06-Jun-2016	✓	**11-Dec-2015**	06-Jun-2016	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
MW202	**09-Dec-2015**	**----**	----	----	**16-Dec-2015**	06-Jan-2016	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035T)							
MW202	**09-Dec-2015**	**----**	----	----	**16-Dec-2015**	06-Jan-2016	✓
EP041A: Nonionic Surfactants							
Pres. with Formaldehyde on receipt (EP041A)							
MW202	**09-Dec-2015**	**----**	----	----	**11-Dec-2015**	06-Jan-2016	✓
EP050: Anionic Surfactants as MBAS							
Pres. with Formaldehyde on receipt (EP050)							
MW202	**09-Dec-2015**	**----**	----	----	**10-Dec-2015**	13-Dec-2015	✓

Quality Control Parameter Frequency Compliance

The following report summarises the frequency of laboratory QC samples analysed within the analytical lot(s) in which the submitted sample(s) was(were) processed. Actual rate should be greater than or equal to the expected rate. A listing of breaches is provided in the Summary of Outliers.

Matrix: **WATER**

Evaluation: ✗ = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Anionic Surfactants as MBAS	EP050	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	3	**33.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	1	1	**100.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Anionic Surfactants as MBAS	EP050	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	0	1	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Anionic Surfactants as MBAS	EP050	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite B	EG020B-F	1	3	**33.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite B	EG020B-T	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	1	1	**100.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Anionic Surfactants as MBAS	EP050	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nonionic Surfactants as CTAS	EP041A	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

Evaluation: × = Quality Control frequency not within specification ; ✓ = Quality Control frequency within specification.

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Matrix Spikes (MS) - Continued							
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	0	1	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the US EPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request. The following report provides brief descriptions of the analytical procedures employed for results reported in the Certificate of Analysis. Sources from which ALS methods have been developed are provided within the Method Descriptions.

Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Unfiltered Metals by ICP-MS - Suite A	EG020A-U	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Metals by ICP-MS - Suite B	EG020B-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45 um filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite B	EG020B-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45 um filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Nonionic Surfactants as CTAS	EP041A	WATER	In house: Referenced to APHA 5540 B&D. This method estimates the non-ionic surfactant content of waters. Sublation transfers all surfactants into a solvent matrix. Cationic and Anionic surfactants are removed by an ion exchange resin column. The remaining surfactant is coloured up with Cobalt Thiocyanate solution and quantified by UV-vis against LAS standards. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Anionic Surfactants as MBAS	EP050	WATER	In house: Referenced to APHA 5540 B&C. This method comprises three successive extractions from acid aqueous medium containing excess methylene blue, into chloroform, followed by an aqueous backwash and measurement of the colour by spectrophotometry at 652nm. This method is compliant with NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Digestion for Total Recoverable Metals	EN25	WATER	USEPA SW846-3005 Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)

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Certificate of Analysis

GHD Pty Ltd
3/24 Honeysuckle Dve
Newcastle
NSW 2300

NATA Accredited
Accreditation Number 1261
Site Number 1254

Accredited for compliance with ISO/IEC 17025.
The results of the tests, calibrations and/or measurements included in this document are traceable to Australian/national standards.

Attention: **Paul McFadyen**

Report **483138-W**
Project name 22180150302
Received Date Dec 11, 2015

Client Sample ID			**MW202**	**MW206**
Sample Matrix			**Water**	**Water**
Eurofins | mgt Sample No.			**M15-De12338**	**M15-De12339**
Date Sampled			**Dec 09, 2015**	**Dec 09, 2015**
Test/Reference	LOR	Unit		
n-Decane	0.01	mg/L	< 0.05	< 0.05
n-Heptane	0.05	mg/L	< 0.05	< 0.05
n-Hexane	0.05	mg/L	< 0.05	< 0.05
n-Nonane	0.05	mg/L	< 0.05	< 0.05
n-Octane	0.05	mg/L	< 0.05	< 0.05
n-Pentane	0.05	mg/L	< 0.05	< 0.05
Chemical Oxygen Demand (COD)	20	mg/L	2900	-
Chloride	1	mg/L	870	-
Chlorine (free)	0.1	mg/L	< 0.1	-
Chlorine (total)	0.1	mg/L	< 0.1	-
Colour(Pt/Co) true	2	Pt/Co unit	13000	-
Conductivity (at 25°C)	1	uS/cm	35000	-
Cyanide (total)	0.005	mg/L	21	-
Cyanide (weak acid dissoc.)	0.005	mg/L	0.047	-
Fluoride	0.5	mg/L	250	-
Formaldehyde	0.2	mg/L	< 0.2	-
pH	0.1	pH Units	8.8	-
Phosphate ortho (as P)	0.05	mg/L	< 0.05	-
Phosphate total (as P)	0.05	mg/L	5.2	-
Reactive Silica (as SiO2)	5	mg/L	< 200	-
Suspended Solids	1	mg/L	240	-
Total Dissolved Solids	10	mg/L	32000	-
Total Organic Carbon[M10]	5	mg/L	310	-
Total Solids	10	mg/L	34000	-
Volatile Suspended Solids	1	mg/L	35	-
Sodium Adsorption Ratio*	0.1		360	-
Acetates				
Butyl acetate	0.5	mg/L	< 0.5	< 0.5
Ethyl acetate	1	mg/L	< 1	< 1
Propyl acetate	1	mg/L	< 1	< 1
Vinyl acetate	2.5	mg/L	< 2.5	< 2.5
Volatile Organics				
Comments			G01	
1.1-Dichloroethane	0.001	mg/L	< 0.02	-
1.1-Dichloroethene	0.001	mg/L	< 0.02	-
1.1.1-Trichloroethane	0.001	mg/L	< 0.02	-

Client Sample ID Sample Matrix Eurofins | mgt Sample No. Date Sampled Test/Reference	LOR	Unit	MW202 Water M15-De12338 Dec 09, 2015	MW206 Water M15-De12339 Dec 09, 2015
Volatile Organics				
1.1.1.2-Tetrachloroethane	0.001	mg/L	< 0.02	-
1.1.2-Trichloroethane	0.001	mg/L	< 0.02	-
1.1.2.2-Tetrachloroethane	0.001	mg/L	< 0.02	-
1.2-Dibromoethane	0.001	mg/L	< 0.02	-
1.2-Dichlorobenzene	0.001	mg/L	< 0.02	-
1.2-Dichloroethane	0.001	mg/L	< 0.02	-
1.2-Dichloropropane	0.001	mg/L	< 0.02	-
1.2.3-Trichloropropane	0.001	mg/L	< 0.02	-
1.2.4-Trimethylbenzene	0.001	mg/L	< 0.02	-
1.3-Dichlorobenzene	0.001	mg/L	< 0.02	-
1.3-Dichloropropane	0.001	mg/L	< 0.02	-
1.3.5-Trimethylbenzene	0.001	mg/L	< 0.02	-
1.4-Dichlorobenzene	0.001	mg/L	< 0.02	-
2-Butanone (MEK)	0.001	mg/L	< 0.02	-
2-Propanone (Acetone)	0.001	mg/L	< 0.02	-
4-Chlorotoluene	0.001	mg/L	< 0.02	-
4-Methyl-2-pentanone (MIBK)	0.001	mg/L	< 0.02	-
Allyl chloride	0.001	mg/L	< 0.02	-
Benzene	0.001	mg/L	0.029	-
Bromobenzene	0.001	mg/L	< 0.02	-
Bromochloromethane	0.001	mg/L	< 0.02	-
Bromodichloromethane	0.001	mg/L	< 0.02	-
Bromoform	0.001	mg/L	< 0.02	-
Bromomethane	0.001	mg/L	< 0.02	-
Carbon disulfide	0.001	mg/L	< 0.02	-
Carbon Tetrachloride	0.001	mg/L	< 0.02	-
Chlorobenzene	0.001	mg/L	< 0.02	-
Chloroethane	0.001	mg/L	< 0.02	-
Chloroform	0.005	mg/L	< 0.02	-
Chloromethane	0.001	mg/L	< 0.02	-
cis-1.2-Dichloroethene	0.001	mg/L	< 0.02	-
cis-1.3-Dichloropropene	0.001	mg/L	< 0.02	-
Dibromochloromethane	0.001	mg/L	< 0.02	-
Dibromomethane	0.001	mg/L	< 0.02	-
Dichlorodifluoromethane	0.001	mg/L	< 0.02	-
Ethylbenzene	0.001	mg/L	< 0.02	-
Iodomethane	0.001	mg/L	< 0.02	-
Isopropyl benzene (Cumene)	0.001	mg/L	< 0.02	-
m&p-Xylenes	0.002	mg/L	< 0.04	-
Methylene Chloride	0.001	mg/L	< 0.02	-
o-Xylene	0.001	mg/L	< 0.02	-
Styrene	0.001	mg/L	< 0.02	-
Tetrachloroethene	0.001	mg/L	< 0.02	-
Toluene	0.001	mg/L	< 0.02	-
trans-1.2-Dichloroethene	0.001	mg/L	< 0.02	-
trans-1.3-Dichloropropene	0.001	mg/L	< 0.02	-
Trichloroethene	0.001	mg/L	< 0.02	-
Trichlorofluoromethane	0.001	mg/L	< 0.02	-
Vinyl chloride	0.001	mg/L	< 0.02	-

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Client Sample ID Sample Matrix Eurofins | mgt Sample No. Date Sampled Test/Reference	LOR	Unit	MW202 Water M15-De12338 Dec 09, 2015	MW206 Water M15-De12339 Dec 09, 2015
Volatile Organics				
Xylenes - Total	0.003	mg/L	< 0.06	-
Fluorobenzene (surr.)	1	%	93	-
4-Bromofluorobenzene (surr.)	1	%	97	-
Semivolatile Organics				
Comments			G01	
2-Methyl-4.6-dinitrophenol	0.03	mg/L	< 0.03	-
1-Chloronaphthalene	0.005	mg/L	< 0.01	-
1-Naphthylamine	0.005	mg/L	< 0.01	-
1.2-Dichlorobenzene	0.005	mg/L	< 0.01	-
1.2.3-Trichlorobenzene	0.005	mg/L	< 0.01	-
1.2.3.4-Tetrachlorobenzene	0.005	mg/L	< 0.01	-
1.2.3.5-Tetrachlorobenzene	0.005	mg/L	< 0.01	-
1.2.4-Trichlorobenzene	0.005	mg/L	< 0.01	-
1.2.4.5-Tetrachlorobenzene	0.005	mg/L	< 0.01	-
1.3-Dichlorobenzene	0.005	mg/L	< 0.01	-
1.3.5-Trichlorobenzene	0.005	mg/L	< 0.01	-
1.4-Dichlorobenzene	0.005	mg/L	< 0.01	-
2-Chloronaphthalene	0.005	mg/L	< 0.01	-
2-Chlorophenol	0.003	mg/L	< 0.003	-
2-Methylnaphthalene	0.005	mg/L	< 0.01	-
2-Methylphenol (o-Cresol)	0.003	mg/L	< 0.003	-
2-Naphthylamine	0.005	mg/L	< 0.01	-
2-Nitroaniline	0.005	mg/L	< 0.01	-
2-Nitrophenol	0.01	mg/L	< 0.01	-
2-Picoline	0.005	mg/L	< 0.01	-
2.3.4.6-Tetrachlorophenol	0.01	mg/L	< 0.02	-
2.4-Dichlorophenol	0.003	mg/L	< 0.003	-
2.4-Dimethylphenol	0.003	mg/L	< 0.003	-
2.4-Dinitrophenol	0.03	mg/L	< 0.03	-
2.4-Dinitrotoluene	0.005	mg/L	< 0.01	-
2.4.5-Trichlorophenol	0.01	mg/L	< 0.01	-
2.4.6-Trichlorophenol	0.01	mg/L	< 0.01	-
2.6-Dichlorophenol	0.003	mg/L	< 0.003	-
2.6-Dinitrotoluene	0.005	mg/L	< 0.01	-
3&4-Methylphenol (m&p-Cresol)	0.006	mg/L	< 0.006	-
3-Methylcholanthrene	0.005	mg/L	< 0.01	-
3.3'-Dichlorobenzidine	0.005	mg/L	< 0.01	-
4-Aminobiphenyl	0.005	mg/L	< 0.01	-
4-Bromophenyl phenyl ether	0.005	mg/L	< 0.01	-
4-Chloro-3-methylphenol	0.01	mg/L	< 0.01	-
4-Chlorophenyl phenyl ether	0.005	mg/L	< 0.01	-
4-Nitrophenol	0.03	mg/L	< 0.03	-
4.4'-DDD	0.005	mg/L	< 0.01	-
4.4'-DDE	0.005	mg/L	< 0.01	-
4.4'-DDT	0.005	mg/L	< 0.01	-
7.12-Dimethylbenz(a)anthracene	0.005	mg/L	< 0.01	-
a-BHC	0.005	mg/L	< 0.01	-
Acenaphthene	0.001	mg/L	< 0.001	-
Acenaphthylene	0.001	mg/L	< 0.001	-

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Client Sample ID			MW202	MW206
Sample Matrix			Water	Water
Eurofins | mgt Sample No.			M15-De12338	M15-De12339
Date Sampled			Dec 09, 2015	Dec 09, 2015
Test/Reference	LOR	Unit		
Semivolatile Organics				
Acetophenone	0.005	mg/L	< 0.01	-
Aldrin	0.005	mg/L	< 0.01	-
Aniline	0.005	mg/L	< 0.01	-
Anthracene	0.001	mg/L	< 0.001	-
b-BHC	0.005	mg/L	< 0.01	-
Benz(a)anthracene	0.001	mg/L	< 0.001	-
Benzo(a)pyrene	0.001	mg/L	< 0.001	-
Benzo(b&j)fluoranthene[N07]	0.001	mg/L	< 0.001	-
Benzo(g.h.i)perylene	0.001	mg/L	< 0.001	-
Benzo(k)fluoranthene	0.001	mg/L	< 0.001	-
Benzyl chloride	0.005	mg/L	< 0.01	-
Bis(2-chloroethoxy)methane	0.005	mg/L	< 0.01	-
Bis(2-chloroisopropyl)ether	0.005	mg/L	< 0.01	-
Bis(2-ethylhexyl)phthalate	0.005	mg/L	< 0.01	-
Butyl benzyl phthalate	0.005	mg/L	< 0.01	-
Chrysene	0.001	mg/L	< 0.001	-
d-BHC	0.005	mg/L	< 0.01	-
Di-n-butyl phthalate	0.005	mg/L	< 0.01	-
Di-n-octyl phthalate	0.005	mg/L	< 0.01	-
Dibenz(a.h)anthracene	0.001	mg/L	< 0.001	-
Dibenz(a.j)acridine	0.005	mg/L	< 0.01	-
Dibenzofuran	0.005	mg/L	< 0.01	-
Dieldrin	0.005	mg/L	< 0.01	-
Diethyl phthalate	0.005	mg/L	< 0.01	-
Dimethyl phthalate	0.005	mg/L	< 0.01	-
Dimethylaminoazobenzene	0.005	mg/L	< 0.01	-
Diphenylamine	0.005	mg/L	< 0.01	-
Endosulfan I	0.005	mg/L	< 0.01	-
Endosulfan II	0.005	mg/L	< 0.01	-
Endosulfan sulphate	0.005	mg/L	< 0.01	-
Endrin	0.005	mg/L	< 0.01	-
Endrin aldehyde	0.005	mg/L	< 0.01	-
Endrin ketone	0.005	mg/L	< 0.01	-
Fluoranthene	0.001	mg/L	< 0.001	-
Fluorene	0.001	mg/L	< 0.001	-
g-BHC (Lindane)	0.005	mg/L	< 0.01	-
Heptachlor	0.005	mg/L	< 0.01	-
Heptachlor epoxide	0.005	mg/L	< 0.01	-
Hexachlorobenzene	0.005	mg/L	< 0.01	-
Hexachlorobutadiene	0.005	mg/L	< 0.01	-
Hexachlorocyclopentadiene	0.005	mg/L	< 0.01	-
Hexachloroethane	0.005	mg/L	< 0.01	-
Indeno(1.2.3-cd)pyrene	0.001	mg/L	< 0.001	-
Methoxychlor	0.005	mg/L	< 0.01	-
N-Nitrosodibutylamine	0.005	mg/L	< 0.01	-
N-Nitrosodipropylamine	0.005	mg/L	< 0.01	-
N-Nitrosopiperidine	0.005	mg/L	< 0.01	-
Naphthalene	0.001	mg/L	0.004	-
Nitrobenzene	0.05	mg/L	< 0.05	-

Client Sample ID			MW202	MW206
Sample Matrix			Water	Water
Eurofins | mgt Sample No.			M15-De12338	M15-De12339
Date Sampled			Dec 09, 2015	Dec 09, 2015
Test/Reference	LOR	Unit		
Semivolatile Organics				
Pentachlorobenzene	0.005	mg/L	< 0.01	-
Pentachloronitrobenzene	0.005	mg/L	< 0.01	-
Pentachlorophenol	0.01	mg/L	< 0.01	-
Phenanthrene	0.001	mg/L	< 0.001	-
Phenol	0.003	mg/L	< 0.003	-
Pronamide	0.005	mg/L	< 0.01	-
Pyrene	0.001	mg/L	< 0.001	-
Trifluralin	0.005	mg/L	< 0.01	-
Phenol-d6 (surr.)	1	%	27	-
Nitrobenzene-d5 (surr.)	1	%	56	-
2-Fluorobiphenyl (surr.)	1	%	53	-
2.4.6-Tribromophenol (surr.)	1	%	42	-
Alkalinity (speciated)				
Bicarbonate Alkalinity (as CaCO3)	20	mg/L	20000	-
Carbonate Alkalinity (as CaCO3)	10	mg/L	6700	-
Hydroxide Alkalinity (as CaCO3)	10	mg/L	< 10	-
Total Alkalinity (as CaCO3)	20	mg/L	27000	-
Total Sulphur Set (as S)				
Sulphate (as S)	5	mg/L	680	-
Sulphide (as S)	0.05	mg/L	< 0.05	-
Sulphite (as S)	0.5	mg/L	< 5	-
Thiosulphate (as S)	1	mg/L	< 10	-
Total Sulphur (as S)	5	mg/L	680	-
Nitrogens (speciated)				
Ammonia (as N)	0.01	mg/L	48	-
Nitrate (as N)	0.02	mg/L	< 0.2	-
Nitrite (as N)	0.02	mg/L	< 0.2	-
Organic Nitrogen (as N)	0.2	mg/L	27	-
Total Kjeldahl Nitrogen (as N)	0.2	mg/L	75	-
Total Nitrogen (as N)	0.2	mg/L	75	-
Alkali Metals				
Calcium	0.5	mg/L	5.0	-
Magnesium	0.5	mg/L	41	-
Potassium	0.5	mg/L	46	-
Sodium	0.5	mg/L	12000	-

Sample History

Where samples are submitted/analysed over several days, the last date of extraction and analysis is reported.
A recent review of our LIMS has resulted in the correction or clarification of some method identifications. Due to this, some of the method reference information on reports has changed. However, no substantive change has been made to our laboratory methods, and as such there is no change in the validity of current or previous results (regarding both quality and NATA accreditation).

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
n-Decane	Melbourne	Dec 11, 2015	14 Day
n-Heptane	Melbourne	Dec 11, 2015	14 Day
- Method: ..			
n-Hexane	Melbourne	Dec 11, 2015	14 Day
- Method: USEPA 8000 - Hexane			
n-Nonane	Melbourne	Dec 11, 2015	14 Day
- Method: ..			
n-Octane	Melbourne	Dec 11, 2015	14 Day
- Method: ..			
n-Pentane	Melbourne	Dec 11, 2015	14 Day
- Method: USEPA 8260 - n-Pentane			
Chemical Oxygen Demand (COD)	Melbourne	Dec 11, 2015	28 Day
- Method: APHA 5220 COD Open Reflux Method			
Chloride	Melbourne	Dec 14, 2015	28 Day
- Method: MGT 1100A			
Chlorine (free)	Melbourne	Dec 11, 2015	1 Day
Chlorine (total)	Melbourne	Dec 11, 2015	5 Day
Colour(Pt/Co) true	Melbourne	Dec 11, 2015	2 Day
- Method: APHA 2120B Colour			
Conductivity (at 25°C)	Melbourne	Dec 14, 2015	28 Day
- Method: LTM-INO-4030			
Cyanide (total)	Melbourne	Dec 14, 2015	14 Day
- Method: LTM-INO-4020 Total Free WAD Cyanide by CFA			
Cyanide (weak acid dissoc.)	Melbourne	Dec 14, 2015	14 Day
- Method: LTM-INO-4020 Total Free WAD Cyanide by CFA			
Fluoride	Melbourne	Dec 11, 2015	28 Day
- Method: LM-LTM-INO-4300 (Fluoride by Ion Chromatography)			
Formaldehyde	Melbourne	Dec 11, 2015	7 Day
- Method: Fomaldehyde MW AWA			
pH	Melbourne	Dec 14, 2015	0 Hours
- Method: LTM-GEN-7090 pH in water by ISE			
Phosphate ortho (as P)	Melbourne	Dec 14, 2015	2 Day
- Method: APHA 4500-P E. Phosphate (ortho)			
Phosphate total (as P)	Melbourne	Dec 14, 2015	28 Day
- Method: APHA 4500-P E. Phosphorous			
Reactive Silica (as SiO2)	Melbourne	Dec 11, 2015	5 Day
- Method: #4500SiC			
Suspended Solids	Melbourne	Dec 11, 2015	7 Day
- Method: APHA 2540D Total Suspended Solids			
Total Dissolved Solids	Melbourne	Dec 11, 2015	7 Day
- Method: APHA 2540C Total Dissolved Solids			
Total Organic Carbon	Melbourne	Dec 14, 2015	28 Day
- Method: APHA 5310B Total Organic Carbon			
Total Solids	Melbourne	Dec 11, 2015	7 Day
- Method: APHA 2540B - Total Solids			
Volatile Suspended Solids	Melbourne	Dec 11, 2015	5 Day
Acetates	Melbourne	Dec 11, 2015	5 Day
- Method: USEPA SW846 Method 8260 Purge & Trap GC/MS & MGT Method 460A Headspace GC-FID			
Volatile Organics	Melbourne	Dec 11, 2015	7 Day
- Method: USEPA 8260 - MGT 350A Volatile Organics by GCMS			

Description	Testing Site	Extracted	Holding Time
Semivolatile Organics	Melbourne	Dec 17, 2015	7 Day
- Method: USEPA 8270 Semivolatile Organics			
Alkalinity (speciated)	Melbourne	Dec 14, 2015	14 Day
- Method: APHA 2320 Alkalinity by Titration			
Total Sulphur Set (as S)			
Sulphate (as S)	Melbourne	Dec 18, 2015	28 Day
- Method: In house MGT1110A (SO4 by Discrete Analyser)			
Sulphide (as S)	Melbourne	Dec 18, 2015	7 Day
- Method: APHA 4500-S C & D - Sulphide			
Sulphite (as S)	Melbourne	Dec 18, 2015	2 Day
- Method: APHA 4500 Sulphite			
Thiosulphate (as S)	Melbourne	Dec 18, 2015	2 Day
- Method: APHA 4500 Thiosulphate			
Total Sulphur (as S)	Melbourne	Dec 18, 2015	7 Day
- Method: Sum of Constituent Analytes			
Nitrogens (speciated)			
Ammonia (as N)	Melbourne	Dec 14, 2015	28 Day
- Method: APHA 4500-NH3 Ammonia Nitrogen by FIA			
Nitrate (as N)	Melbourne	Dec 14, 2015	7 Day
- Method: APHA 4500-NO3 Nitrate Nitrogen by FIA			
Nitrite (as N)	Melbourne	Dec 14, 2015	2 Day
- Method: APHA 4500-NO2 Nitrite Nitrogen by FIA			
Organic Nitrogen (as N)	Melbourne	Dec 14, 2015	7 Day
- Method: APHA 4500 Organic Nitrogen (N)			
Total Kjeldahl Nitrogen (as N)	Melbourne	Dec 14, 2015	7 Day
- Method: APHA 4500 TKN			
Alkali Metals	Melbourne	Dec 11, 2015	180 Day
- Method: USEPA 6010 Alkali Metals			

Company Name:	GHD Pty Ltd NEWCASTLE	**Order No.:**		**Received:**	Dec 11, 2015 12:06 PM
Address:	3/24 Honeysuckle Dve Newcastle NSW 2300	**Report #:**	483138	**Due:**	Dec 18, 2015
		Phone:	02 4979 9999	**Priority:**	5 Day
		Fax:	02 4979 9988	**Contact Name:**	Paul McFadyen
Project Name:	22180150302				

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Sample Detail					Chemical Oxygen Demand (COD)	Chloride	Chlorine (free)	Chlorine (total)	Colour(Pt/Co) true	Conductivity (at 25°C)	Cyanide (total)	Cyanide (weak acid dissoc.)	Fluoride	Formaldehyde	n-Decane	n-Heptane	n-Hexane	n-Nonane	n-Octane	n-Pentane	pH	Phosphate ortho (as P)	Phosphate total (as P)	Reactive Silica (as SiO2)	Sodium Adsorption Ratio*	Suspended Solids	Total Dissolved Solids	Total Organic Carbon	Total Solids	Volatile Suspended Solids	Acetates	Alkalinity (speciated)	Alkali Metals	Total Sulphur Set (as S)	Subcontracted Tests	Nitrogens (speciated)	Volatile Organics	Semivolatile Organics
Laboratory where analysis is conducted																																						
Melbourne Laboratory - NATA Site # 1254 & 14271					X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sydney Laboratory - NATA Site # 18217																																						
Brisbane Laboratory - NATA Site # 20794																																						
External Laboratory																																						
Sample ID	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**																																		
MW202	Dec 09, 2015		Water	M15-De12338	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW206	Dec 09, 2015		Water	M15-De12339											X	X	X	X	X	X											X							

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Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples are included in this QC report where applicable. Additional QC data may be available on request.
2. All soil results are reported on a dry basis, unless otherwise stated.
3. Actual LORs are matrix dependant. Quoted LORs may be raised where sample extracts are diluted due to interferences.
4. Results are uncorrected for matrix spikes or surrogate recoveries.
5. SVOC analysis on waters are performed on homogenised, unfiltered samples, unless noted otherwise.
6. Samples were analysed on an 'as received' basis. 7. This report replaces any interim results previously issued.

Holding Times

Please refer to 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours prior to sample receipt deadlines as stated on the Sample Receipt Advice.

If the Laboratory did not receive the information in the required timeframe, and regardless of any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the date of sampling, therefore compliance to these may be outside the laboratory's control.

****NOTE:** pH duplicates are reported as a range NOT as RPD

Units

mg/kg: milligrams per Kilogram
ug/l: micrograms per litre
ppb: Parts per billion
org/100ml: Organisms per 100 millilitres
MPN/100mL: Most Probable Number of organisms per 100 millilitres
mg/l: milligrams per litre
ppm: Parts per million
%: Percentage
NTU: Nephelometric Turbidity Units

Terms

Dry	Where a moisture has been determined on a solid sample the result is expressed on a dry basis.
LOR	Limit of Reporting.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
LCS	Laboratory Control Sample - reported as percent recovery
CRM	Certified Reference Material - reported as percent recovery
Method Blank	In the case of solid samples these are performed on laboratory certified clean sands. In the case of water samples these are performed on de-ionised water.
Surr - Surrogate	The addition of a like compound to the analyte target and reported as percentage recovery.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
Batch Duplicate	A second piece of analysis from a sample outside of the clients batch of samples but run within the laboratory batch of analysis.
Batch SPIKE	Spike recovery reported on a sample from outside of the clients batch of samples but run within the laboratory batch of analysis.
USEPA	United States Environmental Protection Agency
APHA	American Public Health Association
ASLP	Australian Standard Leaching Procedure (AS4439.3)
TCLP	Toxicity Characteristic Leaching Procedure
COC	Chain of Custody
SRA	Sample Receipt Advice
CP	Client Parent - QC was performed on samples pertaining to this report
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC is representative of the sequence or batch that client samples were analysed within
TEQ	Toxic Equivalency Quotient

QC - Acceptance Criteria

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is 30% however the following acceptance guidelines are equally applicable:

Results <10 times the LOR : No Limit

Results between 10-20 times the LOR : RPD must lie between 0-50%

Results >20 times the LOR : RPD must lie between 0-30%

Surrogate Recoveries : Recoveries must lie between 50-150% - Phenols 20-130%.

QC Data General Comments

1. Where a result is reported as a less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch, but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown is not data from your samples.
3. Organochlorine Pesticide analysis - where reporting LCS data, Toxophene & Chlordane are not added to the LCS.
4. Organochlorine Pesticide analysis - where reporting Spike data, Toxophene is not added to the Spike.
5. Total Recoverable Hydrocarbons - where reporting Spike & LCS data, a single spike of commercial Hydrocarbon products in the range of C12-C30 is added and it's Total Recovery is reported in the C10-C14 cell of the Report.
6. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling.Therefore laboratory analysis is unlikely to be completed within holding time. Analysis will begin as soon as possible after sample receipt.
7. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of Recovery the term "INT" appears against that analyte.
8. Polychlorinated Biphenyls are spiked only using Arochlor 1260 in Matrix Spikes and LCS's.
9. For Matrix Spikes and LCS results a dash " -" in the report means that the specific analyte was not added to the QC sample.
10. Duplicate RPD's are calculated from raw analytical data thus it is possible to have two sets of data.

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Quality Control Results

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Method Blank							
n-Heptane	mg/L	< 0.05			0.05	Pass	
n-Hexane	mg/L	< 0.05			0.05	Pass	
n-Nonane	mg/L	< 0.05			0.05	Pass	
n-Octane	mg/L	< 0.05			0.05	Pass	
n-Pentane	mg/L	< 0.05			0.05	Pass	
Chemical Oxygen Demand (COD)	mg/L	< 20			20	Pass	
Chloride	mg/L	< 1			1	Pass	
Chlorine (free)	mg/L	< 0.1			0.1	Pass	
Chlorine (total)	mg/L	< 0.1			0.1	Pass	
Colour(Pt/Co) true	Pt/Co unit	< 2			2	Pass	
Cyanide (total)	mg/L	< 0.005			0.005	Pass	
Cyanide (weak acid dissoc.)	mg/L	< 0.005			0.005	Pass	
Fluoride	mg/L	< 0.5			0.5	Pass	
Formaldehyde	mg/L	< 0.2			0.2	Pass	
Phosphate ortho (as P)	mg/L	< 0.05			0.05	Pass	
Phosphate total (as P)	mg/L	< 0.05			0.05	Pass	
Reactive Silica (as SiO2)	mg/L	< 5			5	Pass	
Suspended Solids	mg/L	< 1			1	Pass	
Total Dissolved Solids	mg/L	< 10			10	Pass	
Total Organic Carbon	mg/L	< 5			5	Pass	
Total Solids	mg/L	< 10			10	Pass	
Method Blank							
Acetates							
Butyl acetate	mg/L	< 0.5			0.5	Pass	
Ethyl acetate	mg/L	< 1			1	Pass	
Propyl acetate	mg/L	< 1			1	Pass	
Vinyl acetate	mg/L	< 2.5			2.5	Pass	
Method Blank							
Volatile Organics							
1.1-Dichloroethane	mg/L	< 0.001			0.001	Pass	
1.1-Dichloroethene	mg/L	< 0.001			0.001	Pass	
1.1.1-Trichloroethane	mg/L	< 0.001			0.001	Pass	
1.1.1.2-Tetrachloroethane	mg/L	< 0.001			0.001	Pass	
1.1.2-Trichloroethane	mg/L	< 0.001			0.001	Pass	
1.1.2.2-Tetrachloroethane	mg/L	< 0.001			0.001	Pass	
1.2-Dibromoethane	mg/L	< 0.001			0.001	Pass	
1.2-Dichlorobenzene	mg/L	< 0.001			0.001	Pass	
1.2-Dichloroethane	mg/L	< 0.001			0.001	Pass	
1.2-Dichloropropane	mg/L	< 0.001			0.001	Pass	
1.2.3-Trichloropropane	mg/L	< 0.001			0.001	Pass	
1.2.4-Trimethylbenzene	mg/L	< 0.001			0.001	Pass	
1.3-Dichlorobenzene	mg/L	< 0.001			0.001	Pass	
1.3-Dichloropropane	mg/L	< 0.001			0.001	Pass	
1.3.5-Trimethylbenzene	mg/L	< 0.001			0.001	Pass	
1.4-Dichlorobenzene	mg/L	< 0.001			0.001	Pass	
2-Butanone (MEK)	mg/L	< 0.001			0.001	Pass	
2-Propanone (Acetone)	mg/L	< 0.001			0.001	Pass	
4-Chlorotoluene	mg/L	< 0.001			0.001	Pass	
4-Methyl-2-pentanone (MIBK)	mg/L	< 0.001			0.001	Pass	
Allyl chloride	mg/L	< 0.001			0.001	Pass	
Benzene	mg/L	< 0.001			0.001	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Bromobenzene	mg/L	< 0.001			0.001	Pass	
Bromochloromethane	mg/L	< 0.001			0.001	Pass	
Bromodichloromethane	mg/L	< 0.001			0.001	Pass	
Bromoform	mg/L	< 0.001			0.001	Pass	
Bromomethane	mg/L	< 0.001			0.001	Pass	
Carbon disulfide	mg/L	< 0.001			0.001	Pass	
Carbon Tetrachloride	mg/L	< 0.001			0.001	Pass	
Chlorobenzene	mg/L	< 0.001			0.001	Pass	
Chloroethane	mg/L	< 0.001			0.001	Pass	
Chloroform	mg/L	< 0.005			0.005	Pass	
Chloromethane	mg/L	< 0.001			0.001	Pass	
cis-1.2-Dichloroethene	mg/L	< 0.001			0.001	Pass	
cis-1.3-Dichloropropene	mg/L	< 0.001			0.001	Pass	
Dibromochloromethane	mg/L	< 0.001			0.001	Pass	
Dibromomethane	mg/L	< 0.001			0.001	Pass	
Dichlorodifluoromethane	mg/L	< 0.001			0.001	Pass	
Ethylbenzene	mg/L	< 0.001			0.001	Pass	
Iodomethane	mg/L	< 0.001			0.001	Pass	
Isopropyl benzene (Cumene)	mg/L	< 0.001			0.001	Pass	
m&p-Xylenes	mg/L	< 0.002			0.002	Pass	
Methylene Chloride	mg/L	< 0.001			0.001	Pass	
o-Xylene	mg/L	< 0.001			0.001	Pass	
Styrene	mg/L	< 0.001			0.001	Pass	
Tetrachloroethene	mg/L	< 0.001			0.001	Pass	
Toluene	mg/L	< 0.001			0.001	Pass	
trans-1.2-Dichloroethene	mg/L	< 0.001			0.001	Pass	
trans-1.3-Dichloropropene	mg/L	< 0.001			0.001	Pass	
Trichloroethene	mg/L	< 0.001			0.001	Pass	
Trichlorofluoromethane	mg/L	< 0.001			0.001	Pass	
Vinyl chloride	mg/L	< 0.001			0.001	Pass	
Xylenes - Total	mg/L	< 0.003			0.003	Pass	
Method Blank							
Semivolatile Organics							
2-Methyl-4.6-dinitrophenol	mg/L	< 0.03			0.03	Pass	
1-Chloronaphthalene	mg/L	< 0.005			0.005	Pass	
1-Naphthylamine	mg/L	< 0.005			0.005	Pass	
1.2-Dichlorobenzene	mg/L	< 0.005			0.005	Pass	
1.2.3-Trichlorobenzene	mg/L	< 0.005			0.005	Pass	
1.2.3.4-Tetrachlorobenzene	mg/L	< 0.005			0.005	Pass	
1.2.3.5-Tetrachlorobenzene	mg/L	< 0.005			0.005	Pass	
1.2.4-Trichlorobenzene	mg/L	< 0.005			0.005	Pass	
1.2.4.5-Tetrachlorobenzene	mg/L	< 0.005			0.005	Pass	
1.3-Dichlorobenzene	mg/L	< 0.005			0.005	Pass	
1.3.5-Trichlorobenzene	mg/L	< 0.005			0.005	Pass	
1.4-Dichlorobenzene	mg/L	< 0.005			0.005	Pass	
2-Chloronaphthalene	mg/L	< 0.005			0.005	Pass	
2-Chlorophenol	mg/L	< 0.003			0.003	Pass	
2-Methylnaphthalene	mg/L	< 0.005			0.005	Pass	
2-Methylphenol (o-Cresol)	mg/L	< 0.003			0.003	Pass	
2-Naphthylamine	mg/L	< 0.005			0.005	Pass	
2-Nitroaniline	mg/L	< 0.005			0.005	Pass	
2-Nitrophenol	mg/L	< 0.01			0.01	Pass	
2-Picoline	mg/L	<0.005			0.005	Pass	
2.3.4.6-Tetrachlorophenol	mg/L	< 0.01			0.01	Pass	

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Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
2.4-Dichlorophenol	mg/L	< 0.003			0.003	Pass	
2.4-Dimethylphenol	mg/L	< 0.003			0.003	Pass	
2.4-Dinitrophenol	mg/L	< 0.03			0.03	Pass	
2.4-Dinitrotoluene	mg/L	< 0.005			0.005	Pass	
2.4.5-Trichlorophenol	mg/L	< 0.01			0.01	Pass	
2.4.6-Trichlorophenol	mg/L	< 0.01			0.01	Pass	
2.6-Dichlorophenol	mg/L	< 0.003			0.003	Pass	
2.6-Dinitrotoluene	mg/L	< 0.005			0.005	Pass	
3&4-Methylphenol (m&p-Cresol)	mg/L	< 0.006			0.006	Pass	
3-Methylcholanthrene	mg/L	< 0.005			0.005	Pass	
3.3'-Dichlorobenzidine	mg/L	< 0.005			0.005	Pass	
4-Aminobiphenyl	mg/L	< 0.005			0.005	Pass	
4-Bromophenyl phenyl ether	mg/L	< 0.005			0.005	Pass	
4-Chloro-3-methylphenol	mg/L	< 0.01			0.01	Pass	
4-Chlorophenyl phenyl ether	mg/L	< 0.005			0.005	Pass	
4-Nitrophenol	mg/L	< 0.03			0.03	Pass	
4.4'-DDD	mg/L	< 0.005			0.005	Pass	
4.4'-DDE	mg/L	< 0.005			0.005	Pass	
4.4'-DDT	mg/L	< 0.005			0.005	Pass	
7.12-Dimethylbenz(a)anthracene	mg/L	< 0.005			0.005	Pass	
a-BHC	mg/L	< 0.005			0.005	Pass	
Acenaphthene	mg/L	< 0.001			0.001	Pass	
Acenaphthylene	mg/L	< 0.001			0.001	Pass	
Acetophenone	mg/L	< 0.005			0.005	Pass	
Aldrin	mg/L	< 0.005			0.005	Pass	
Aniline	mg/L	< 0.005			0.005	Pass	
Anthracene	mg/L	< 0.001			0.001	Pass	
b-BHC	mg/L	< 0.005			0.005	Pass	
Benz(a)anthracene	mg/L	< 0.001			0.001	Pass	
Benzo(a)pyrene	mg/L	< 0.0005			0.001	Pass	
Benzo(b&j)fluoranthene	mg/L	< 0.001			0.001	Pass	
Benzo(g.h.i)perylene	mg/L	< 0.001			0.001	Pass	
Benzo(k)fluoranthene	mg/L	< 0.001			0.001	Pass	
Benzyl chloride	mg/L	< 0.005			0.005	Pass	
Bis(2-chloroethoxy)methane	mg/L	< 0.005			0.005	Pass	
Bis(2-chloroisopropyl)ether	mg/L	< 0.005			0.005	Pass	
Bis(2-ethylhexyl)phthalate	mg/L	< 0.005			0.005	Pass	
Butyl benzyl phthalate	mg/L	< 0.005			0.005	Pass	
Chrysene	mg/L	< 0.001			0.001	Pass	
d-BHC	mg/L	< 0.005			0.005	Pass	
Di-n-butyl phthalate	mg/L	< 0.005			0.005	Pass	
Di-n-octyl phthalate	mg/L	< 0.005			0.005	Pass	
Dibenz(a.h)anthracene	mg/L	< 0.001			0.001	Pass	
Dibenz(a.j)acridine	mg/L	< 0.005			0.005	Pass	
Dibenzofuran	mg/L	< 0.005			0.005	Pass	
Dieldrin	mg/L	< 0.005			0.005	Pass	
Diethyl phthalate	mg/L	< 0.005			0.005	Pass	
Dimethyl phthalate	mg/L	<0.005			0.005	Pass	
Dimethylaminoazobenzene	mg/L	< 0.005			0.005	Pass	
Diphenylamine	mg/L	< 0.005			0.005	Pass	
Endosulfan I	mg/L	< 0.005			0.005	Pass	
Endosulfan II	mg/L	< 0.005			0.005	Pass	
Endosulfan sulphate	mg/L	< 0.005			0.005	Pass	
Endrin	mg/L	< 0.005			0.005	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Endrin aldehyde	mg/L	< 0.005			0.005	Pass	
Endrin ketone	mg/L	< 0.005			0.005	Pass	
Fluoranthene	mg/L	<0.001			0.001	Pass	
Fluorene	mg/L	< 0.001			0.001	Pass	
g-BHC (Lindane)	mg/L	< 0.005			0.005	Pass	
Heptachlor	mg/L	< 0.005			0.005	Pass	
Heptachlor epoxide	mg/L	< 0.005			0.005	Pass	
Hexachlorobenzene	mg/L	< 0.005			0.005	Pass	
Hexachlorobutadiene	mg/L	< 0.005			0.005	Pass	
Hexachlorocyclopentadiene	mg/L	< 0.005			0.005	Pass	
Hexachloroethane	mg/L	< 0.005			0.005	Pass	
Indeno(1.2.3-cd)pyrene	mg/L	< 0.001			0.001	Pass	
Methoxychlor	mg/L	< 0.005			0.005	Pass	
N-Nitrosodibutylamine	mg/L	< 0.005			0.005	Pass	
N-Nitrosodipropylamine	mg/L	< 0.005			0.005	Pass	
N-Nitrosopiperidine	mg/L	< 0.005			0.005	Pass	
Naphthalene	mg/L	<0.001			0.001	Pass	
Nitrobenzene	mg/L	< 0.05			0.05	Pass	
Pentachlorobenzene	mg/L	< 0.005			0.005	Pass	
Pentachloronitrobenzene	mg/L	< 0.005			0.005	Pass	
Pentachlorophenol	mg/L	< 0.01			0.01	Pass	
Phenanthrene	mg/L	< 0.001			0.001	Pass	
Phenol	mg/L	< 0.003			0.003	Pass	
Pronamide	mg/L	< 0.005			0.005	Pass	
Pyrene	mg/L	<0.001			0.001	Pass	
Trifluralin	mg/L	< 0.005			0.005	Pass	
Method Blank							
Alkalinity (speciated)							
Bicarbonate Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Carbonate Alkalinity (as CaCO3)	mg/L	< 10			10	Pass	
Hydroxide Alkalinity (as CaCO3)	mg/L	< 10			10	Pass	
Total Alkalinity (as CaCO3)	mg/L	< 20			20	Pass	
Method Blank							
Total Sulphur Set (as S)							
Sulphate (as S)	mg/L	< 5			5	Pass	
Sulphide (as S)	mg/L	< 0.05			0.05	Pass	
Sulphite (as S)	mg/L	< 0.5			0.5	Pass	
Thiosulphate (as S)	mg/L	< 1			1	Pass	
Method Blank							
Nitrogens (speciated)							
Ammonia (as N)	mg/L	< 0.01			0.01	Pass	
Nitrate (as N)	mg/L	< 0.02			0.02	Pass	
Nitrite (as N)	mg/L	< 0.02			0.02	Pass	
Total Kjeldahl Nitrogen (as N)	mg/L	< 0.2			0.2	Pass	
Total Nitrogen (as N)	mg/L	< 0.2			0.2	Pass	
Method Blank							
Alkali Metals							
Calcium	mg/L	< 0.5			0.5	Pass	
Magnesium	mg/L	< 0.5			0.5	Pass	
Potassium	mg/L	< 0.5			0.5	Pass	
Sodium	mg/L	< 0.5			0.5	Pass	
LCS - % Recovery							
Chemical Oxygen Demand (COD)	%	105			70-130	Pass	
Chloride	%	105			70-130	Pass	

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Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Chlorine (total)	%	103			70-130	Pass	
Cyanide (total)	%	105			70-130	Pass	
Cyanide (weak acid dissoc.)	%	104			70-130	Pass	
Fluoride	%	104			70-130	Pass	
Formaldehyde	%	102			70-130	Pass	
Phosphate ortho (as P)	%	106			70-130	Pass	
Phosphate total (as P)	%	102			70-130	Pass	
Reactive Silica (as SiO2)	%	106			70-130	Pass	
Total Organic Carbon	%	90			70-130	Pass	
LCS - % Recovery							
Acetates							
Butyl acetate	%	95			70-130	Pass	
LCS - % Recovery							
Volatile Organics							
1.1-Dichloroethene	%	87			70-130	Pass	
1.1.1-Trichloroethane	%	111			70-130	Pass	
1.2-Dichlorobenzene	%	101			70-130	Pass	
1.2-Dichloroethane	%	94			70-130	Pass	
Benzene	%	91			70-130	Pass	
Ethylbenzene	%	83			70-130	Pass	
m&p-Xylenes	%	93			70-130	Pass	
Toluene	%	90			70-130	Pass	
Trichloroethene	%	82			70-130	Pass	
Xylenes - Total	%	94			70-130	Pass	
LCS - % Recovery							
Semivolatile Organics							
2-Methyl-4.6-dinitrophenol	%	74			30-130	Pass	
1.2.4-Trichlorobenzene	%	118			70-130	Pass	
1.4-Dichlorobenzene	%	111			70-130	Pass	
2-Chlorophenol	%	81			30-130	Pass	
2-Methylphenol (o-Cresol)	%	65			30-130	Pass	
2-Nitrophenol	%	124			30-130	Pass	
2.4-Dichlorophenol	%	95			30-130	Pass	
2.4-Dimethylphenol	%	77			30-130	Pass	
2.4-Dinitrophenol	%	48			30-130	Pass	
2.4-Dinitrotoluene	%	95			75-125	Pass	
2.4.5-Trichlorophenol	%	92			30-130	Pass	
2.4.6-Trichlorophenol	%	87			30-130	Pass	
2.6-Dichlorophenol	%	78			30-130	Pass	
3&4-Methylphenol (m&p-Cresol)	%	59			30-130	Pass	
4-Chloro-3-methylphenol	%	80			30-130	Pass	
4-Nitrophenol	%	64			30-130	Pass	
Acenaphthene	%	88			70-130	Pass	
Acenaphthylene	%	94			70-130	Pass	
Anthracene	%	75			70-130	Pass	
Benz(a)anthracene	%	99			70-130	Pass	
Benzo(a)pyrene	%	106			70-130	Pass	
Benzo(b&j)fluoranthene	%	94			70-130	Pass	
Benzo(g.h.i)perylene	%	90			70-130	Pass	
Benzo(k)fluoranthene	%	97			70-130	Pass	
Chrysene	%	99			70-130	Pass	
Dibenz(a.h)anthracene	%	121			70-130	Pass	
Fluoranthene	%	94			70-130	Pass	
Fluorene	%	96			70-130	Pass	

Test	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Indeno(1.2.3-cd)pyrene	%	119			70-130	Pass	
N-Nitrosodipropylamine	%	77			75-125	Pass	
Naphthalene	%	75			70-130	Pass	
Pentachlorophenol	%	68			30-130	Pass	
Phenanthrene	%	97			70-130	Pass	
Phenol	%	32			30-130	Pass	
Pyrene	%	91			70-130	Pass	
LCS - % Recovery							
Alkalinity (speciated)							
Total Alkalinity (as CaCO3)	%	112			70-130	Pass	
LCS - % Recovery							
Total Sulphur Set (as S)							
Sulphate (as S)	%	101			70-130	Pass	
Sulphide (as S)	%	80			70-130	Pass	
LCS - % Recovery							
Nitrogens (speciated)							
Ammonia (as N)	%	99			70-130	Pass	
Nitrate (as N)	%	91			70-130	Pass	
Nitrite (as N)	%	110			70-130	Pass	
Total Kjeldahl Nitrogen (as N)	%	106			70-130	Pass	
Total Nitrogen (as N)	%	106			70-130	Pass	
LCS - % Recovery							
Alkali Metals							
Calcium	%	108			70-130	Pass	
Magnesium	%	116			70-130	Pass	
Potassium	%	102			70-130	Pass	
Sodium	%	96			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Spike - % Recovery									
				Result 1					
Chemical Oxygen Demand (COD)	M15-Jl27328	NCP	%	99			70-130	Pass	
Chloride	M15-De16286	NCP	%	100			70-130	Pass	
Cyanide (total)	M15-De15969	NCP	%	87			70-130	Pass	
Cyanide (weak acid dissoc.)	M15-De07990	NCP	%	89			70-130	Pass	
Fluoride	M15-De11530	NCP	%	89			70-130	Pass	
Phosphate ortho (as P)	M15-De16309	NCP	%	100			70-130	Pass	
Phosphate total (as P)	B15-De13949	NCP	%	83			70-130	Pass	
Spike - % Recovery									
Semivolatile Organics				Result 1					
2-Chlorophenol	M15-De15572	NCP	%	105			30-130	Pass	
2-Methylphenol (o-Cresol)	M15-De15572	NCP	%	107			30-130	Pass	
2-Nitrophenol	M15-De15572	NCP	%	115			30-130	Pass	
2.4-Dichlorophenol	M15-De15572	NCP	%	111			30-130	Pass	
2.4-Dimethylphenol	M15-De15572	NCP	%	103			30-130	Pass	
2.4.5-Trichlorophenol	M15-De15572	NCP	%	88			30-130	Pass	
2.4.6-Trichlorophenol	M15-De15572	NCP	%	43			30-130	Pass	
2.6-Dichlorophenol	M15-De15572	NCP	%	72			30-130	Pass	
3&4-Methylphenol (m&p-Cresol)	M15-De15572	NCP	%	109			30-130	Pass	
4-Chloro-3-methylphenol	M15-De15572	NCP	%	98			30-130	Pass	
4-Nitrophenol	M15-De15572	NCP	%	129			30-130	Pass	
Acenaphthene	S15-De12086	NCP	%	73			70-130	Pass	
Acenaphthylene	S15-De12086	NCP	%	77			70-130	Pass	
Anthracene	S15-De12086	NCP	%	88			70-130	Pass	
Benz(a)anthracene	S15-De12086	NCP	%	79			70-130	Pass	

Test	Lab Sample ID	QA Source	Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
Benzo(a)pyrene	S15-De12086	NCP	%	86			70-130	Pass	
Benzo(b&j)fluoranthene	S15-De12086	NCP	%	75			70-130	Pass	
Benzo(g.h.i)perylene	S15-De12086	NCP	%	74			70-130	Pass	
Benzo(k)fluoranthene	S15-De12086	NCP	%	75			70-130	Pass	
Chrysene	S15-De12086	NCP	%	79			70-130	Pass	
Dibenz(a.h)anthracene	S15-De12086	NCP	%	98			70-130	Pass	
Fluoranthene	S15-De12086	NCP	%	74			70-130	Pass	
Fluorene	S15-De12086	NCP	%	76			70-130	Pass	
Indeno(1.2.3-cd)pyrene	S15-De12086	NCP	%	96			70-130	Pass	
Naphthalene	S15-De12086	NCP	%	74			70-130	Pass	
Phenanthrene	S15-De12086	NCP	%	75			70-130	Pass	
Phenol	M15-De15572	NCP	%	90			30-130	Pass	
Pyrene	S15-De12086	NCP	%	74			70-130	Pass	
Spike - % Recovery									
Alkalinity (speciated)				Result 1					
Bicarbonate Alkalinity (as CaCO3)	M15-De15171	NCP	%	96			70-130	Pass	
Total Alkalinity (as CaCO3)	M15-De13661	NCP	%	112			70-130	Pass	
Spike - % Recovery									
Total Sulphur Set (as S)				Result 1					
Sulphate (as S)	M15-De12492	NCP	%	94			70-130	Pass	
Spike - % Recovery									
Nitrogens (speciated)				Result 1					
Ammonia (as N)	M15-De11770	NCP	%	101			70-130	Pass	
Nitrate (as N)	M15-De11770	NCP	%	95			70-130	Pass	
Nitrite (as N)	M15-De11770	NCP	%	105			70-130	Pass	
Spike - % Recovery									
Alkali Metals				Result 1					
Calcium	S15-De10350	NCP	%	97			70-130	Pass	
Magnesium	S15-De10350	NCP	%	95			70-130	Pass	
Potassium	S15-De10350	NCP	%	88			70-130	Pass	
Sodium	M15-De14933	NCP	%	106			70-130	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
				Result 1	Result 2	RPD			
Chemical Oxygen Demand (COD)	M15-De12338	CP	mg/L	2900	3000	2.0	30%	Pass	
Chloride	M15-De16285	NCP	mg/L	110	100	1.5	30%	Pass	
Chlorine (free)	M15-De11503	NCP	mg/L	31	33	6.0	30%	Pass	
Colour(Pt/Co) true	B15-De11914	NCP	Pt/Co unit	15	15	<1	30%	Pass	
Conductivity (at 25°C)	M15-De12492	NCP	uS/cm	4000	4000	1.0	30%	Pass	
Cyanide (total)	M15-De15969	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Cyanide (weak acid dissoc.)	M15-De07990	NCP	mg/L	0.028	0.018	16	30%	Pass	
Fluoride	M15-De11530	NCP	mg/L	< 0.5	< 0.5	<1	30%	Pass	
Formaldehyde	M15-De12426	NCP	mg/L	2.1	1.9	9.9	30%	Pass	
pH	M15-De12492	NCP	pH Units	7.9	7.9	pass	30%	Pass	
Phosphate ortho (as P)	M15-De16285	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Phosphate total (as P)	B15-De13949	NCP	mg/L	0.26	0.28	9.0	30%	Pass	
Total Dissolved Solids	M15-De12338	CP	mg/L	32000	31000	3.0	30%	Pass	
Total Organic Carbon	M15-De13301	NCP	mg/L	< 5	< 5	<1	30%	Pass	
Duplicate									
Volatile Organics				Result 1	Result 2	RPD			
1.1-Dichloroethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.1-Dichloroethene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.1.1-Trichloroethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.1.1.2-Tetrachloroethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	

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Duplicate									
Volatile Organics				Result 1	Result 2	RPD			
1.1.2-Trichloroethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.1.2.2-Tetrachloroethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.2-Dibromoethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.2-Dichlorobenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.2-Dichloroethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.2-Dichloropropane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.2.3-Trichloropropane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.2.4-Trimethylbenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.3-Dichlorobenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.3-Dichloropropane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.3.5-Trimethylbenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
1.4-Dichlorobenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
2-Butanone (MEK)	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
2-Propanone (Acetone)	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
4-Chlorotoluene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
4-Methyl-2-pentanone (MIBK)	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Allyl chloride	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Bromobenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Bromochloromethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Bromodichloromethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Bromoform	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Bromomethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Carbon disulfide	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Carbon Tetrachloride	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Chlorobenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Chloroethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Chloroform	M15-De12429	NCP	mg/L	< 0.005	< 0.005	<1	30%	Pass	
Chloromethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
cis-1.2-Dichloroethene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
cis-1.3-Dichloropropene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Dibromochloromethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Dibromomethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Dichlorodifluoromethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Ethylbenzene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Iodomethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Isopropyl benzene (Cumene)	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
m&p-Xylenes	M15-De12429	NCP	mg/L	< 0.002	< 0.002	<1	30%	Pass	
Methylene Chloride	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
o-Xylene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Styrene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Tetrachloroethene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Toluene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
trans-1.2-Dichloroethene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
trans-1.3-Dichloropropene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Trichloroethene	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Trichlorofluoromethane	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Vinyl chloride	M15-De12429	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Xylenes - Total	M15-De12429	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	

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Duplicate									
Semivolatile Organics				Result 1	Result 2	RPD			
2-Methyl-4.6-dinitrophenol	S15-De12085	NCP	mg/L	< 0.03	< 0.03	<1	30%	Pass	
1-Chloronaphthalene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1-Naphthylamine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.2-Dichlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.2.3-Trichlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.2.3.4-Tetrachlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.2.3.5-Tetrachlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.2.4-Trichlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.2.4.5-Tetrachlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.3-Dichlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.3.5-Trichlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
1.4-Dichlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2-Chloronaphthalene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2-Chlorophenol	S15-De12085	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
2-Methylnaphthalene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2-Methylphenol (o-Cresol)	S15-De12085	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
2-Naphthylamine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2-Nitroaniline	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2-Nitrophenol	S15-De12085	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2-Picoline	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2.3.4.6-Tetrachlorophenol	M15-De18212	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
2.4-Dichlorophenol	S15-De12085	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
2.4-Dimethylphenol	S15-De12085	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
2.4-Dinitrophenol	S15-De12085	NCP	mg/L	< 0.03	< 0.03	<1	30%	Pass	
2.4-Dinitrotoluene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2.4.5-Trichlorophenol	S15-De12085	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2.4.6-Trichlorophenol	S15-De12085	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
2.6-Dichlorophenol	S15-De12085	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
2.6-Dinitrotoluene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
3&4-Methylphenol (m&p-Cresol)	S15-De12085	NCP	mg/L	< 0.006	< 0.006	<1	30%	Pass	
3-Methylcholanthrene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
3.3'-Dichlorobenzidine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
4-Aminobiphenyl	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
4-Bromophenyl phenyl ether	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
4-Chloro-3-methylphenol	S15-De12085	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
4-Chlorophenyl phenyl ether	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
4-Nitrophenol	S15-De12085	NCP	mg/L	< 0.03	< 0.03	<1	30%	Pass	
4.4'-DDD	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
4.4'-DDE	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
4.4'-DDT	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
7.12-Dimethylbenz(a)anthracene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
a-BHC	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Acenaphthene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Acenaphthylene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Acetophenone	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Aldrin	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Aniline	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Anthracene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
b-BHC	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Benz(a)anthracene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(a)pyrene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(b&j)fluoranthene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(g.h.i)perylene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Benzo(k)fluoranthene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	

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Duplicate									
Semivolatile Organics				Result 1	Result 2	RPD			
Benzyl chloride	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Bis(2-chloroethoxy)methane	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Bis(2-chloroisopropyl)ether	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Bis(2-ethylhexyl)phthalate	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Butyl benzyl phthalate	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Chrysene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
d-BHC	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Di-n-butyl phthalate	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Di-n-octyl phthalate	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Dibenz(a.h)anthracene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Dibenz(a.j)acridine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Dibenzofuran	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Dieldrin	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Diethyl phthalate	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Dimethyl phthalate	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Dimethylaminoazobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Diphenylamine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Endosulfan I	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Endosulfan II	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Endosulfan sulphate	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Endrin	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Endrin aldehyde	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Endrin ketone	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Fluoranthene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Fluorene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
g-BHC (Lindane)	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Heptachlor	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Heptachlor epoxide	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Hexachlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Hexachlorobutadiene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Hexachlorocyclopentadiene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Hexachloroethane	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Indeno(1.2.3-cd)pyrene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Methoxychlor	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
N-Nitrosodibutylamine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
N-Nitrosodipropylamine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
N-Nitrosopiperidine	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Naphthalene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Nitrobenzene	M15-De18212	NCP	mg/L	< 0.05	< 0.05	<1	30%	Pass	
Pentachlorobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Pentachloronitrobenzene	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Pentachlorophenol	S15-De12085	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Phenanthrene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Phenol	S15-De12085	NCP	mg/L	< 0.003	< 0.003	<1	30%	Pass	
Pronamide	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Pyrene	S15-De12085	NCP	mg/L	< 0.001	< 0.001	<1	30%	Pass	
Trifluralin	M15-De18212	NCP	mg/L	< 0.01	< 0.01	<1	30%	Pass	
Duplicate									
Alkalinity (speciated)				Result 1	Result 2	RPD			
Bicarbonate Alkalinity (as CaCO3)	B15-De11621	NCP	mg/L	< 20	< 20	<1	30%	Pass	
Carbonate Alkalinity (as CaCO3)	B15-De11621	NCP	mg/L	< 10	< 10	<1	30%	Pass	
Hydroxide Alkalinity (as CaCO3)	B15-De11621	NCP	mg/L	< 10	< 10	<1	30%	Pass	
Total Alkalinity (as CaCO3)	B15-De11621	NCP	mg/L	< 20	< 20	<1	30%	Pass	

Duplicate									
Total Sulphur Set (as S)				Result 1	Result 2	RPD			
Sulphate (as S)	M15-De16285	NCP	mg/L	60	60	<1	30%	Pass	
Sulphide (as S)	M15-De09731	NCP	mg/L	0.10	0.10	<1	30%	Pass	
Sulphite (as S)	M15-De12338	CP	mg/L	< 5	< 5	<1	30%	Pass	
Thiosulphate (as S)	M15-De12338	CP	mg/L	< 10	< 10	<1	30%	Pass	
Duplicate									
Nitrogens (speciated)				Result 1	Result 2	RPD			
Ammonia (as N)	M15-De11770	NCP	mg/L	0.02	0.02	7.0	30%	Pass	
Nitrate (as N)	M15-De11770	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Nitrite (as N)	M15-De11770	NCP	mg/L	< 0.02	< 0.02	<1	30%	Pass	
Duplicate									
Alkali Metals				Result 1	Result 2	RPD			
Calcium	S15-De10350	NCP	mg/L	41	40	2.0	30%	Pass	
Magnesium	S15-De10350	NCP	mg/L	49	48	1.0	30%	Pass	
Potassium	S15-De10350	NCP	mg/L	< 5	< 5	<1	30%	Pass	
Sodium	M15-De14933	NCP	mg/L	560	540	4.0	30%	Pass	

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Comments

1,2-Diphenylhydrazine: Conducted by SGS Leeder Consulting, Report number M152819

Mercaptans: Conducted by ACS Laboratories, Report number ACS1612541

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	Yes

Qualifier Codes/Comments

Code	Description
G01	The LORs have been raised due to matrix interference
M10	NATA accreditation does not cover the performance of this service in soil matrices
N07	Please note:- These two PAH isomers closely co-elute using the most contemporary analytical methods and both the reported concentration (and the TEQ) apply specifically to the total of the two co-eluting PAHs

Authorised By

Charl Du Preez	Analytical Services Manager
Emily Rosenberg	Senior Analyst-Metal (VIC)
Harry Bacalis	Senior Analyst-Volatile (VIC)
Huong Le	Senior Analyst-Inorganic (VIC)
Mele Singh	Senior Analyst-Organic (VIC)

Glenn Jackson

National Operations Manager

Final report - this Report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Uncertainty data is available on request

ACS Laboratories (Australia)
ABN: 85 708 233 006

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12 January 2016 **Report No: ACS1612541**

Charl Du Preez
Eurofins MGT
2-5 Kingston Town Close
Oakleigh, Vic 3164

Dear Charl

Date of Sample Receipt: 14th December 2015
No. of Samples Received: 1
MGT-LabMark Ref: 483138

Results (mg/L)

Analyte	**ID: DE12338**
	Lab No: 12541-1
Methyl Mercaptan	<0.05
Ethyl Mercaptan	<0.05
Isobutyl Mercaptan	<0.05
Propyl Mercaptan	<0.05
Butyl Mercaptan	<0.05

Method: ACS-TM-AM 125.

Comment
Benzene Detected

Yours faithfully,
ACS Laboratories (Australia)

Vince Murone
Principal Chemist

SGS LEEDER CONSULTING

A.B.N. 44 000 964 278
3 - 5, 18 Redland Drive
Mitcham, Vic, 3132
Telephone: (03) 9874 1988
Fax: (03) 9874 1933

Chartered Chemists

REPORT NUMBER: M152819
Site/Client Ref: 483138
Order No: 483138 15/1409

21-Dec-2015

Eurofins /MGT

3 Kingston Town Close
Oakleigh
VIC 3166
Attention: Charl Du Preez

CERTIFICATE OF ANALYSIS

SAMPLES: Two samples were received for analysis

DATE RECEIVED: **14-Dec-2015**

DATE COMMENCED: **14-Dec-2015**

METHODS: See Attached Results

RESULTS: Please refer to attached pages for results.

Note: Results are based on samples as received at SGS Leeder Consulting's laboratories

REPORTED BY:

Adam Atkinson
Business Manager

SGS LEEDER CONSULTING

Report N°: M152819

ANALYTICAL RESULTS

Matrix: Water
Method: USEPA 8270C.WW.ADD.00 Additional SVOCs in water
Sample units are expressed in mg/L

Test Started: 17-Dec-15

Analyte Name	Leeder ID / Client ID / Sampled Date / PQL	2015034389	2015034390	2015034392
	Client ID	MW202 DE12338	MW206 DE12339	Method
	Sampled Date			
	PQL			Blank
1,2-Diphenylhydrazine	0.001	nd	nd	nd

Matrix: Water
Method: Surrogate Recovery
Sample units are expressed in %

Test Started: 17-Dec-15

Analyte Name	Leeder ID / Client ID / Sampled Date / PQL	2015034389	2015034390	2015034392
	Client ID	MW202 DE12338	MW206 DE12339	Method
	Sampled Date			
	PQL			Blank
Fluorobiphenyl		90	83	65

QA/QC RESULTS

Matrix: Water
Method: USEPA 8270C.WW.ADD.00 Additional SVOCs in water
Quality Control Results are expressed in Percent Recovery of expected result

Test Started: 17-Dec-15

	Leeder ID	2015034393	2015034394
	Client ID	MW202	MW202
Analyte Name	Sampled Date		
	PQL	Spike	Spike Dup
1,2-Diphenylhydrazine		71	76

Matrix: Water
Method: Surrogate Recovery
Quality Control Results are expressed in Percent Recovery of expected result

Test Started: 17-Dec-15

	Leeder ID	2015034393	2015034394
	Client ID	MW202	MW202
Analyte Name	Sampled Date		
	PQL	Spike	Spike Dup
Fluorobiphenyl		84	82

QUALIFIERS / NOTES FOR REPORTED RESULTS

PQL	Practical Quantitation Limit
nd	Not Detected – The analyte was not detected above the reported PQL.
is	Insufficient Sample to perform this analysis.
T	Tentative identification based on computer library search of mass spectra.
NC	Not calculated and/or Results below PQL
NV	No Vacuum, Canister received above standard atmospheric pressure
nr	Not Requested for analysis.
R	Rejected Result – results for this analysis failed QC checks.
SQ	Semi-Quantitative result – quantitation based on a generic response factor for this class of analyte.
IM	Inappropriate method of analysis for this compound
U	Unable to provide Quality Control data – high levels of compounds in sample interfered with analysis of QC results.
UF	Unable to provide Quality Control data- Surrogates failed QC checks due to sample matrix effects
L	Analyte detected at a level above the linear response of calibration curve.
E	Estimated result. NATA accreditation does not cover estimated results.
C1	These compounds co-elute.
--	Parameter Not Determined
CT	Elevated concentration. Results reported from carbon tube analysis
**	Sample shows non-petroleum hydrocarbon profile

SGS LEEDER CONSULTING

APPENDIX ONE.

CHAIN OF CUSTODY DOCUMENT

eurofins | mgt

☒ **MELBOURNE**
Ph: +61 3 8564 5000
2-5 Kingston Town Close, Oakleigh, Vic 3164
Email: EnviroSampleVic@eurofins.com.au

☐ **BRISBANE**
Ph: +61 7 3902 4600
1/21 Smallwood Place Murarrie, Qld 4172
Email: EnviroSampleQLD@eurofins.com.au

☐ **SYDNEY**
Ph: +61 2 9900 8400
Unit F3, 16 Mars Road, Lane Cove West, NSW 2066
Email: EnviroSampleNSW@eurofins.com.au

Purchase Order for External Analysis

Eurofins | mgt Ref: 483138 **Eurofins | mgt Purchase Order:** 483138 15/1409 **Results Required:** 5 DAY **Page :** 1 of 1

Receiving Laboratory: SGS/Leeder Consulting **Eurofins | mgt Contact:** ~~Bob Symons~~ Charl Du Preez

Address: 3-5 Redland Drive
Mitcham, Vic 3132

Telephone: **Fax:**

Report results to: EnviroReports@eurofins.com.au ☒
Eurofins | mgt, P.O. Box 276, Oakleigh, Vic 3166, Australia ☐
Send invoices to: EnviroAP@eurofins.com.au ☒

Client ID	Eurofins | mgt ID	Matrix	Tests Required	
MW202	DE12338	w	1.2-Diphenylhydrazine	
MW206	DE12339	w	1.2-Diphenylhydrazine	

Total No. Samples: 2

Comments: Please identify samples using Eurofins | mgt ID and Client ID

Chain of Custody

Relinquished by:	Liam Prescott	Date/Time:	11/12/2015
Received by:	Benedict Robinson	Date/Time:	14/12/15 11:15am
Relinquished by:		Date/Time:	
Received by:		Date/Time:	

Sample Receipt Advice *(Receiving Lab Use Only)*

All Samples Received in Good Condition ☑
All Documentation in Proper Order ☐
Samples Received with an Attempt to Chill ☑
Samples Received Within Holding Times ☑

Average sample temp on receipt: (°C) 7.8

For all enquires please quote Ref. No.

Please complete this section and email a scan copy to EnviroReports@eurofins.com.au

Appendix B - Estimated Leachate Generation

Leachate Flow Design Basis Summary Tables

Leachate generation – 50% AEP rainfall year			Stage/ Transition Duration (Months)	Leachate Generation												
Stage	Stage Description	Leachate Source		January (kL/mth)	February (kL/mth)	March (kL/mth)	April (kL/mth)	May (kL/mth)	June (kL/mth)	July (kL/mth)	August (kL/mth)	September (kL/mth)	October (kL/mth)	November (kL/mth)	December (kL/mth)	Annual (kL/yr)
1	Filling occurring in sub-cell 1 below ground, all	Sub-Cells - Stage 1	5	296	530	273	225	200	179	97	122	160	216	314	371	3744
	other sub-cells separated from sub-cell 1	Capped Waste Stockpile - Stage 1	5	178	318	164	135	120	107	58	73	96	130	188	222	2246
2	Filling occurring in sub-cell 2 below ground, sub-	Sub-Cells - Stage 1 to 2	2	474	848	437	360	319	286	155	195	256	346	502	593	5990
	cell 1 intermediate covered, sub-cell 3 separated	Sub-Cells - Stage 2 (after 1 to 2 transition)	3	355	636	328	270	239	214	116	146	192	259	377	445	4492
	from sub-cells 1 and 2	Capped Waste Stockpile - Stage 2	5	181	324	167	138	122	109	59	75	98	132	192	227	2291
3	Filling occurring in sub-cell 3 below ground, sub-	Sub-Cells - Stage 2 to 3	2	533	954	491	405	359	321	175	220	288	389	565	667	6738
	cell 2 intermediate covered, sub-cell 1 interim	Sub-Cells - Stage 3 (after 2 to 3 transition)	3	414	742	382	315	279	250	136	171	224	302	440	519	5241
	capped	Capped Waste Stockpile - Stage 3	5	185	331	170	140	124	111	61	76	100	135	196	231	2336
4	All cells interim capped	Sub-Cells - Stage 3 to 4	2	592	1060	546	450	399	357	194	244	320	432	628	741	7487
		Sub-Cells - Stage 4 (after 3 to 4 transition)	3	474	848	437	360	319	286	155	195	256	346	502	593	5990
		Capped Waste Stockpile - Stage 4	5	188	337	174	143	127	114	62	78	102	137	200	236	2381
Final	All cells final capped	Sub-Cells - Final capped	12	237	424	218	180	160	143	78	98	128	173	251	296	2995
		Sub-Cells - Final capped 1-2 yr	12	36	64	33	27	24	21	12	15	19	26	38	44	449
		Sub-Cells - Final capped 2-3 yr	12	5.3	9.5	4.9	4.1	3.6	3.2	1.7	2.2	2.9	3.9	5.7	6.7	67.4
		Sub-Cells - Final capped 3-4 yr	12	0.8	1.4	0.7	0.6	0.5	0.5	0.3	0.3	0.4	0.6	0.8	1.0	10.1
		Sub-Cells - Final capped 4-5 yr	12	0.12	0.21	0.11	0.09	0.08	0.07	0.04	0.05	0.06	0.09	0.13	0.15	1.52
		Sub-Cells - Final capped + 5 yr	12	0.024	0.042	0.022	0.018	0.016	0.014	0.008	0.010	0.013	0.017	0.025	0.030	0.299

Leachate generation – 90% AEP rainfall year			Stage/ Transition Duration (Months)	Leachate Generation												
Stage	Stage Description	Leachate Source		January (kL/mth)	February (kL/mth)	March (kL/mth)	April (kL/mth)	May (kL/mth)	June (kL/mth)	July (kL/mth)	August (kL/mth)	September (kL/mth)	October (kL/mth)	November (kL/mth)	December (kL/mth)	Annual (kL/yr)
1	Filling occurring in sub-cell 1 below ground, all	Sub-Cells - Stage 1	5	**760**	**974**	**637**	**598**	**396**	**549**	**265**	**388**	**485**	**496**	**718**	**702**	**4855**
	other sub-cells separated from sub-cell 1	Capped Waste Stockpile - Stage 1	5	456	584	382	359	238	329	159	233	291	297	431	421	2913
2	Filling occurring in sub-cell 2 below ground, sub-	Sub-Cells - Stage 1 to 2	2	1216	1558	1019	956	634	878	424	620	776	793	1148	1123	7767
	cell 1 intermediate covered, sub-cell 3 separated	Sub-Cells - Stage 2 (after 1 to 2 transition)	3	912	1169	764	717	475	659	318	465	582	595	861	842	5825
	from sub-cells 1 and 2	Capped Waste Stockpile - Stage 2	5	465	596	390	366	242	336	162	237	297	303	439	430	2971
3	Filling occurring in sub-cell 3 below ground, sub-	Sub-Cells - Stage 2 to 3	2	1368	1753	1147	1076	713	988	477	698	873	892	1292	1264	8738
	cell 2 intermediate covered, sub-cell 1 interim	Sub-Cells - Stage 3 (after 2 to 3 transition)	3	1064	1364	892	837	554	769	371	543	679	694	1005	983	6796
	capped	Capped Waste Stockpile - Stage 3	5	474	608	397	373	247	343	165	242	303	309	448	438	3029
4	All cells interim capped	Sub-Cells - Stage 3 to 4	2	1520	1948	1274	1195	792	1098	530	775	970	991	1435	1404	9709
		Sub-Cells - Stage 4 (after 3 to 4 transition)	3	1216	1558	1019	956	634	878	424	620	776	793	1148	1123	7767
		Capped Waste Stockpile - Stage 4	5	483	619	405	380	252	349	169	246	308	315	456	446	3087
Final	All cells final capped	Sub-Cells - Final capped	12	608	779	510	478	317	439	212	310	388	396	574	562	3884
		Sub-Cells - Final capped 1-2 yr	12	91	117	76	72	48	66	32	47	58	59	86	84	583
		Sub-Cells - Final capped 2-3 yr	12	13.7	17.5	11.5	10.8	7.1	9.9	4.8	7.0	8.7	8.9	12.9	12.6	87.4
		Sub-Cells - Final capped 3-4 yr	12	2.1	2.6	1.7	1.6	1.1	1.5	0.7	1.0	1.3	1.3	1.9	1.9	13.1
		Sub-Cells - Final capped 4-5 yr	12	0.31	0.39	0.26	0.24	0.16	0.22	0.11	0.16	0.20	0.20	0.29	0.28	1.97
		Sub-Cells - Final capped + 5 yr	12	0.061	0.078	0.051	0.048	0.032	0.044	0.021	0.031	0.039	0.040	0.057	0.056	0.388

Appendix C - Australian Sewage Quality Management Guidelines

3. Determine the local trade waste guideline concentration based on Best Economically Available Reasonable Pre treatment Technology (BEARPIT)

Local trade waste guideline concentration = 1.0 mg/L

4. Determine the local trade waste guideline concentration

Comparing guideline concentrations determined in Steps 2 and 3, the trade waste mass load based guideline concentration is the limiting aspect for nickel in this sewage system with the trade waste guideline concentration for nickel = 0.47 mg/L.

5. Determine the nickel upper daily mass load for a trade waste customer

The trade waste mass load allocation is 341 gram/day.

Upper daily mass load = trade waste mass load allocation / maximum number of nickel dischargers
= 341 gram/day / 6 customers
= 57 gram/day per customer

Implementation

The upper daily mass load may be used in conjunction with the trade waste guideline concentration to establish a comprehensive local trade waste acceptance criterion for nickel as follows:

- For mass discharges up to 57 gram/day, the local trade waste guideline concentration of 0.47 mg/L applies.
- The mass discharge must not exceed 57 gram/day, irrespective of concentration. Additional preventative measures will be needed to reduce the mass load if the discharge exceeds 57 gram/day.

Table C3: Guideline concentrations for discharge to sewerage systems

Fact sheet no.*	Parameter	Primary basis for guideline concentration	Guideline concentration (mg/L)	Typical sewage concentration influent value (mg/L)	Analytical method reference APHA Method
NA	Acetaldehyde	worker safety	5	<0.001	
NA	Acetone	worker safety	400	<0.001	
2	Ammonia	worker safety	100[1]	50	4500-NH3-B
NA	Benzene	worker safety	<0.001	<0.001	6200
NA	Chloroform	worker safety	0.1	<0.001	
NA	Dimethyl sulphide	odour	1		
NA	Ethylbenzene	worker safety	1	<0.001	6200
22	Sulphide - dissolved	asset protection	1	1	4500S2-C&D or E
10	Flammable / explosive substances	flammability	5% LEL		
11	Formaldehyde	worker safety	30	<DL	
NA	Gross solids – non-faecal	asset protection	13 mm QSV<3m/hr	N/A	

NA	Halogenated volatile organic compounds – total	worker safety	1[2]	<0.001	6200B
NA	Methyl mercaptan	odour	1	<0.1	NA
NA	Methyl Ethyl Ketone (MEK)	worker safety	100	<0.001	
NA	Perchloroethylene				
NA	Petroleum hydrocarbons C6-C9	flammability	5		USEPA 8015B USEPA 8260B
NA	Propionaldehyde	worker safety	5	<0.001	
17	pH	asset protection	6 to 10	7.5	
NA	Radioactive isotopes	worker safety	site specific		
NA	Sulphite	asset protection	15		4500BSO3B
22	Temperature	worker safety and asset protection	< 38ºC	22ºC	
NA	Toluene	worker safety	0.5		6200
NA	Trichloroethylene	worker safety	0.1	<0.001	
NA	Xylene (o)	worker safety	1		6200

[1] Henry's Law assessment based on a maximum sewer pH of 8.8
[1] Henry's Law assessment based on the common volatile organic compound, Methylene Chloride

Table C4: BEARPIT threshold values

Fact sheet no.	Parameter	BEARPIT	Guideline concentration (mg/L)	Typical sewage concentration influent value (mg/L)	Analytical method reference APHA Method
1	Aluminium	chemical precipitation (hydroxide)	100	1.5	3120B
NA	Arsenic	chemical precipitation (iron and hydroxide)	0.5	0.002	3114B
NA	Barium	chemical precipitation	5	0.05	3120B
3	Biochemical oxygen demand	N/A (Designed to be removed via sewage treatment)	To be determined - site specific	325	5210B
4	Boron	chemical precipitation	5	0.3	3120B
NA	Bromine - free	air-stripping	5		DPD-colorimetric test kit
5	Cadmium	chemical precipitation (iron - hydroxide)	1	0.0005	3120B
3	Chemical oxygen demand (COD)	N/A (designed to be removed via sewage treatment)	To be determined - site specific	800	
NA	Chlorine - Free	air-stripping	10	<DL	DPD-colorimetric test kit
6	Chromium (total)	Reduction (SMBS) and chemical precipitation (hydroxide)	3	0.03	3120B
NA	Cobalt	chemical precipitation	5	0.002	3120B
7	Colour	chemical oxidation (ozone)	100 (Pt–Co)	90	
8	Copper	chemical precipitation (hydroxide)	5	0.13	3120B
9	Cyanide - weak and dissociable	alkaline chlorination	1		4500-CN-G and E
NA	Fluoride	chemical precipitation (calcium)	30	0.3	4500-F-C
NA	Genetically engineered/ modified organisms	cleaner production	To be determined - site specific		
NA	Iron	chemical precipitation (hydroxide)	10	1.6	3120B
	Lead	chemical precipitation(carbonate or hydroxide)	1	0.01	3120B
12	Lithium	chemical precipitation	10		3120B
NA	Manganese	chemical oxidation, precipitation, clarification	10	0.15	3120B

Fact sheet no.	Parameter	BEARPIT	Guideline concentration (mg/L)	Typical sewage concentration influent value (mg/L)	Analytical method reference APHA Method
NA	Methylene blue active substances	cleaner production	100	2	
NA	Mercury	chemical precipitation (iron) ion exchange carbon adsorption	.01	0.0001	3112B
NA		mercury amalgam trap[3]	??		
NA	Molybdenum	chemical precipitation	5	0.01	3120B
NA	Non-ionic surfactants	cleaner production	100	2	
NA	Nickel	chemical precipitation (hydroxide)	1	0.03	3120B
13	Oil and grease - non hydrocarbon (TOG - TPH)	grease trap	200	60	USEPA1664
16	Organic nitrogen (TKN-Ammonia)	cleaner production	150	20	4500-Norg B or C
14	Organoarsenic compounds	cleaner production	0.1		NA
NA	Organochlorine pesticides	N/A (Hazardous Waste)	prohibited discharge		6410B
NA	Organophosphate pesticides	adsorption (activated carbon) and chemical oxidation (H2O2)	prohibited discharge		6410B
NA	Petroleum hydrocarbons - total	CPI or VGS	30		USEPA 8015B USEPA 8260B
NA	Phenolic compounds - non-halogenated	chemical oxidation	1		6410B
18	Phosphorous - total	N/A (designed to be removed via sewage treatment)	To be determined - site specific	13	4500P-I & 4500P-F
19	Polybrominated biphenyls (PBB's)	N/A (hazardous waste)	prohibited discharge		6200B
NA	Polychlorinated biphenyls (PCB's)	N/A (hazardous waste)	prohibited discharge		6200B
	Polynuclear aromatic hydrocarbons	adsorption (activated carbon) and chemical oxidation (H2O2)	5		6410B & 6440
NA	Selenium	chemical precipitation (sulphide)	1	0.001	3120B

[33] Dental Industry only

Fact sheet no.	Parameter	BEARPIT	Guideline concentration (mg/L)	Typical sewage concentration influent value (mg/L)	Analytical method reference APHA Method
NA	Silver	silver recovery unit	50		3120B
20	Sulphate	chemical precipitation (calcium)	2000 [4]	100	3120B
21	Suspended solids	N/A (Designed to be removed via sewage treatment)	To be determined - site specific	350	2540D
22	Temperature	equalisation heat exchange	< 38ºC	22ºC	
15	Tin	chemical precipitation	10	0.004	3120B
23	Total dissolved solids (TDS)	cleaner production	5000	850	2510B
24	Zinc	chemical precipitation (hydroxide)	1	0.2	3120B
25					
26					

Table C5: Typical threshold concentrations (mg/L) for common substances in sewage that are known to inhibit activated sludge, nitrification and anaerobic digestion processes.

Pollutant	Activated Sludge	Anaerobic Digestion	Nitrification
Acenaphthene	NI# at 10	Not Available	Not Available
Acrolein	NI at 62	Not Available	Not Available
Acrylonitrile	NI at 152	5	Not Available
Ammonia	480	1500-3000	Not Available
Arsenic	0.04-0.4	0.1-1	Not Available
Benzene	125	Not Available	Not Available
Benzidine	5	S	Not Available
Boron	0.05-10	2	Not Available
Cadmium	0.5-10	0.02-1	5-9
Calcium	2500	Not Available	Not Available
Carbon tetrachloride	NI at 10	2.9	Not Available
Chlorobenzene	NI at 1	0.96	Not Available
1,2,4-tridilorobenzene	NI at 6	Not Available	Not Available
Hezachlorobenzene	5	Not Available	Not Available
1,2-dichloroethane	NI at 258	1	Not Available
1,1,1-trichloroethane	NI at 10	Not Available	Not Available
Hexachloroethane	NI at 10	Not Available	Not Available
1,1-dichloroethane	NI at 10	Not Available	Not Available

[4] Measured as SO4-S

Pollutant	Activated Sludge	Anaerobic Digestion	Nitrification
1,1,2-trichloroethane	NI at 5	Not Available	Not Available
1,1,2,2-tetrachloroethane	NI at 201	20	Not Available
Bis-(2-chloroethyl)ether	NI at 10	Not Available	Not Available
2-chloroethyl vinyl ether	NI at 10	Not Available	Not Available
2-chloranaphthalene	NI at 10	Not Available	Not Available
2,4,6-trichlorophenol	50	Not Available	Not Available
Pata-chloro-meta-cresol	NI at 10	Not Available	Not Available
Chloroform	NI at 10	1	10
2-chlorophenol	NI at 10	Not Available	Not Available
1,2-dichlorobenzene	5	0.23	Not Available
1,3-dichlorobenzene	5	Not Available	Not Available
1,4-dichlorobenzene	5	1.4	Not Available
1,1 -dichloroethylene	NI at 10	Not Available	Not Available
1,2-trans-dichloroethylene	NI at 10	Not Available	Not Available
2,4-dichlorophenol	NI at 75	Not Available	Not Available
1,2-dichloropropane	NI at 182	Not Available	Not Available
1,3-dichloropropylene	NI at 10	Not Available	Not Available
2,4-dimethylphenol	NI at 10	Not Available	Not Available
2,4-dinitrotoluene	5	Not Available	Not Available
2,6-dinitrotoluene	5	Not Available	Not Available
1,2-diphenylhydrazine	5	Not Available	Not Available
Ethylbenzene	NI at 10	Not Available	Not Available
Fluoroanthene	NI at 5	Not Available	Not Available
bis-(2-chloroisopropyl)ether	NI at 10	Not Available	Not Available
Chloride	Not Available	20000	180
Chloromethane	NI at 180	3..3	Not Available
Methylene chloride	Not Available	100	Not Available
Chloroform	NI at 10	Not Available	Not Available
Dichlorobromomethane	NI at 10	Not Available	Not Available
Trichlorofluoromethane	NI at 10	0.7	Not Available
Chlorodibramomethane	NI at 10	Not Available	Not Available
Hexachlorobutadiene	NI at 10	Not Available	Not Available
Hexachlorocyclopentadiene	NI at 10	Not Available	Not Available
Chromium (Tot.)	0.1-20	1.5-50	0.25-1
Chromium (Hex.)	1	50	Not Available
Copper	0.1-1	0.5-100	0.05-0.5
Iodine	10	Not Available	Not Available
Iron	5-500	5	Not Available
Isophorone	NI at 15.4	Not Available	Not Available

Pollutant	Activated Sludge	Anaerobic Digestion	Nitrification
Lead	0.1-10	50-250	0.5-1.7
Manganese	10	Not Available	Not Available
Magnesium	Not Available	1000	50
Mercury	0.1-5	1400	2-12.5
Napthalene	500	Not Available	Not Available
Nickel	1-5	2-200	0.25-5
Nitrobenzene	500	Not Available	Not Available
2-nitrophenol	NI at 10	Not Available	Not Available
4-nitrophenol	NI at 10	Not Available	Not Available
2,4-dinitrophenol	1	Not Available	Not Available
N-nitrosodiphenylamine	NI at 10	Not Available	Not Available
N-nitraso-di-N-propylamine	NI at 10	Not Available	Not Available
Pentachlorophenol	0.95	0.2	Not Available
Phenol	200	Not Available	4
Bis-(2-ethyl hexyl)phthalate	NI at 10	Not Available	Not Available
Butyl benzyl phthalate	NI at 10	Not Available	Not Available
Di-n-butyl phthalate	NI at 10	Not Available	Not Available
Di-N-octyl phthalate	NI at 16..3	Not Available	Not Available
Diethyl phthalate	NI at 10	Not Available	Not Available
Dimethyl phthalate	NI at 10	Not Available	Not Available
Chrysene	NI at 5	Not Available	Not Available
Acenaphthylene	NI at 10	Not Available	Not Available
Anthracene	500	Not Available	Not Available
Fluotene	NI at 10	Not Available	Not Available
Phenanthrene	500	Not Available	Not Available
Pyrene	NI at 5	Not Available	Not Available
Tetrachloroethylene	NI at 10	20	Not Available
Toluene	NI at 35	Not Available	Not Available
Trichloroethylene	NI at 10	20	Not Available
Aroclor-1242	NI at 1	Not Available	Not Available
Aroclor-1254	NI at 1	Not Available	Not Available
Aroclor-1221	NI at 1	Not Available	Not Available
Aroclor-1232	NI at 10	Not Available	Not Available
Aroclor-1016	NI at 1	Not Available	Not Available
Silver	0.03-5	Not Available	0.25
Sodium	Not Available	3500	Not Available
Sulphide	50	50-100	Not Available
Tin	Not Available	9	Not Available
Vanadium	20	Not Available	Not Available
Zinc	0.3-20	1-10	0.01-1

Key: NI – No Inhibition at the nominated concentrations

Table C6: Typical substance removal rates through an extended aeration activated sludge treatment plant.

Substances	Removal Efficiency	Type
Alkalinity	52%	Inorganic
Aluminium	99%	Inorganic
Ammonia	100%	Inorganic
Arsenic	77%	Inorganic
Barium	91%	Inorganic
Biochemical Oxygen Demand	99.9%	
Cadmium	84%	Inorganic
Calcium	18%	Inorganic
Chromium	65%	Inorganic
Copper	93%	Inorganic
Iron	96%	Inorganic
Lead	85%	Inorganic
Magnesium	18%	Inorganic
Manganese	68%	Inorganic
Mercury	87%	Inorganic
Methylene Blue Anionic Surfactants	87%	
Nickel	52%	Inorganic
Ortho-Phosphorus	54%	Inorganic
pH	No Reduction	
Potassium	9%	Inorganic
Sodium	No Reduction	Inorganic
Suspended Solids	99%	
Total Nitrogen	95%	Inorganic
Total Phosphorus	65%	Inorganic
Zinc	69%	Inorganic
Acrylonitrile	99%	Volatile Organic Carbon
Benzene	100%	Volatile Organic Carbon
Bromomethane	100%	Volatile Organic Carbon
Bromodichloromethane	100%	Volatile Organic Carbon

Substances	Removal Efficiency	Type
Carbon Tetrachloride	100%	Volatile Organic Carbon
Chlorobenzene	56%	Volatile Organic Carbon
Chloroethane	91%	Volatile Organic Carbon
Chloroform	99%	Volatile Organic Carbon
Dibromochloromethane	100%	Volatile Organic Carbon
1,1 Dichloroethane	79%	Volatile Organic Carbon
1,2 Dichloroethane	99%	Volatile Organic Carbon
1,1 Dichloroethene	100%	Volatile Organic Carbon
1,2 Dichloroethene	98%	Volatile Organic Carbon
1,2 Dichloropropane	97%	Volatile Organic Carbon
1,3 Dichloropropane	98%	Volatile Organic Carbon
Ethyl acetate	98%	Volatile Organic Carbon
Ethylbenzene	99%	Volatile Organic Carbon
Methylene Chloride	75%	Volatile Organic Carbon
1,1,2,2 Tetrachloroethane	93%	Volatile Organic Carbon
1,1,2,2 Tetrachloroethene	27%	Volatile Organic Carbon
1,1,1 Trichloroethane	38%	Volatile Organic Carbon
1,1,2 Trichloroethane	72%	Volatile Organic Carbon
Trichloroethene	40%	Volatile Organic Carbon
Toluene	100%	Volatile Organic Carbon
Vinyl Chloride	100%	Volatile Organic Carbon
Acenaphthene	95%	Base / Neutral Compounds
Acenaphthylene	93%	Base / Neutral Compounds
Anthracene	97%	Base / Neutral Compounds
Benzo (a) anthracene	56%	Base / Neutral Compounds
Bis (2-ethylhexyl) phthalates	64%	Base / Neutral Compounds
Di-n-butylphthalate	99%	Base / Neutral Compounds
1,3 Dichlorobenzene	100%	Base / Neutral Compounds
1,2 Dichlorobenzene	94%	Base / Neutral Compounds
Diethylphthalate	99%	Base / Neutral Compounds
Dimethylphthalate	99%	Base / Neutral Compounds

Substances	Removal Efficiency	Type
Dioctylphthalate	90%	Base / Neutral Compounds
Fluoranthene	83%	Base / Neutral Compounds
Isophorone	100%	Base / Neutral Compounds
Naphthalene	100%	Base / Neutral Compounds
Nitrobenzene	98%	Base / Neutral Compounds
Phananthrene	98%	Base / Neutral Compounds
Pyrene	84%	Base / Neutral Compounds
1,2,4 Trichlorobenzene	82%	Acid Compounds
2 Chlorophenol	41%	Acid Compounds
2,4 Dichlorophenol	91%	Acid Compounds
2,4 Dimethylphenol	100%	Acid Compounds
2,4 Dinitrophenol	84%	Acid Compounds
2 Nitrophenol	77%	Acid Compounds
Pentachlorophenol	36%	Acid Compounds
Phenol	98%	Acid Compounds
2,4,6 Trichlorophenol	45%	Acid Compounds

Sewage quality within a typical domestic catchment in City West Water's service area is provided in Table C7. The sewer services predominantly domestic and commercial catchments within a growth area in Melbourne's Western suburbs. Water restrictions were in place during the sampling. Samples were obtained over 2 x 14 day periods in 2006 and 2007. The data is representative of the daily composite samples taken over 2 x 14 day periods.

Table C7: Typical concentrations for common substances in 'domestic' sewage (Source: City West Water's data).

Parameter	Average Concentration (mg/L)
Antimony	ND
Barium	0.027
Beryllium	ND
Boron	0.134
Chromium	0.006*
Cobalt	ND
Copper	0.118
Manganese	0.038
Molybdenum	ND
Nickel	0.006*
Selenium	0.008*
Silver	ND
Strontium	0.041
Thallium	ND
Tin	0.007
Titanium	0.023
Vanadium	ND
Zinc	0.120
Arsenic	0.002*
Cadmium	ND
Lead	0.003*
Mercury	ND
Calcium	11.493
Iron	0.486
Magnesium	3.890
Potassium	17.907
Sodium	78.018
Biological Oxygen Demand	287.286
chemical Oxygen Demand	657.024
Cyanide	0.010*
Electrical Conductivity	842.393
pH	7.275
Bicarbonate Alkalinity	300.500
Ammonia Nitrogen	45.324
Grease & Oil	60.357
Chloride	44.348
fluoride	0.62*
Phosphate	25.229
Sulphate	31.919
Total Kjeldahl Nitrogen	53.500
Total Nitrogen	59.802
Organic Total Dissolved Solids	121.536
Total Suspended solids	326.010
Sulphide	0.147
Total organic carbon	176.495
Total Phenols	0.107
Total Solids	646.167
Silica	11.786

ND – Not detected

* – Represents the maximum result obtained from a measured concentration during one of the composite sampling programs and a non detect during the other program, rather than an average.

Appendix D - Worth Recycling Acceptance Criteria
Liquid Waste

WORTH RECYCLING PTY LTD
ACN 001 630 306 ABN 24 001 630 306

Head Office: 1st Floor, 458 Rocky Point Road Sans Souci NSW 2219
Postal Address: PO Box 585 Sans Souci NSW 2219
Telephone: (02) 8558 5100 Fax: (02) 8558 5122 Web: www.worthrecycling.com.au

WORTH RECYCLING
WINDSOR WASTE WATER ACCEPTANCE CRITERIA

Water Classification	Free Oil Sludge/Solids %	COD (mg/L) (water phase)	Ammonia (mg/L)	Phenols (mg/L)	pH
Range A	<1%	< 1200	<10	<20	6.5-8.5
Range B	>1% & <5%	< 2000	< 30	<40	6.5-8.5
Range C	>5% & <10%	< 3000	< 60	<60	5.5-9.5
Range D	>10% & < 20%	< 4000	< 100	<80	4.5-9.5

Metals

Total concentrations for all classifications (mg/L):

Aluminium (Al)	100	Arsenic (As)	1	Cadmium (Cd)	1
Total Chromium (Cr)	3	Cobalt (Co)	5	Copper (Cu)	10
Iron (Fe)	100	Lead (Pb)	2	Manganese (Mn)	10
Mercury (Hg)	0.03	Molybdenum (Mo)	10	Nickel (Ni)	2
Selenium (Se)	5	Silver (Ag)	5	Tin (Sn)	5
Uranium (U)	5	Zinc (Zn)	10		

Other Substances

Total concentrations for all classifications (mg/L):

Barium (Ba)	2	Boron (B)	25	Bromine (Br)	5
Chlorinated Hydrocarbons	2	Chlorine (Cl)	50	Organoarsenic Compounds	0.1
Cyanide (Cn)	1	Fluoride (F^-)	20	Formaldehyde	5
Herbicides	0.1	Mercaptans	1	Hexavalent Chromium	0.05
Penta-chloro-phenol	0.05				

Pesticides including toxic by-products:	General	0.1
	Organophosphates	0.01
	Organochlorines	NIL

Sulphur Compounds:	Sulphates SO_4^-	100	Thiosulphate	150
	Sulphites SO_3^-	15		
	Sulphide S^-	5		

If the stream is outside the limits specified above, Worth Recycling will examine and assess on case by case basis to see if we have treatment option suitable.

GHD

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	A Roberts P McFadyen	D. Barrett		D.Barrett		29.08.16
B	A Roberts P McFadyen	D. Barrett		D.Barrett		30.09.16

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Appendix G Design Calculations

Client: Hydro Aluminium Kurri Kurri Pty Ltd
Project: Containment Cell for the HAKK Demolition and Remediation Project
Job no: 22-18015
Revision: 0

Item	Description	Rev	Date of Issue
1	Leachate collection pipe spacing	0	13/07/2018
2	Leachate collection pipe perforation spacing	0	13/07/2018
3	Flexible pipe loading	0	13/07/2018
4	Protection geotextile design	0	13/07/2018
5	Drainage geocomposite design - basal leachate collection	0	13/07/2018
6	Drainage geocomposite design - leak detection system	0	13/07/2018

Client:	Hydro Aluminium Kurri Kurri Pty Ltd	**Job Number:**	22-18015		
Project:	Containment Cell for the HAKK Demolition and Remediation Project	**Calcs by:**	R Grewal	**Date:**	10/07/2018
Subject:	Leachate Collection Pipe Spacing Calculations	**Checked by:**	A Roberts	**Date:**	11/07/2018

Statement of design procedure	
This spreadsheet provides design calculations for the spacing of leachate collection pipework	
References	
Based on Giroud's Equation	
Design cases / assumptions	
1	Not used
2	Not used
3	Not used
4	Not used

Item	Description	Symbol	Case				Unit	Notes
			1	2	3	4		
1	Maximum allowable leachate head over liner	Δh	0.3				m	EPA guidelines
2	Liner gradient	i	3.00%				%	From design (transverse cross fall) p19 - Section 4.5.3
3	Permeability of drainage layer	ki	1.00E-03				m/s	EPA guidelines
4	Leachate seepage rate into drainage layer	Q_{max}	1.00E-07				m/s	Estimated permeability of waste
5	j =	j	0.904					
6	Min. spacing between drainage pipes	D_{min}	110				m	To maintain max. leachate level
7	**Design spacing between drainage pipes**	D_{des}	**50**				m	Maximum spacing in EPA guidelines 50m

Client:	Hydro Aluminium Kurri Kurri Pty Ltd	**Job Number:**	22-18015		
Project:	Containment Cell for the HAKK Demolition and Remediation Project	**Calcs by:**	R Grewal	**Date:**	10/07/2018
Subject:	Leachate Collection Pipe Perforation Spacing Calculations	**Checked by:**	A Roberts	**Date:**	11/07/2018

Statement of design procedure	
This spreadsheet provides design calculations for the perforation of leachate collection pipework based on Bernoulli's Equation	
References	
Geotechnical Aspects of Landfil Design and Construction, Qian , Koerner, Gray, 2001	
Design cases / assumptions	
1	Leachate collection pipes for northern cells
2	Leachate collection pipes for southern cells
3	Not used
4	Not used

Item	**Description**	**Symbol**	**Case**				**Unit**	**Notes**
			1	**2**	**3**	**4**		
1	Assumed maximum leachate flow	Q_{max}	1.00E-07	1.00E-07			m3/s/m2	1. Saturated hydraulic conductivity of waste 2. Maximum pump rate x sump surface
2	Drainage area length	x	135	135			m	From design drawing no 22-18015-C021
3	Drainage area width	y	64	64			m	From design drawing no 22-18015-C021
4	Length of pipe	L	371	371			m	From design drawing no 22-18015-C021
5	Cell area per unit length of pipe	A_{unit}	23.2884097	23.2884097			m2 / m	
6	Leachate generated	Qb	2.33E-06	2.33E-06			m3/s	
7	Discharge coefficient	C	0.62	0.62				
8	Liquid head	Δh	0.3	0.3			m	From design
9	Limiting leachate entrance velocity	V_{ent}	2.43	2.43			m/s	Equation 9.1
10	Required total area of perforations	A_b	1.55E-06	1.55E-06			m2	
11	Diameter of perforations	dp	10	10			mm	From design drawing no 22-18015-C071
12	Area of single perforation	Ap	7.85E-05	7.85E-05			m2	
13	Blockage	b	50%	50%			%	
14	Required number of perforations	Np	0	0				
15	Number of perforations per set	n	4	4			-	
16	**Minimum distance between sets**	d	**101457**	**101457**			mm	

Client:	Hydro Aluminium Kurri Kurri Pty Ltd	**Job Number:**	22-18015	**Revision:**	A
Project:	Containment Cell for the HAKK Demolition and Remediation Project	**Calcs by:**	R Grewal	**Date:**	11/07/2018
Subject:	Leachate Collection Pipe Loading Calculations	**Checked by:**	A Roberts	**Date:**	11/07/2018

Statement of design procedure

This spreadsheet provides design calculations for the structural capacity of leachate collection pipe

References

AS2566.1 Buried flexible pipelines - part 1: structural design

Design cases / assumptions

1. PE100 PN16 DN200 Leachate collection - Construction loading
2. PE100 PN16 DN200 Leachate Collection - Operational loading
3. PE100 PN16 DN450 Leachate Riser (2 pipes)

Item	Description	Symbol	1	2	3	Unit	Notes
1	**Ring-bending stiffness**						
1.1	DN		200	200'	450	mm	
1.2	External diameter	D_e	0.2	0.2	0.45	m	
1.3	Wall thickness	t	0.0182	0.0182	0.0409	m	Poliplex design book p 6-3
1.4	Initial (3-minute) ring bending modulus of elasticity	E_b	693.5	693.5	693.5	MPa	Poliplex design book p 7-46 and 3-13
1.5	Long-term ring-bending modulus of elasticity	E_{bL}	189.8	189.8	189.8	MPa	Poliplex design book p 7-46 and 3-13
1.6	Diameter of neutral axis	D	0.1818	0.1818	0.4091	m	
1.7	Moment of inertia for ring bending	I_{xx}	5.0238E-07	5.0238E-07	5.7015E-06	m^4/m	Equation 2.2.1.2
1.8	Initial (3-minute) ring-bending stiffness	S_{DI}	57983	57983	57749	N/m/m	Equation 2.2.1.1(1)
1.9	Long-term ring-bending stiffness	S_{DL}	15869	15869	15805	N/m/m	Equation 2.2.1.1(2)
2	**Soil moduli**						
2.1	Width of trench or embedment measured at the spring line	B	0.4	0.4	1.2	m	1 & 2-Design drawing no 22-18015-C071; 3-Design drawing no 22-18015-C082
2.2	Native soil modulus	E'_n	5	5	5	MPa	Given
2.3	Embedment soil modulus	E'_e	5	7	5	MPa	Given
2.4		Δ_f	0.63	0.63	0.88		Equation 3.4.3(3)
2.5	Leonhardt Correction Factor	ξ	1.00	0.82	1.00		Equation 3.4.3(2)
2.6	Effective combined soil modulus	E'	5.00	5.71	5.00	MPa	Equation 3.4.3(1)
3	**Design loads due to trench fill and embankment fill**						
3.1	Cover, vertical distance between top of the pipe and the finished surface	H	0.30	20.00	0.30	m	1-From design report; 2-From design-Table 2; 3-Design drawing no 22-18015-C082
3.2	Assessed unit weight of trench fill or embankment fill	γ	17	16	17	kN/m^3	1 & 3-Assumed; 2- From design report-Table 2
3.3	Vertical design load (pressure at top of pipe) due to soil dead load	w_g	5	320	5.1	kPa	Equation 4.3
4	**Deflection**						
4.1	Bedding constant	K	0.1	0.1	0.1		Assumed value
4.2	Vertical design load due to surface-applied dead load	w_{gs}	0	0	0	kPa	Estimation
4.3	Wheel load (ΣP is the sum of the individual wheel loads)	P	510	510	510	kN	Largest likely plant

Client:	Hydro Aluminium Kurri Kurri Pty Ltd	**Job Number:**	22-18015	**Revision:**	A
Project:	Containment Cell for the HAKK Demolition and Remediation Project	**Calcs by:**	R Grewal	**Date:**	11/07/2018
Subject:	Leachate Collection Pipe Loading Calculations	**Checked by:**	A Roberts	**Date:**	11/07/2018

Statement of design procedure

This spreadsheet provides design calculations for the structural capacity of leachate collection pipe

References

AS2566.1 Buried flexible pipelines - part 1: structural design

Design cases / assumptions

1. PE100 PN16 DN200 Leachate collection - Construction loading
2. PE100 PN16 DN200 Leachate Collection - Operational loading
3. PE100 PN16 DN450 Leachate Riser (2 pipes)

Item	Description	Symbol	1	2	3	Unit	Notes
4.4	Length of wheel or track load contact area	a	0.4	0.4	0.4	m	Assumed
4.5	Width of wheel or track load contact area	b	4.4	4.4	4.4	m	Assumed
4.6	Allowable long-term vertical pipe deflection for non-pressure	Δ_{yall}/D	0.075	0.075	0.075		Poliplex design book p 7-52
4.7	Length of the base of the live load distribution, resulting from wheel or track loads, measured perpendicular to the direction of travel at the top of the pipe	L_1	4.84	33.40	4.84	m	Figure 4.2
4.8	Length of the base of the live load distribution, resulting from wheel or track loads, measured parallel to the direction of travel of the vehicle at the top of the pipe	L_2	0.84	29.40	0.84	m	Figure 4.2
4.9	Live load impact factor	α	1.355	1.1	1.355		Equation 4.7.2(2)
4.10	Vertical design load due to surface-applied live load	w_q	171.2	0.6	171.2	kPa	Equation 4.7.2(1)
4.11	Predicted long-term vertical deflection	Δ_y/D	0.041	0.067	0.041		Equation 5.2(2)
4.12	**Is $\Delta_y/D \le \Delta_{yall}/D$?**		YES	YES	YES		
5	**External loadings**						
5.1	Allowable long-term ring-bending strain	ε_{ball}	0.04	0.04	0.04		Poliplex design book p 7-52
5.2	Effective wall thickness	t_{es}	0.0182	0.0182	0.0409	m	Poliplex design book p 6-3
5.3	Shape factor	D_f	3.25	3.28	3.25		Equation 5.3.1(3)
5.4	Predicted long-term ring-bending strain	ε_b	0.01326	0.02215	0.01327		Equation 5.3.1(2)
5.5	**Is $\varepsilon_b \le \varepsilon_{ball}$?**		YES	YES	YES		
6	**Internal pressure**						
6.1	Internal working pressure	P_w	0.01	0.01	0.01	MPa	Given
6.2	Allowable long-term internal pressure	P_{all}	1.6	1.6	1.6	MPa	Poliplex design book p 3-9 using SDR=13.6 and safety factor of 1.25
6.3	**Is $P_w \le P_{all}$?**		YES	YES	YES		
7	**Combined loading**						
7.1	Factor of safety for long-term combined external load and internal pressure (combined loading)	η	1.5	1.5	1.5		Poliplex design book p 7-54
7.2	Factor of safety for log-term internal pressure	η_p	1.25	1.25	1.25		Poliplex design book p 3-4 (lower typical value)
7.3	Factor of safety for long-term ring-bending strain	η_b	2.5	2.5	2.5		Poliplex design book p 7-57
7.4	Re-rounding coefficient	r_c	0.997	0.997	0.997		Section 5.3.3

Client:	Hydro Aluminium Kurri Kurri Pty Ltd	**Job Number:**	22-18015	**Revision:**	A
Project:	Containment Cell for the HAKK Demolition and Remediation Project	**Calcs by:**	R Grewal	**Date:**	11/07/2018
Subject:	Leachate Collection Pipe Loading Calculations	**Checked by:**	A Roberts	**Date:**	11/07/2018

Statement of design procedure

This spreadsheet provides design calculations for the structural capacity of leachate collection pipe

References

AS2566.1 Buried flexible pipelines - part 1: structural design

Design cases / assumptions

1. PE100 PN16 DN200 Leachate collection - Construction loading
2. PE100 PN16 DN200 Leachate Collection - Operational loading
3. PE100 PN16 DN450 Leachate Riser (2 pipes)

Item	Description	Symbol	1	2	3	Unit	Notes
7.5	$P_w/\eta_p P_{all} + r_c \varepsilon_b/\eta_b \varepsilon_{ball}$		0.1372	0.2258	0.1372		Equation 5.3.3
7.6	$1/\eta$		0.667	0.667	0.667		Equation 5.3.3
7.7	**Is $P_w/\eta_p P_{all} + r_c \varepsilon_b/\eta_b \varepsilon_{ball} \leq 1/\eta$?**		**YES**	**YES**	**YES**		
8	**Buckling**						
8.1	Height of water surface above the top of the pipe	H_w	0.3	0.3	0.85	m	Given
8.2	Assessed unit weight of liquid external to the pipe	γ_L	10	10	10	kN/m^3	Assumed
8.3	Internal vacuum	q_v	0	0	0	kPa	Assumed
8.4	Design factor for buckling	F_s	2.5	2.5	2.5		Poliplex design book p 7-57
8.5	Poisson's ratio	v	0.4	0.4	0.4		Poliplex design book p 3-24
8.6	Specific gravity of soil particle	ρ_s	2.65	2.65	2.65		Assumed (from p 25 of standard)
8.7	Allowable buckling pressure, based on pipe alone	q_{all1}	663	663	660	kPa	Equation 5.4(4)
8.8	Allowable buckling pressure, based on pipe/embedment interaction	q_{all2}	453	495	452	kPa	Equation 5.4(5)
8.9	Allowable buckling pressure for material	q_{all}	663	663	660	kPa	Max of q_{all1} and q_{all2}
8.10	Submerged unit weight of trench fill or embankment fill	γ_{sub}	10.58	9.96	10.58	kN/m^3	Equation 5.4(2)
8.11	$\gamma(H-H_w)+(\gamma_L+\gamma_{sub})(D_e/2+H_w)+w_{gs}+w_q+q_v$		179.4	323.8	183.9	kPa	Equation 5.4(1)
8.12	**Is $\gamma(H-H_w)+(\gamma_L+\gamma_{sub})(D_e/2+H_w)+w_{gs}+w_q+q_v \leq q_{all}$?**		**YES**	**YES**	**YES**		

Client:	Hydro Aluminium Kurri Kurri Pty Ltd	**Job Number:**	22-18015	
Project:	Containment Cell for the HAKK Demolition and Remediation Project	**Calcs by:**	R Grewal	**Date:** 10/07/2018
Subject:	Leachate Collection Pipe Loading Calculations	**Checked by:**		**Date:** 11/07/2018

Statement of design procedure

This spreadsheet provides design calculations for the protection geotextile thickness

References

Designing with Geosynthetics (5th Edition), Robert M. Koerner

Barrier Systems for Waste Disposal (2nd Edition) Rowe et al

Design cases / assumptions

1	Cell base membrane protection
2	Cell sidewall membrane protection
3	Not used
4	Not used

Item	**Description**	**Symbol**	**Case**				**Unit**	**Notes**
			1	**2**	**3**	**4**		
1	Factor of safety	FOS	10	10				Refer table 13.3 pg 412 (Rowe, 2004)
2	Height of fill	h	20	20			m	From design-Table 2
3	Density of waste	γ	16.0	16.0			kN/m3	From design-Table 2
4	Slope of batter	θ	1.7	14.0			degrees	1-From design 3% basal liner slope; 2-1V:4H sidewall slopes
5	Pressure allow	p_{app}	320.0	320.0			kN/m2	Refer table 13.3 pg 412 (Rowe, 2004)
6	Protrusion height	Hp	0.02	0.02			m	Half the particle size
7	Protrusion shape		Subrounded	Subrounded				Assumed
8	Modification factor for protrusion shape	MF_S	0.5	0.5				Refer table 13.3 pg 412 (Rowe, 2004)
9	Packing density		Dense, 38 mm	Dense, 38 mm				Assumed
10	Modification factor for packing density	MF_{PD}	0.83	0.83				Refer Table 5.18, pg 548 (Koerner, 2005)
11	Arching in solids		Geostatic, moderate	Geostatic, moderate				Assumed
12	Modification factor for arching in solids	MF_A	0.5	0.5				Refer table 13.3 pg 412 (Rowe, 2004)
13	Factor for creep	RFcr	1.5	1.5				Refer Table 5.18, pg 548 (Koerner, 2005)
14	Leachate strength		Moderate Leachate	Moderate Leachate				Assumed
15	Factor for degradation	RFcbd	1.3	1.3				
16	**Minimum mass of geotextile neccesary**		**1110**	**1070**			g/m2	

Client:	Hydro Aluminium Kurri Kurri Pty Ltd	**Job Number:**	22-18015		
Project:	Containment Cell for the HAKK Demolition and Remediation Project	**Calcs by:**	R Grewal	**Date:**	11/07/2018
Subject:	Leachate Collection Pipe Spacing Calculations	**Checked by:**	A Roberts	**Date:**	11/07/2018

Statement of design procedure

This spreadsheet provides design calculations for the leachate collection geocomposite design

References

drainage design manual, Bachus et al, June 2004

Geotechnical Aspects of Landfill Design and Construction, Qian et al, 2002

Design cases / assumptions

1 Not used

2 Not used

Item	Description	Symbol	Case				Unit	Notes
			1	2	3	4		
1	Side slope	x	4				1 in x	Refer 22-18015-C071
2	Side slope	β_s	0.26				rad	
3	Vertical height of the slope measured from toe	H_s	6				m	Refer 22-18015-C041
4	Drainage length (sidewall)	L_{ds}	24.74				m	
5	Hydraulic gradient (side)	i_s	0.25				m/m	
6	Angle of floor slope		3.0%					Refer to deisgn report - Section 4.5.3
7	Angle of floor slope	β_b	0.03				rad	
8	Floor max. drainage length (plan)	L_b	135				m	Refer 22-18015-C041
9	Drainage length (floor)	L_{db}	135.06				m	
10	Hydraulic gradient (floor)	i_b	0.03				m/m	
11	Depth of waste	h	20.00				m	From design report - Table 2
12	Unit weight of waste	γ	16.00				kN/m3	From design report - Table 2
13	Waste permeability	k_w	1.0E-06				m/s	Assumed
14	Cover permeability	k_c	1.0E-07				m	Assumed
15	Reduction factor - chemical clogging	RF_{cc}	1.5					Qian et al (2002) Table 8.8 (as per GSI White Paper #4)
16	Reduction factor - intrusion	RF_i	1.5					Qian et al (2002) Table 8.8 (as per GSI White Paper #4)
17	Reduction factor - biological clogging	RF_{bc}	1.5					Qian et al (2002) Table 8.8 (as per GSI White Paper #4)
18	Reduction factor - creep	RF_{cr}	1.4					Qian et al (2002) Table 8.8 (as per GSI White Paper #4)
19	Factor of safety (FOS) drainage	FS_d	2					Assumed
20	Factor of safety (FOS) applied stress	FS_s	2.5					Assumed
21	Transmissivity - base only covered	θ_b	1.20E-03				m2/s	
22	Transmissivity - side only covered	θ_s	9.79E-05					
23	Transmissivity - base and side covered	θ_{b+s}	5.48E-04				m2/s	
24	Transmissivity design value	θ_{req}	1.20E-03				m2/s	
25	Specified transmissivity	θ_{allow}	**1.13E-02**				m2/s	
26	Minimum applied normal stress for laboratory test conditions	σ_{test}	**320**				kN/m2	
27	Minimum average roll value normal stress determined by ASTM 1621	σ_{allow}	**800**					
28	Minimum gradient for laboratory test conditions		**0.03**				m/m	

Client:	Hydro Aluminium Kurri Kurri Pty Ltd	**Job Number:**	22-18015		
Project:	Containment Cell for the HAKK Demolition and Remediation Project	**Calcs by:**	R Grewal	**Date:**	11/07/2018
Subject:	Leachate Collection Pipe Spacing Calculations	**Checked by:**	A Roberts	**Date:**	11/07/2018

Statement of design procedure

This spreadsheet provides design calculations for the leak detection geocomposite design

References

drainage design manual, Bachus et al, June 2004

Geotechnical Aspects of Landfill Design and Construction, Qian et al, 2002

Design cases / assumptions

1 Not used

2 Not used

Item	Description	Symbol	Case				Unit	Notes
			1	2	3	4		
1	Side slope	x	4				1 in x	Refer 22-18015-C071
2	Side slope	β_s	0.26				rad	
3	Vertical height of the slope measured from toe	H_s	6				m	Refer 22-18015-C041
4	Drainage length (sidewall)	L_{ds}	24.74				m	
5	Hydraulic gradient (side)	i_s	0.25				m/m	
6	Angle of floor slope		3.0%					Refer to deisgn report - Section 4.5.3
7	Angle of floor slope	β_b	0.03				rad	
8	Floor max. drainage length (plan)	L_b	135				m	Refer 22-18015-C041
9	Drainage length (floor)	L_{db}	135.06				m	
10	Hydraulic gradient (floor)	i_b	0.03				m/m	
11	Depth of waste	h	20.00				m	From design report - Table 2
12	Unit weight of waste	γ	16.00				kN/m3	From design report - Table 2
13	GCL permeability	k_{GCL}	3E-11				m/s	Assumed
14	GCL thickness	t_{GCL}	0.005				m	Assumed
15	Geomembrane hole frequency	f	2.50E-04				per m2	Assumed
16	Geomembrane hole size	a	3.10E-06				m2	Assumed
17	Assume geocomposite thickness	t_{geo}	0.005				m	Assumed
18	Assume porosity of geocomposite	n_{geo}	0.5					Assumed
19	Depth of leachate over membrane (side)	h_{ws}	0.005				m	Assumed
20	Depth of leachate over membrane (base)	h_{wb}	0.3				m	Assumed
21	Cooefficient of contact	C	0.21					(membrane to GCL --> 0.21 = good, 1.15=poor)
22	Reduction factor - chemical clogging	RF_{cc}	1.5					Qian et al (2002) Table 8.8 (as per GSI White Paper #4)
23	Reduction factor - intrusion	RF_i	1.5					Qian et al (2002) Table 8.8 (as per GSI White Paper #4)
24	Reduction factor - biological clogging	RF_{bc}	1.5					Qian et al (2002) Table 8.8 (as per GSI White Paper #4)
25	Reduction factor - creep	RF_{cr}	1.4					Qian et al (2002) Table 8.8 (as per GSI White Paper #4)
26	Factor of safety (FOS) drainage	FS_d	2					Assumed
27	Factor of safety (FOS) applied stress	FS_s	2.5					Assumed
28	Minimum detection time	T	24				hrs	
27	Side slope inflow percolation rate	Q_s	1.92E-09				m3/s/hole	
28	Base inflow percolation rate	Q_b	9.01E-12				m3/s/hole	
29	Side slope inflow percolation rate	q_s	4.81E-13				m3/s/m2	
30	Base inflow percolation rate	q_b	2.25E-15				m3/s/m2	
31	Transmissivity or unconfined flow (sidewall)	θ_s	4.71E-11				m2/s	

Client:	Hydro Aluminium Kurri Kurri Pty Ltd	**Job Number:**	22-18015		
Project:	Containment Cell for the HAKK Demolition and Remediation Project	**Calcs by:**	R Grewal	**Date:**	11/07/2018
Subject:	Leachate Collection Pipe Spacing Calculations	**Checked by:**	A Roberts	**Date:**	11/07/2018

Statement of design procedure

This spreadsheet provides design calculations for the leak detection geocomposite design

References

drainage design manual, Bachus et al, June 2004

Geotechnical Aspects of Landfill Design and Construction, Qian et al, 2002

Design cases / assumptions

1 Not used

2 Not used

Item	Description	Symbol	Case 1	Case 2	Case 3	Case 4	Unit	Notes
32	Transmissivity for unconfined flow (base + sidewall)	θ_{b+s1}	5.72E-11				m2/s	
33	Transmissivity for rapid detection (base + sidewall)	θ_{b+s2}	1.33E-04				m2/s	
34	Transmissivity design value	θ_{req}	1.33E-04				m2/s	
35	Specified transmissivity	θ_{allow}	**1.26E-03**				m2/s	
36	Minimum applied normal stress for laboratory test conditions	σ_{test}	**320**				kN/m2	
37	Minimum average roll value normal stress determined by ASTM 1621	σ_{allow}	**800**					
38	Minimum gradient for laboratory test conditions	i_{test}	**0.03**				m/m	

Client:	Hydro	**Job Number:**		**Revision:**	0
Project:	Containment Cell	**Calcs by:**	A Roberts	**Date:**	12-Feb-19
Subject:	Cap Slope Stability Calculation	**Checked by:**	D Barrett	**Date:**	12-Feb-19

Statement of design procedure

This spreadsheet calculates the case of no pore pressure buildup (due to inclusion of geosynthetic drainage layer or similar) based on Qian *et al* (2002)

References

Qian X, Koerner RM and Gray D H (2002). *Geotechnical Aspects of Landfill Design and Construction*. Prentice Hall, Upper Saddle River, NJ, USA.

Design cases / assumptions

1	Soil Layer - Seperation Geotextile
2	Geotextile - Aggregate
3	Geotextile - Geomembrane
4	Geomembrane-Reinforced GCL
5	Reinforced GCL-GCL (internal)
6	Reinforced GCL- Seal Bearing Layer
7	Seal Bearing Layer - Geocomposite
8	Geocomposite - Waste

Item	Description	Symbol	Case								Unit	Notes
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**		
1	Unit weight of cover soil	γ	18.0	18.0	18.0	18.0	18.0	18.0	18.0	18.0	kN/m^3	
2	Thickness of cover soil	h	1.75	1.75	1.75	1.75	1.75	1.75	1.75	1.75	m	Pependicular to slope
3	Grade of slope		5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	1 : ?	Vertical : horizontal
4	Vertical height of the slope measured from toe	H	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	m	
5	Angle of slope	β	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	degree	
6	Length of slope	L	96.9	96.9	96.9	96.9	96.9	96.9	96.9	96.9	m	
7	Weight of active wedge	W_A	2765.2	2765.2	2765.2	2765.2	2765.2	2765.2	2765.2	2765.2	kN/m	Equation 13.4
8	Weight of passive wedge	W_P	143.3	143.3	143.3	143.3	143.3	143.3	143.3	143.3	kN/m	Equation 13.8
9	Friction angle of cover soil	ϕ'_{soil}	30	30	30	30	30	30	30	30	degree	
10	Cohesion of cover soil	c'_{soil}	0	0	0	0	0	0	0	0	kN/m^2	
11	Interface friction angle of critical interface	$\phi'_{critical}$	24.0	33.0	26.0	23.0	16.0	22.0	24.0	26.0	degree	
12	Cohesion of critical interface	$c'_{critical}$	0	0	8	8	38	0	0	0	kN/m^2	
13	Normal force acting on bottom of active wedge	N_A	2711.5	2711.5	2711.5	2711.5	2711.5	2711.5	2711.5	2711.5	kN/m	Equation 13.5
14	Adhesive force acting on bottom of active wedge	C_a	0	0	704	704	3342	0	0	0	kN/m	Equation 13.6
15	Cohesive force along the failure plane of the passive wedge	C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	kN/m	Equation 13.8
16	FoS quadratic equation parameter	a	104.3	104.3	104.3	104.3	104.3	104.3	104.3	104.3	kN/m	Equation 13.9
17	FoS quadratic equation parameter	b	-260.4	-366.9	-417.9	-384.9	-820.6	-238.9	-260.4	-282.6	kN/m	Equation 13.9
18	FoS quadratic equation parameter	c	26.8	39.1	29.5	25.7	18.1	24.3	26.8	29.4	kN/m	Equation 13.9
19	Factor of safety for stability of the cover soil mass	FoS	**2.4**	**3.4**	**3.9**	**3.6**	**7.8**	**2.2**	**2.4**	**2.6**		Equation 13.9

Appendix H Technical Specification

Hydro Aluminium Kurri Kurri Pty Ltd

Containment Cell Design

Technical Specification

July 2018

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Appendices

1. Introduction

1.1 General

This Specification contains the technical requirements for materials and procedures to be implemented for the construction of the containment cell (the Works) at Hydro Aluminium Kurri Kurri (the site) and must be read in conjunction with the other Contract Documents.

Where the Specification and any other Contract Documents do not agree, the Contractor shall seek clarification from the Superintendent.

1.2 Definitions

The following additional terms used in this Specification shall have the meanings ascribed to them below unless the context otherwise requires:

‘Contract’ – The agreement between the Superintendent and Contractor.

‘Contract Drawings’ – The construction drawings which form part of the Contract Documents.

‘Contract Documents’ – The documents which form the Contract.

‘Contractor’ – The person bound to execute the work under the Contract.

‘Contractor’s Independent Testing Firm’ – Independent testing firm(s) engaged by the Contractor to conduct construction quality control (CQC) testing.

‘Construction Quality Assurance (CQA) Engineer’ – Suitably qualified professional responsible for administering the CQA requirements for the Works.

‘Construction Quality Assurance (CQA) Engineer’s Independent Testing Firm’ – Independent testing firm(s) engaged by the CQA Engineer to conduct construction quality assurance testing.

‘Construction Quality Assurance (CQA) Plan’ – Plan forming part of the Contract Documents, describing the construction quality assurance requirements for the Works.

‘ENM’ – Excavated natural material. As defined in the NSW EPA excavated natural material exemption 2014 (http://www.epa.nsw.gov.au/resources/waste/rre14-excavated-natural-material.pdf).

‘Field Crew Foreman’ – Foreman for the Geosynthetic Installer’s field crew, as defined by the Contractor.

‘Geosynthetic’ – Synthetic material (man-made plastic and fabric) used in geotechnical and construction applications.

‘Geosynthetic Installer’ – Firm subcontracted by the Contractor to complete the installation of geosynthetic for the Works.

‘MARV’ – Minimum average roll value.

‘MaxARV’ – Maximum average roll value.

‘PE’ – Polyethylene.

‘Regulatory Authority’ – Authority responsible for licencing the Works.

SBS Bitumen mix -- Styrene-butadiene-styrene: a polymer modifier added to improve the mechanical properties of the bitumen.

‘Seaming Crew’ – Crew responsible for the seaming activities performed by the Geosynthetic Installer, as defined by the Contractor.

‘Seaming Foreman’ – Foreman for the seaming activities performed by the Geosynthetic Installer, as defined by the Contractor.

‘Specification’ – This document.

‘Superintendent’ – As defined in the Conditions of Contract.

‘VENM’ – Virgin excavated natural material. As defined in Schedule 1 of the *Protection of the Environment Operations Act 1997.*

‘Waste’ – Material identified by the Superintendent to be placed in the containment cell.

‘Work under the Contract' – The work which the Contractor is or may be required to execute under the Contract and includes variations, remedial work, constructional plant and temporary works.

‘Works’ – The whole of the work to be executed in accordance with the Contract, including variations provided for by the Contract, which by the Contract is to be handed over to the Superintendent.

‘Works Area’ – As shown on the Contract Drawings.

1.3 Lines of communication

The Superintendent shall be the main point of liaison between the Contractor and the CQA Engineer, as well as the Client.

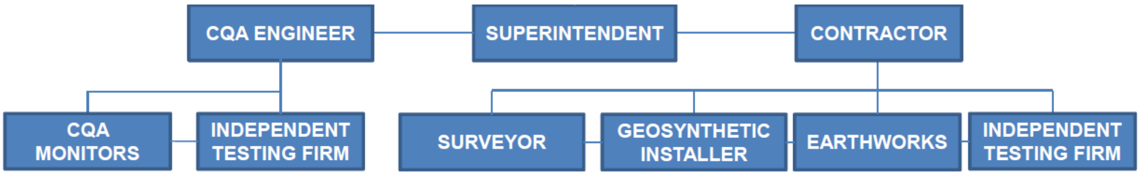

Figure 1 Lines of communication

1.4 Materials

The Contractor shall be responsible for the sourcing, delivery, storage, preparation, handling and installation of all materials, except as modified in individual sections of this Specification.

Material and installation specifications are included in the individual sections of this Specification for each material type.

1.5 Sequencing and scheduling

The Contractor shall be responsible for sequencing the installation of all materials, including surveys, testing and field trials.

In general, installation sequencing shall proceed from higher elevations to lower elevations to prevent precipitation runoff from flowing into and/or below installed products.

Individual components shall not be covered with the subsequent component until the underlying component has been accepted by the Superintendent.

1.6 Construction program

The Contractor shall prepare a program for the Works. The program shall encompass all phases of the Works. The Contractor shall submit a draft of the program to the Superintendent for review and approval at least 10 working days prior to construction. The Contractor shall not undertake any works on the site until approval for such is given by the Superintendent. The program shall include regular progress meetings with the Superintendent.

1.7 Submittals

Submittals for each material are included in the individual chapters of this Specification. Each submittal shall be submitted alongside the relevant submittal forms found in Appendix B.

The following pre-qualification submittals are required to be submitted by the Contractor at least 10 working days prior to construction for approval by the Superintendent.

Note: This technical specification only covers some of the technical submittals required under the Contract.

1.7.1 Pre-qualification of the Geosynthetic Installer

Prior to construction, the Contractor shall provide a list documenting completed facilities for which the Geosynthetic Installer has completed the installation of a geosynthetic systems similar to this Specification. For each facility, the following information shall be provided:

- The name and purpose of the facility, its location, and the date of installation
- The name of the owner, project manager, designer, manufacturer, and fabricator (if any)
- If requested, the name and telephone number of a reference contact at the facility who can discuss the project
- The name and qualifications of the supervisor(s) of the installer's crew(s)
- The type(s) of seaming, patching, and tacking equipment
- Any available information on the performance of the geosynthetic systems at the facility

The Contractor shall also provide:

- Certification indicating an approval or licence from the proposed geosynthetic manufacturers for the Contractor to install the manufacturer's materials.
- Certification that the Geosynthetic Installer's Field Crew Foreman has a minimum of 200 hectares of actual geosynthetic installation experience and a minimum of 100 hectares of supervisory experience for geosynthetic installation on a minimum of 10 different projects.
- Certification that the Geosynthetic Installer's Seaming Foreman is an International Association of Geosynthetic Installer's Certified Welding Technician and has a minimum of 100 hectares of actual geosynthetic seaming experience and a minimum of 50 hectares of supervisory experience during the seaming of geosynthetic materials.
- Certification that each individual on the Geosynthetic Installer's Seaming Crew has a minimum of 10 hectares of geosynthetic seaming experience and a minimum of 5 hectares of seaming experience with geosynthetics similar to this Specification. This condition may be relaxed at the discretion of the Superintendent to allow training of installation staff.

1.7.2 Pre-qualification of the Contractor’s Independent Testing Firm

Prior to construction, the Contractor shall provide a listing of qualifications for the proposed Contractor’s Independent Testing Firms(s) and its key personnel who shall perform the work described in this Specification. The Contractor’s Independent Testing Firms(s) shall be National Association Testing Authorities (NATA) accredited and proof of accreditation shall be maintained throughout the duration of the Works. All site subcontractors and key suppliers (quarry material, HDPE, Bix culverts) will require to be approved by the Superintendent prior to engagement.

A listing of testing apparatus and testing standards typically performed by the testing firm shall be provided along with a letter stating that the testing firm is independent and has no financial interest in the Contractor, the Geosynthetic Installer or any of the manufacturers/suppliers that are providing materials for the Works.

1.7.3 Construction program

Refer Section 1.6.

1.7.4 Procurement plan

Prior to construction, the Contractor shall provide a procurement plan, which considers each material to be supplied for the Works. For each material, the plan shall consider:

- Material sources and relevant quantities from each source
- Estimated timeframe for pre-qualification testing, provision of results and subsequent approval to deliver to site
- Estimated timeframe for delivery of material on-site
- Estimated timeframe for independent conformance testing, provision of results and subsequent approval for use (where required, refer Section 1.9.2)

The procurement plan shall align with the Works program, including installation timeframes.

1.7.5 Construction quality control plan

Refer Section 1.8.

1.8 Construction quality control

All construction quality control (CQC) testing shall be arranged by the Contractor and shall be carried out by the Contractor’s Independent Testing Firm. The cost of CQC testing shall be borne by the Contractor. Unless noted otherwise, copies of all test results shall be sent to the Superintendent as soon as available but in any event within two days of becoming available. The minimum testing frequencies shall be as nominated within this Specification.

The Contractor shall prepare and implement a CQC Plan for the Works, and the plan shall address all quality considerations identified or outlined in this Specification. The CQC plan shall incorporate, as necessary, field testing, field verification, manufacturer’s certifications and quality control testing at the manufacturing plant, to demonstrate that all Works comply with this Specification. The CQC plan shall also demonstrate how construction will occur and the methods by which the materials will be supplied, placed and tested to ensure compliance with this Specification.

Works shall not commence until the CQC plan has been approved by the Superintendent.

The Superintendent may, at its discretion, audit the Contractor’s implementation of the CQC plan. The Contractor shall co-operate with all such auditing.

At any stage throughout the Works, the Superintendent may arrange for independent testing and/or surveying to be carried out. If that testing reveals that any works are found to be not compliant with the requirements of this Specification and the Contract Drawings, the Contractor shall undertake rectification of the non-compliant items and conduct re-testing in accordance with this Specification. All costs of undertaking such rectification work and re-testing shall be borne by the Contractor.

1.9 Construction quality assurance

1.9.1 General

A Construction Quality Assurance (CQA) Plan has been developed in conjunction with this Specification and shall be implemented by the Superintendent to verify that the Works are undertaken in a manner that meets the requirements of the Contract Documents.

The Superintendent shall engage an independent organisation (the CQA Engineer), under contract to the Superintendent, who shall facilitate the requirements of the CQA Plan. This shall include independent CQA monitoring, observation, testing and documentation on behalf of the Superintendent.

The Contractor shall cooperate fully with the Superintendent and all representatives of the CQA Engineer during any independent CQA sampling, testing, and certification and shall ensure, at all times, safe access to the Works for the purpose of monitoring, observation, and CQA implementation. This shall include sampling of geosynthetic materials by the Geosynthetic Installer under the supervision of the CQA Engineer.

1.9.2 Independent conformance testing

The CQA Engineer shall arrange for independent conformance testing of the materials used in the Works, in accordance with the CQA Plan, to assure conformance with this Specification. Samples shall be collected at locations designated by the CQA Engineer and all independent conformance sampling shall be witnessed by the CQA Engineer. Where sampling of geosynthetics is necessary, the sampling shall be undertaken by the Geosynthetic Installer from the relevant materials for the independent conformance testing of the material. The Contractor shall make a suitable allowance for this testing within their construction program.

The sample frequency shall be in accordance with Table 1-1 . The table also identifies the indicative sample size. The sample sizes shall be confirmed by the CQA Engineer prior to construction. Sampling shall include the first and last roll. The specified frequency assumes all rolls are from a single manufacturing run. If rolls are from different manufacturing runs then the frequency shall be applied to each manufacturing run. The test frequency for all rolls where, in the opinion of the CQA Engineer, the manufacturing run cannot be identified shall be every roll for all test types. Samples shall not be taken from the outer wrap of the roll.

Table 1-1 Independent sample size and frequency schedule

Material	Indicative size	Frequency
Geonet drainage composite	1 metre by roll width	TBC
Sand drainage layer	20 kg bucket	TBC
Geosynthetic clay liner	1 metre by roll width	TBC
PE geomembrane	1 metre by roll width	TBC
Geotextile	1 metre by roll width	TBC
Drainage aggregate	20 kg bucket	TBC

As a minimum, a period of 8 weeks shall be allowed for from the completion of on-site sampling of all geosynthetic materials on-site to the receipt of independent conformance testing results and subsequent approval/rejection of the materials for use. This shall be confirmed by the CQA Engineer prior to construction.

If a sample records a non-conforming test result, it may be re-tested. If it passes this retest, both results shall be provided in the laboratory report from the relevant independent testing firm. If the retest produces a non-conforming test result, the Contractor shall remove and replace all rolls between the sampled roll and the nearest conforming rolls either side (based on the production order of the rolls). The Contractor may, by testing and verification of these intermediate rolls, reduce the range of rolls to be removed in this way. Such additional testing shall be for the full range of specified tests, not just the test or property which yielded a failure.

In the event of discrepancies between the CQA Engineer's test results and the Contractor's test results, the Contractor shall be responsible for arranging at his cost a third independent testing firm to verify the test results.

Any replacement material shall receive the independent conformance testing, at a cost to the contractor, in accordance with the CQA Plan.

1.10 Work method statements

Prior to the commencement of each type of work, the Contractor shall submit to the Superintendent work method statements that detail how the work is to be carried out and the plant and equipment proposed.

The Contractor shall submit such work method statements to the Superintendent at least 5 working days prior to undertaking any work addressed by the work method statement.

The Superintendent may reject the submitted work method statement if, in the opinion of the Superintendent, the statement does not comply with the Specification or any other Contract Documents provided to the Contractor prior to or during construction.

Where a work method statement is rejected the Contractor shall revise and resubmit the statement. No work addressed by the work method statement shall be undertaken by the Contractor until the work method statement is accepted by the Superintendent.

Acceptance by the Superintendent of a proposed work method statement in no way reduces the Contractor's liability to achieve the requirements described in this Specification.

Appendix A contains a schedule of activities for which the Contractor shall produce work method statements.

1.11 Survey requirements

Prior to commencing construction, the Contractor shall establish a survey grid over the Works footprint. The survey grid shall be a maximum 10 m spacing over the Works footprint, as well as any locations at which there is a change or break in grade and set out points identified on the Contract Drawings. The elevation of excavated surfaces and placed materials shall be recorded at these grid locations.

Survey data shall be provided to the Superintendent in graphical and tabular formats. All survey shall be to MGA and levels shall be based on Australian Height Datum (AHD).

Table 1-2 contains a schedule of survey requirements for the Works.

Table 1-2 Survey requirements

Component	Survey requirements
Bulk earthworks	Following completion of clearing and grubbing works, survey the elevation of the completed surface at all grid locations and at any changes in grade.
Access roads	Following completion of the works, survey the levels and alignments at maximum 10 m spacing and at any changes in grade.
Containment cell excavated surface	Following completion of excavation works, survey the elevation of the completed surface at all grid locations and at any changes in grade.
Containment cell subgrade surface (including external bunds)	Following completion of filling works, survey the elevation of the completed surface at all grid locations and at any changes in grade.
Clay rich fill layer	Following placement of the clay rich fill layer, survey the elevation of the completed layer at all grid locations and at any changes in grade. A conformance survey shall also be provided (with consideration to the surveyed elevations of the underlying surface) showing conforming layer thickness within the allowable tolerances.
Sand drainage layer	Following installation of the sand drainage layer, survey the elevation of the completed surface at all grid locations and at any changes in grade. A conformance survey shall also be provided (with consideration to the surveyed elevations of the underlying surface) showing conforming layer thickness within the allowable tolerances.
Internal bunds	Following installation of the internal bunds, survey the elevation of the completed surface at all grid locations and at any changes in grade.
Drainage aggregate layer	Following installation of the drainage aggregate layer in the base of the containment cell, survey the elevation of the completed surface at all grid locations and at any changes in grade. A conformance survey shall also be provided (with consideration to the surveyed elevations of the underlying surface) showing conforming layer thickness within the allowable tolerances.
Soil confining layer	Following installation of the soil confining layer on the sidewalls of the containment cell, survey the elevation of the completed surface at all grid locations and at any changes in grade. A conformance survey shall also be provided (with consideration to the surveyed elevations of the underlying surface) showing conforming layer thickness within the allowable tolerances.
Leachate drainage pipes	Following installation of the leachate drainage pipes, survey the levels and alignments of all pipework at maximum 10 m spacing and at any changes in grade.
Leachate storage pond subgrade	Following completion of excavation and filling works, survey the elevation of the completed surface at all grid locations and at any changes in grade.
Progressive waste heights	On a weekly basis, survey the elevation of the waste material at all grid locations and at any changes in grade.
Sediment detention basins subgrade	Following completion of excavation and filling works, survey the elevation of the completed surface at all grid locations and at any changes in grade.
Surface water drains	Following completion of the surface water drains, survey the levels and alignments of drain inverts at maximum 10 m spacing and at any changes in grade or structure type.

Component	Survey requirements
Completed waste surface	Following completion of landfilling works, survey the elevation of the completed surface at all grid locations and at any changes in grade.
Recycled drainage aggregate layer	Following placement of the layer, survey the elevation of the completed layer at all grid locations and at any changes in grade. A conformance survey shall also be provided (with consideration to the surveyed elevations of the underlying surface) showing conforming layer thickness within the allowable tolerances.
Subsoil	Following placement of the layer, survey the elevation of the completed layer at all grid locations and at any changes in grade. A conformance survey shall also be provided (with consideration to the surveyed elevations of the underlying surface) showing conforming layer thickness within the allowable tolerances.
Topsoil	Following placement of the layer, survey the elevation of the completed layer at all grid locations and at any changes in grade. A conformance survey shall also be provided (with consideration to the surveyed elevations of the underlying surface) showing conforming layer thickness within the allowable tolerances.
Landfill gas system trenches	Following completion of the landfill gas system trenches, survey the levels and alignments of the invert at maximum 10 m spacing and at any changes in grade.
Landfill gas system bores and landfill gas monitoring bores	Following completion of the landfill gas system bores and landfill gas monitoring bores , survey the locations.

1.12 Witness and hold points

The following information applies to witness and hold points for the Works:

- A hold point is a defined position in the Works beyond which work shall not proceed without mandatory verification and acceptance by the Superintendent
- A witness point is a nominated position in the Works where the option of attendance may be exercised by the Superintendent, after notification of the requirement
- It shall be the Contractor's responsibility to ensure that all obligations are fulfilled in regards to the witness and hold points within the Contract
- The Contractor shall give the Superintendent a minimum 2 days notice prior to the required inspection
- Where the witness or hold point relates to the condition of a surface or installed material, the Contractor shall verify that the completed surface has achieved full conformance with the Contract Documents
- Witness or hold points may be released for part of the Works Area only, as defined by the Superintendent, so that the Works can be completed in a sequenced manner. The Superintendent's approval of the completed items is required prior to the release of each witness or hold point.

Table 1-3 contains a list of activities to which witness and hold points apply.

Table 1-3 Witness and hold points

Item	Description	Witness	Hold
1	General		
	Provision of required pre-construction submittals, including general work method statements, management plans and details of proposed testing firm(s)		✓

Item	Description	Witness	Hold
2	Bulk earthworks		
	Provision of required submittals prior to delivery and placement of fill materials		✓
	Survey following completion of clearing and grubbing works		✓
	Inspection of finished surface		✓
2	Subgrade		
	Provision of required submittals prior to delivery and placement of fill materials		✓
	Survey following completion of clearing and grubbing works		✓
	Results of CQC results	✓	
	Inspection of finished surface		✓
3	Clay rich fill		
	Provision of required submittals prior to placement of clay rich fill		✓
	Results of CQC results	✓	
	Inspection of finished surface		✓
3	Geonet drainage composite		
	Provision of required submittals prior to delivery and placement		✓
	Results of CQC results	✓	
	Inspection of finished surface	✓	
4	Sand drainage layer		
	Provision of required submittals prior to delivery and placement		✓
	Results of CQC results	✓	
	Inspection of finished surface		✓
5	Geosynthetic clay liner		
	Provision of required submittals prior to delivery and placement		✓
	Results of CQC results	✓	
	Inspection of finished surface	✓	
6	PE geomembrane		
	Provision of required submittals prior to delivery and placement		✓
	Results of CQC results	✓	
	Inspection of finished surface		✓
7	Geotextile		
	Provision of required submittals prior to delivery and placement		✓
	Results of CQC results	✓	
	Inspection of finished surface	✓	
8	Drainage aggregate		
	Provision of required submittals prior to delivery and placement of materials		✓
	Results of CQC results	✓	
	Inspection of finished surface	✓	
9	PE pipework		
	Provision of required submittals prior to delivery and placement of materials		✓

Item	Description	Witness	Hold
	Results of CQC results	✓	
10	Soil confining layer		
	Provision of required submittals prior to delivery and placement of materials		✓
	Results of CQC results	✓	
	Inspection of finished surface	✓	
11	Waste placement		
	Survey following completion of clearing and grubbing works		✓
	Placement of waste fill	✓	
	Inspection of finished surface		✓
12	Seal bearing layer		
	Provision of required submittals prior to delivery and placement of fill materials		✓
	Survey following completion of seal bearing layer		✓
	Results of CQC results	✓	
	Inspection of finished surface		✓
13	Revegetation layer		
	Provision of required submittals prior to delivery and placement of fill materials		✓
	Survey following completion of seal bearing layer		✓
	Results of CQC results	✓	
	Inspection of finished surface		✓
14	Field Trials		
	Prior to conducting field trials, provision of submittals identified in Section 17.2.1 and Section 18.2.1		✓
	Field trial being undertaken	✓	
	Following completion of the field trials, provision of submittals identified in Section 17.2.2 and Section 18.2.2		✓
15	Stormwater Drainage		
	Completion of trench excavation, before placing Bed Zone material		✓
	Completion of laying and jointing, before placing Haunch Zone material		✓
	Inspection of trench prior to back filling	✓	
	Completion of formwork and reinforcement in stormwater drainage structures, before placing concrete		✓
16	Concrete		
	Completion of excavation and prior to placement of formwork and reinforcement		✓
	Completion of formwork, reinforcement and other embedded items, before placing concrete		✓
	At Completion of formwork Stripping	✓	
17	Pavements		
	Proof rolling of subgrade	✓	
	Placement of subbase course		✓
	Placement of base course		✓
	Placement of wearing course		✓

Item	Description	Witness	Hold
18	Rock Mattresses and / or Rock Fill		
	Completion of trimming area before placing geotextile and rock fill		✓
	Inspection of completed Rock Mattresses and / or rock fill		✓
21	Landfill gas system		
	Provision of required submittals prior to delivery and placement		✓
	As built-survey of landfill gas system		✓
	Inspection of finished system		✓
22	*Services*		
	Completion of trench excavation, before placing bed zone material		✓
	Installation of electrical and communications cable pits, before laying conduits	✓	
	Completion of laying each layer of electrical and communications conduits, before refilling	✓	

1.13 Works as Executed Drawings

The Contractor shall provide one (1) set of Works as Executed Drawings, which shall include all corrections and as-constructed information done in a professional draftsman-like manner. All Works as Executed Drawings shall be certified by a Registered Surveyor.

The following Works as Executed Drawings shall be prepared as a minimum:

- Surface contours following clearing and grubbing
- Surface contour following construction of access roads
- Surface contours of the completed subgrade
- Surface contours of the completed sand drainage layer
- Surface contours of the completed drainage aggregate layer
- Surface contours of the completed soil confining layer
- Surface contours of the completed clay rich fill layer
- Plans detailing the progression of the containment cell as per survey requirements.
- Alignment and levels of all pipework, drains and culverts
- Final contours of landfilled waste
- Surface contours of completed recycled aggregate layer
- Surface contours of completed seal bearing layer
- Surface contours of completed revegetation layers
- Alignment, locations and levels of all gas management system infrastructure including gas monitoring bores including logs

All Works as Executed Drawings shall include test locations, showing as a minimum the approximate location, identification number, date sampled and type of testing completed.

2. Erosion and sediment control

2.1 General

The Contractor shall provide all erosion and sediment controls necessary to protect the areas immediately adjacent to the Works Area from negative impacts.

The removal of temporary erosion and sediment control works shall be the responsibility of the Contractor. The extent of removal of the temporary works shall be confirmed by the Contractor with the Superintendent before Date of Practical Completion. Materials used for the temporary erosion and sediment control works shall be removed from the Works Area or otherwise disposed of by the Contractor to the satisfaction of the Superintendent. Maintenance of permanent control measures entrusted into the care and control of the Contractor by the Contract up until the Date of Practical Completion shall be the responsibility of the Contractor.

2.2 Standards

Relevant Australian standards are as follows:

- International Erosion Control Association (Australasia) Best Practice Erosion and Sediment Control Books and Principles of Construction Site ESC.
- Site Environment Protection Licence (EPL) No. 20148[1].
- Landcom (2004) Managing Urban Stormwater: Soils and Construction – Volume 1 (4th Ed.), informally known as the "Blue Book".
- NSW Department of Environment and Climate Change (2008) Managing Urban Stormwater: Soils and Construction – Volume 2B, Waste Landfills.

2.3 Submittals

2.3.1 Draft and Final Erosion and Sediment Control Plan

The Contractor shall submit to the Superintendent for review and approval a draft Erosion and Sediment Control Plan (ESCP) at least 10 working days prior to initiating the Works. The draft shall be submitted in electronic format (.PDF) and as one (1) bound hard copy.

The Contractor shall submit to the Superintendent for review and approval a final ESCP incorporating any required changes prior to initiating the Works. The final shall be submitted in electronic format (.PDF) and as one (1) bound hard copy.

The Contractor shall maintain on site for examination by authorized representatives one (1) bound hard copy of the final approved ESCP, and as may be amended.

2.4 Erosion and Sediment Control Plan

The Contractor shall prepare and implement an ESCP for the Works with consideration to this Specification, the standards noted in above Section 2.2 and the Contract Drawings.

[1] The Contractor shall ensure that the version of EPL No. 20148 considered shall be the version applicable at the time of the works

The ESCP shall identify all temporary and permanent erosion and sediment control measures the Contractor shall implement during the Works (including staging). The ESCP shall identify monitoring the Contractor shall undertake to ensure the Contractor complies with the surface water release criteria at the site (as per EPL No. 20148). The ESCP shall also identify the requirement and guidance for minimum three (3) site visits including:

- Prior to submission and sign off of the ESCP;
- Prior to installation of topsoil and vegetation; and
- Prior to Practical Completion.

The ESCP shall be signed off by a Certified Professional in Erosion and Sediment Control under the International Erosion Control Association (Australasia). The personnel who will prepare and sign off on the ESCP shall undertake the required minimum one (1) site visit noted above.

2.5 Materials

Materials used for erosion and sediment control measures shall meet the objectives and requirements of the applicable standards noted in above Section 2.2.

2.6 Installation

The Contractor shall:

1. Construct temporary erosion control items in accordance with applicable standards, Laws and Regulations. Actual alignment and/or location of the various items as directed by Superintendent.
2. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas, from stockpiles, staging areas, and other work areas. Prevent erosion and sedimentation.
3. Minimize amount of bare soil exposed at one time. Stabilize disturbed soils as quickly as practical. Strip vegetation, regrade, or otherwise develop in such a way as to minimize erosion. Remove accumulated sediment resulting from construction activity from adjoining surfaces, drainage systems, and water courses, and repair damage caused by soil erosion and sedimentation as directed by Superintendent.
4. Not construct bale barriers and silt fence in flowing streams or in swales where there is the possibility of a washout.
5. Check erosion and sediment control measures weekly and after each rainfall. During prolonged rainfall, check daily.
6. Permit bales and/or silt fence to be removed at the beginning of the work day, though these are be replaced at the end of the work day.
7. Remove sedimentation from adjoining surfaces, drainage systems, and watercourses, and repair damage as quickly as possible whenever sedimentation is caused by stripping vegetation, regrading, or other development.
8. Pay close attention to the repair of damaged bales, end runs, and undercutting beneath bales.
9. Remove temporary erosion and sediment control devices upon completion of the Works, unless otherwise specified on the Drawings or directed by Superintendent. Spread accumulated sediments to form a suitable surface for seeding or dispose of, and shape the area to permit natural drainage; all to the satisfaction of Superintendent. Materials once removed become the property of Superintendent.

10. Provide and maintain temporary measures which may include, but are not limited to, silt fences, hay or straw bales, ditches, geotextiles, drains, berms, terracing, riprap, temporary drainage piping, sedimentation basins, vegetative cover, dikes, and any other construction required to prevent erosion and migration of silt, mud, sediment, and other debris off the Site or to other areas of the Site where damage might result, or that might otherwise be required by Laws and Regulations. Make sediment control measures available during construction. Place silt fences and/or hay or straw bales in ditches to prevent sediments from escaping from the ditch terminations.
11. Plan construction procedures to avoid damage to or work or equipment encroachment onto water bodies or drainage ditch banks. In the event of damage, promptly take action to mitigate the effects of such damage. Restore the affected bank or water body to its existing condition.
12. Construct fill areas by selective placement to avoid erosive surface silts or clays.
13. Not disturb existing embankments or embankment protection.
14. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.
15. Remove the accumulation of soil and debris and restore the area to its original condition, if soil and debris from the Site accumulate in low areas, storm sewers, roadways, gutters, ditches, or other areas where in Superintendent's determination it is undesirable.

Prior to or during construction, Superintendent may require the installation or construction of improvements to prevent or correct temporary conditions on the Site. Improvements may include berms, mulching, sediment traps, detention and retention basins, grading, planting, retaining walls, culverts, pipes, guardrails, temporary roads, and other measures appropriate to the specific condition. Temporary improvements shall remain in place and in operation as necessary or until otherwise directed by Superintendent.

2.7 Vegetation establishment

Erosion and sediment control measures for the Works are crucial following placement of the subsoil/topsoil layer and prior to vegetation establishment, to prevent any significant erosion of the subsoil/topsoil layers (and potential damage to the layers beneath them). Erosion and sediment control measures are also particularly important on the landform batters exceeding a gradient of 25 per cent.

The Contractor shall be responsible for establishing suitable controls for managing erosion and sediment control during the establishment of vegetation, including inspection of non-vegetated or partially vegetated areas following rain events.

The Contractor shall remediate any erosion of the final landform areas identified following rainfall to the satisfaction of the Superintendent, including any damage the erosion causes to other components of the Works.

2.8 Defects and repairs

Any erosion and sediment control measures which become damaged, clogged or otherwise non-functional shall be immediately replaced by the Contractor, without additional compensation.

The Contractor shall clean and repair damage caused by installation or use of erosion and sediment control measures. Further, the Contractor shall restore existing facilities used during construction to original and functional condition.

Should the planned ESCP measures not result in effective control of erosion and sediment runoff to the satisfaction of the Superintendent, the Contractor shall immediately adjust their ESCP and/or institute additional measures to eliminate excessive erosion and sediment-runoff.

If the Contractor fails or refuses to comply promptly, the Superintendent may issue an order stopping all or part of the work until satisfactory corrective action has been taken. No part of the time lost due to any such stop orders shall be made the subject of a claim for extension of time or for excess costs or damages by the Contractor.

2.9 Acceptance

The temporary, permanent and any additional erosion and sediment control measures shall be to the satisfaction of the Superintendent, including the ESCP, materials, installation, vegetation establishment and repairs. All costs associated with erosion and sediment control for the Works shall be borne by the Contractor.

3. Earthworks

3.1 General

This section contains the technical requirements for earthworks.

The Superintendent may reject any earthworks that do not meet or exceed the requirements of this section.

Any earthworks rejected by the Superintendent shall be remediated at the expense of the Contractor.

3.2 Standards

3.2.1 Australian standards

Relevant Australian standards are as follows but not limited to:

- 1152 Specification for test sieves
- 1289 Methods of testing soils for engineering purposes
- 1289.2.1.1 Determination of the moisture content of a soil - oven drying method
- 1289.3.1.1 Soil classification tests - Calculation of the plasticity index of a soil
- 1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving
- 1289.3.6.3 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of fine analysis using a hydrometer
- 1289.3.8.1 Soil classification tests - Dispersion - Determination of emerson class number of a soil
- 1289.5.1.1 Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using standard compactive effort
- 1289.5.6.1 Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
- 1289.5.7.1 Soil compaction and density tests - Compaction control test - Hilf density ratio and Hilf moisture variation (rapid method)
- 1289.5.8.1 Soil compaction and density tests - Determination of field density and field moisture content of a soil using a nuclear surface moisture density gauge
- 1289.6.7.2 Determination of the permeability of a soil - Falling head method for a remoulded specimen
- 1289.6.7.3 Determination of the permeability of a soil - Constant head method using a flexible wall permeameter
- 1726 Geotechnical site investigations
- 2868 Classification of machinery for earthmoving, construction, surface mining and agricultural purposes
- 3798 Guidelines on earthworks for commercial and residential developments
- 4419 Soil for landscaping and garden use

3.3 Submittals

3.3.1 Prior to delivery and placement of fill material

The Contractor shall submit the following to the Superintendent for review and approval prior to placement of each type of fill material:

- Certification that the material is VENM or ENM or NSW EPA Resource Recovery Exemption appropriate for use as fill material
- Pre-qualification test results/reports demonstrating that the material complies with the relevant material property requirements of this Specification
- Estimated quantity of material which is represented by the pre-qualification test results/reports.
- Survey of the underlying surface in accordance with Section 1.11
- Work method statement(s) for the placement of the fill material, including testing and repair procedures (refer Appendix A)

Note: This technical specification only covers some of the technical submittals required under the Contract.

3.3.2 Following completion of earthworks

The Contractor shall submit the following to the Superintendent for review and approval following completion of earthworks (per layer and/or segment):

- As-built survey of the completed surface/s showing conforming layer thickness within the allowable tolerances
- CQC testing results/reports showing compliance with the requirements of this Specification
- Defect and repairs log, showing details of all defects identified and any repairs completed

3.4 Materials

3.4.1 Unsuitable material

Fill material shall not contain any of the following:

- Organic soils, such as top soils, severely root-affected subsoils and peat, except where used for revegetation layers
- Materials contaminated through past site usage which may contain toxic substances or soluble compounds harmful to water supply or agriculture
- Materials containing substances that can be dissolved or leached out in the presence of moisture, or which undergo volume change or loss of strength when disturbed and exposed to moisture
- Materials which may be detrimental to the lining material
- Silts or materials that have the deleterious engineering properties of silt
- Materials containing fire ant infestation/s
- Fill that contains wood, metal, plastic, boulders or other deleterious material
- Actual or potential acid sulphate soils (ASS)
- High plasticity clays

- Material susceptible to combustion

3.4.2 Select fill

Select fill material shall:

- Be selectively sourced material from on-site
- Not contain any unsuitable materials identified in Section 3.4.1 unless accepted by the Superintendent
- Be well graded in accordance with AS 1726
- Comply with the acceptance criteria specified in Table 3-1.

The Contractor shall supply pre-qualification testing results in accordance with the testing frequencies identified in Table 3-1 showing that the proposed material meets the requirements of this table. Samples taken shall be representative of the whole material source and shall be evenly distributed across the material source.

If required by the Superintendent, a sample of the material shall be provided (per source) and the Superintendent and/or CQA Engineer may undertake an inspection of the material source. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

Table 3-1 Acceptance criteria – select fill

Property	Test method	Acceptance criteria	Minimum test frequency
Particle size distribution: - Passing 19 mm - Passing 0.075 mm	AS 1141.11,12,13 or AS 1289.3.6.1, 3.6.3	100% > 25%	Greater of: 1 per 5,000 m^3 of material or 3 per source
Atterberg limits: - Plasticity index - Liquid limit	AS 1289.3.1.1, 3.2.1 & 3.3.1	8 – 35 ≤ 50	Greater of: 1 per 5,000 m^3 of material or 3 per source
California Bearing Ratio (CBR)	AS1289.5.7.1	≥ 5	Greater of: 1 per 5,000 m^3 of material or 3 per source
Emerson class	AS 1289.3.8.1	> 3	Greater of: 1 per 5,000 m^3 of material or 3 per source

3.5 Equipment

All earthworks shall be undertaken using conventional earthmoving equipment and methods typical to this type of project. Equipment shall be industry standard and operated in accordance with the equipment manufacturer's instructions.

Blasting is not permitted.

3.6 Quantities

The Contractor shall monitor all earthworks and shall be responsible for verifying the quantities of cut and fill available for constructing the Works.

Quantities of cut and fill provided in the Contract Documents are provided for bidding purposes only and do not account for shrinkage and swell or excess material.

The Contractor shall be responsible for any assumptions made in relation to the nature, hardness and types of materials to be encountered in excavations and the bulking and compaction characteristics of materials.

3.7 Extent of disturbed areas

The Contractor shall confine machinery operations within the Works Area as shown on the Contract Drawings.

All disturbed, compacted or spoiled ground outside of the designated Works Area shall be cultivated and sown with an approved grass mix. The Contractor shall ensure that this operation is programmed to enable germination of seed prior to the Date of Practical Completion.

3.8 Lines and levels

All earthworks shall be to the lines and levels shown in the Contract Drawings.

Earthworks shall be trimmed to line and level by machine and/or hand as necessary to produce profiles to the tolerances required.

3.9 Clearing and grubbing

The Contractor shall undertake all clearing and grubbing necessary to execute the Works including all vegetation, both living and dead, all minor man-made structures (such as fences and livestock yards), all rubbish and other materials which, in the opinion of the Superintendent, are unsuitable for use in the Works, the chipping of the crowns of trees and the branches of shrubs, and the grubbing of trees and stumps from the Works Area. Clearing and grubbing shall also include the disposal of all materials that have been cleared and grubbed. All natural landscape features, including natural rock outcrops, natural vegetation, soil and watercourses are to remain undisturbed except where affected by the Works.

Cleared vegetation material shall be retained on site (chipped/reused). If required, vegetation for disposal shall be disposed of by the Contractor at a facility accepted by the Superintendent.

During clearing and grubbing works, the Contractor may ascertain material which can be utilised as topsoil for the purpose outlined in this Specification. Subject to approval, the Contractor may stockpile this material for use as topsoil. Stockpiling of topsoil shall be undertaken in accordance with Section 3.16.

3.10 Excavation

Excavation shall consist of all excavation required to complete the Works unless separately designated.

Material that is unsuitable for use shall be excavated and disposed by the Contractor as directed by the Superintendent.

If excavated material is unsatisfactory for its specified use because of high moisture content, the Contractor may be directed by the Superintendent to either process the material to reduce the moisture content or to remove the material and replace it with suitable material.

Excavation slopes shall be finished in conformance with the lines and grades shown on the Contract Drawings or as re-determined by the Superintendent on the basis of site inspection and investigation during the works. All debris and loose material shall be removed.

The tops of excavation slopes and the end of excavations shall be rounded where shown on the Contract Drawings.

If the Contractor excavates beyond the slope line and the tolerance applicable, the Contractor shall request and the Superintendent may authorise a minor change in the general slope of the surface. This shall not be regarded as a redetermination of the final grades and levels. If the Contractor's request is denied, the Contractor shall submit details of the material and/or methods proposed to restore the specified slope and stability of the surface for approval.

3.11 Filling

Filling includes all operations associated with the preparation of the Works on which fill material to be placed and the placing and compacting of approved fill material to the alignment, grading and dimensions shown on the Contract Drawings, including any pre-treatment such as breaking down, blending or drying out material containing excess moisture.

All fill shall be placed, spread, mixed, watered and compacted in accordance with the Specification.

The ground surface prepared to receive fill shall be firm and unyielding. This shall be determined by undertaking compaction testing and roll testing.

Prior to filling, the ground surface shall be scarified, disked, or bladed until it is uniform and free from uneven features which may prevent uniform compaction. The scarified ground surface shall then be brought to appropriate moisture content, mixed as required and compacted. If the scarified zone is greater than 300 mm in depth, the excess shall be removed and placed in compacted lifts not greater than 200 mm compacted thickness, unless otherwise specified.

Unless otherwise specified, fill material shall be placed in thin lifts with a maximum compacted lift thickness of 200 mm. Each lift shall be spread evenly and thoroughly mixed to obtain a near uniform condition in each lift. In areas of excess lift thickness, regrading of the surface to the maximum lift thickness shall be completed prior to construction of additional lifts.

Handling and spreading of all fill material shall produce a gradation of the materials when compacted to comply with this Specification.

All fill materials shall be placed in such a manner that the distribution and gradation of the materials throughout will be such that the fill will be free from lenses, pockets, streaks, or layers of material differing substantially in texture or gradation from the surrounding material within the zone.

Where work is interrupted by rain, fill operations shall not be resumed until observations and field tests by the Contractor indicate that the moisture content and density of the in-place fill materials and/or materials intended for placement are within the limits identified in this Specification. This requirement does not preclude the Contractor from disking or aerating excessively wet areas to enhance drying.

3.12 Compaction

Unless stated otherwise, all fill shall be compacted at a moisture content of -2 to +2% of optimum moisture content (OMC) in accordance with Table 3-2.

Table 3-2 Minimum relative compaction

Application	Minimum relative compaction (%)	
	Minimum density ratio (cohesive soils)	Minimum density index (cohesionless soils)
Subgrade materials, embankments/bunds and trench backfill	98 std	60
Select fill	98 std	-
Sand fill	-	70 - 75
Clay rich fill	95 std	-
Soil confining material	90 std	-
Seal bearing material	98 std	-
Subsoil material	Refer Section 16.4.1	-

3.13 Construction quality control testing

Unless stated otherwise, the Contractor shall undertake CQC testing of all fill in accordance with Table 3-3 (general filling works) and Table 3-4 (trench filling works) as a minimum. Sampling locations for testing shall be agreed with the Superintendent and CQA Engineer.

The Superintendent may request additional tests at any time, where in the opinion of the Superintendent, a deficiency is suspected.

The Superintendent shall direct the extent of work rejected due to non-conforming CQC test results based on the area represented by the non-conforming test results (with respect to test locations and frequencies). Following a thorough re-working of a non-conforming area, retesting shall be performed by the Contractor to evaluate whether the re-worked area meets the requirements of the Specification. The Contractor shall undertake all necessary remedial work, including retesting, to reinstate the work to the requirements of the Specification. Further details are provided in Section 3.17.

CQC testing for all earthworks shall be carried out by the Contractor's Independent Testing Firm who shall supply reports identifying the material type, the Specification requirements, and associated results.

The Contractor shall maintain a register of in-situ test results, which shall record the following details:

- Test number
- Description of the fill material
- Location/Grids or co-ordinates of the tests
- Lift tested
- Density ratio
- Moisture content
- Method of testing in accordance with AS 1289

Where tests do not conform to the Specification requirements, retests shall be undertaken and these shall be clearly identified in the register.

Table 3-3 Construction quality control testing – earthworks (general)

Property	Test method	Minimum test frequency
Moisture content	AS 1289.5.1.1 or AS 1289.5.7.1	Greater of: 1 per layer per 2,500 m^2 or 1 per 500 m^3 or 3 per lift
Dry density	AS 1289.5.8.1 AS 1289.5.1.1 or AS 1289.5.7.1	Greater of: 1 per layer per 2,500 m^2 or 1 per 500 m^3 or 3 per lift

Table 3-4 Construction quality testing – earthworks (trenches)

Property	Test method	Minimum test frequency
Moisture content	AS 1289.5.1.1 or AS 1289.5.7.1	1 per 2 layers per 40 linear metres
Dry density	AS 1289.5.8.1 AS 1289.5.1.1 or AS 1289.5.7.1	1 per 2 layers per 40 linear metres

3.14 Tolerances

Unless specified otherwise, tolerances shall meet the acceptance criteria in Table 3-5.

The Contractor may excavate and re-compact the existing material if necessary to assist in achieving this tolerance.

Notwithstanding these allowable tolerances, the Contractor shall be responsible for meeting grading requirements across the surfaces of earthworks materials as shown on the Contract Drawings.

Plus (+) refers to the following:

- Elevation: Plus (+) is higher than design
- Layer thickness: Plus (+) is thicker than design
- Depth: Plus (+) is deeper than design
- Width: Plus (+) is wider than design

Minus (-) refers to the following:

- Elevation: Minus (-) is lower than design
- Layer thickness: Minus (-) is thinner than design
- Depth: Minus (-) is shallower than design
- Width: Minus (-) is narrower than design

Table 3-5 Tolerances

Element	Measurement	Acceptance criteria
General excavation	Elevation	±100 mm
Subgrade	Elevation	+0, -100 mm
Sidewalls: At the toe of the batter 2 m above toe of batter and higher Between toe of batter and 2 m above toe of batter	Elevation	 +0, -100 mm ± 100 mm pro rata basis
Embankments/bunds	Elevation	+100, -0 mm
All trenches	Depth	+100, -0 mm

Element	Measurement	Acceptance criteria
	Width	+100, -0 mm
Clay rich fill layer	Layer thickness	+50, -0 mm
Sand drainage layer	Layer thickness	+50, -0 mm
Leachate drainage aggregate layer	Layer thickness	+50, -0 mm
Soil confining layer	Layer thickness	+50, -0 mm
Recycled aggregate layer	Layer thickness	+50, -0 mm
Seal bearing layer	Layer thickness	+100, -0 mm
Revegetation layer	Layer thickness	+100, -0 mm
Capping layer	Elevation	+0 mm

3.15 Anchoring of geosynthetics

Anchor trench excavation, backfill, and compaction shall be completed to the line and grades shown on the Contract Drawings. A work method statement shall be prepared for the excavation and backfill of anchor trenches during the Works with consideration to the guidance below.

Anchor trenches shall be prepared with slightly rounded corners where the geosynthetics adjoin the trench so as to avoid sharp bends in the geosynthetic material. The base of the anchor trench must be a smooth uniform surface that is free of defects and loose material.

The geosynthetic layers shall be placed in the trench as per the Contract Drawings to ensure effective anchorage. Fill material shall be placed in maximum 100 mm loose lifts if compacted with hand-operated compaction equipment, or maximum 200 mm loose lifts if compacted with a self-propelled compactor.

The Contractor shall repair or replace any geosynthetics damaged as a result of placement or compaction of backfill to the satisfaction of the superintendent.

3.16 Stockpiles

The Contractor shall be responsible for managing stockpiles of fill materials for the Works until the Date of Practical Completion. It is the Contractor's responsibility to prevent the fill material stockpiles to become contaminated with unsuitable material (refer Section 3.4.1) or by other methods (such as fines contamination) which may result in the fill material no longer meeting the relevant acceptance criteria in this Specification. The Superintendent may organise independent inspections and/or testing of the fill material stockpiles to verify conformance with these requirements. In the Superintendent's opinion, if remediation of any contaminated fill materials is not viable then the fill shall be rejected by the Superintendent and removed from the site at the expense of the Contractor.

All stockpiles shall be located so that drainage from the stockpile flows into the site or to the proposed sedimentation basins. Where a stockpile cannot be located such that drainage flows into the site, the stockpile shall have a drainage swale placed on the uphill side of the stockpile to divert surface water from the stockpile area and sediment traps at its base to capture sediment running off the stockpile. These drainage measures shall be constructed as per the Blue Book. Stockpile management shall be considered as part of the ESCP submitted for the Works.

In addition, all stockpiles shall:

- Have maximum slopes not exceeding 1(V):2(H)
- Have rounded shoulders and base of batters to minimise wind and water erosion
- Be surrounded by filter fence

3.17 Defects and repairs

Compacted fill material with non-conforming CQC test results shall be remediated as Table 3-6. This includes non-conformances resulting from independent testing commissioned by the Superintendent or CQA Engineer.

Material with non-conforming CQC test results after remedial work has been implemented (that is, tested for a second time) shall be removed and replaced.

The Contractor shall submit to the Superintendent for review a log containing details of any defects identified and repairs carried out.

Table 3-6 Remedial actions for compacted fill

Category	Density ratio result	Density index result	Moisture result	Remedial action[2]
A	Non-conforming by less than 1%	Non-conforming by less than 3%	Conforming	Re-compact (maximum of three passes)
B	Non-conforming by 1% or more	Non-conforming by less than 5%	Conforming, but not more than 1.0% wet of OMC	Rip, re-water, re-compact and re-test
C	Non-conforming by 1% or more	N/A	Pass, but 1.0% or more wet of OMC	Rip, re-compact and re-test
D	Conforming	N/A	Non-conforming	Rip, re-water, re-compact and re-test
E	Non-conforming	Non-conforming by more than 5%	Non-conforming	Remove fill, replace, compact and re-test

3.18 Acceptance

The Contractor shall retain ownership and responsibility for the earthwork activities until Practical Completion.

The earthworks shall be accepted by the Superintendent when all of the following conditions are met:

- Required submittals are provided by the Contractor to the Superintendent and accepted
- The Contractor has submitted the required as-built surveys of the completed earthworks showing conformance with the Contract Drawings within the allowable tolerances, and this has been accepted by the Superintendent
- CQC test results showing compliance with the requirements of this Specification have been provided by the Contractor to the Superintendent and accepted
- Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and accepted
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
- The Superintendent has inspected and accepted the finished surface/s

[2] Should the Superintendent deem the depth of insufficiently compacted material to be greater than can be effectively compacted from the surface, material shall be removed to a depth at which compaction is satisfactory and replaced and compacted in layers

4. Subgrade

4.1 General

This section contains the technical requirements for the subgrade preparation. The relevant requirements for the subgrade in Section 3 shall be considered alongside guidance provided in this section.

The Superintendent may reject any component of the subgrade that does not meet or exceed the requirements of this section.

Any subgrade rejected by the Superintendent shall be remediated at the expense of the Contractor.

4.2 Standards

4.2.1 Australian standards

Relevant Australian standards are as follows but not limited to:

- 1152 Specification for test sieves
- 1289 Methods of testing soils for engineering purposes
- 1289.2.1.1 Determination of the moisture content of a soil - oven drying method
- 1289.3.1.1 Soil classification tests - Calculation of the plasticity index of a soil
- 1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving
- 1289.3.6.3 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of fine analysis using a hydrometer
- 1289.3.8.1 Soil classification tests - Dispersion - Determination of emerson class number of a soil
- 1289.5.1.1 Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using standard compactive effort
- 1289.5.6.1 Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
- 1289.5.7.1 Soil compaction and density tests - Compaction control test - Hilf density ratio and Hilf moisture variation (rapid method)
- 1289.5.8.1 Soil compaction and density tests - Determination of field density and field moisture content of a soil using a nuclear surface moisture density gauge
- 1289.6.7.3 Methods of testing soils for engineering purposes - Soil strength and consolidation tests - Determination of permeability of a soil - Constant head method using a flexible wall permeameter
- 1726 Geotechnical site investigations
- 2868 Classification of machinery for earthmoving, construction, surface mining and agricultural purposes
- 3798 Guidelines on earthworks for commercial and residential developments
- 4419 Soil for landscaping and garden use

4.3 Submittals

4.3.1 Prior to delivery and placement of fill material

Refer Section 3.3.1

4.3.2 Prior to subgrade preparation

The Contractor shall submit the following to the Superintendent for review and approval prior to subgrade preparation:

- Work method statement for the subgrade preparation, including testing, proof rolling and repair procedures (refer Appendix A).

4.3.3 Following completion of subgrade preparation

The Contractor shall submit the following to the Superintendent for review and approval following completion of subgrade preparation:

- As-built survey of the completed surface showing conforming layer thickness within the allowable tolerances
- CQC testing results/reports showing compliance with the requirements of this Specification
- Defect and repairs log, showing details of all defects identified and any repairs completed

4.4 Preparation

The Contractor shall prepare a work method statement for subgrade preparation outlining the preparation methodology and proposed construction plant to be used (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and comment prior to placement.

The work method statement and construction methodology for the subgrade shall be developed in accordance with the guidance provided below:

- Where unsuitable material is found (refer Section 3.4.1), such material shall be removed to the extent directed by the Superintendent It should be noted that some remaining smelter refactory may be encountered in the subgrade that were left from previous works.
- Select fill (refer Section 3.4.2) shall be used to achieve the required lines and levels where the subgrade has been over-excavated or unsuitable material has been removed.
- Soil berms and undulations shall be graded out on site to provide a smooth and unyielding surface.
- Proof-rolling operations shall be carried out as necessary to determine the soundness and suitability of the prepared subgrade (refer Section 4.8).
- The surface shall be sealed (by smooth drum rolling) at the end of each day to minimise the penetration of water, with erosion protection measures provided and drainage systems (permanent and temporary) maintained.
- The Contractor shall match compaction methods to the material and location, with consideration of the following guidelines:
  - Rubber-tired rollers are preferable to prevent bridging of softer materials
  - Double smooth drum rolling may be used provided that careful inspection is undertaken to monitor and prevent bridging

  - Proof-rolling equipment should, in general, provide more compaction effort than backfill compaction equipment, to assure integrity
  - Hand compaction equipment such as impact rammers or plate or small drum vibrators should be used to sound material
- Any desiccations, cracks, or inconsistencies in the subgrade shall be remediated as directed by the Superintendent.

4.5 Compaction

All subgrade material shall be placed and compacted to the requirements of Section 3.12.

4.6 Construction quality control testing

The Contractor shall undertake CQC testing of the subgrade material in accordance with Section 3.13.

4.7 Tolerances

The completed subgrade shall be within the tolerances provided in Section 3.14.

4.8 Proof rolling

Proof rolling shall be used throughout preparation of the subgrade to assist in identifying soft spots and unsuitable material.

The prepared subgrade shall be proof rolled by a mechanical self-propelled smooth drum roller (or equivalent) in the presence of the Superintendent to assess the soundness and suitability of the subgrade.

Proof rolling shall be conducted upon the full width and length of the subgrade. A final proof roll shall be conducted over the finished surface prior to acceptance.

To show conformance with the requirements of the Specification, during final proof rolling of the prepared subgrade the surface shall not exhibit visible deformation, rutting, yielding and/or show signs of distress or instability.

4.9 Finished surface

The finished surface of the subgrade shall exhibit the following characteristics:

- The surface shall be smooth, flat, firm and unyielding to the satisfaction of the Superintendent.
- The surface shall not exhibit visible deformation, rutting, yielding and/or show signs of distress or instability during final proof rolling.
- The surface shall be free of debris, roots, angular material (such as sharp rocks), desiccation cracks, abrupt breaks, indentations, sudden changes in grade, defects and/or imperfections that may result in damage to the overlying materials.
- No loose, coarse-grained material shall remain on the surface. If required, the surface shall be raked or graded to remove any material penetrating out of the surface.
- The surface shall promote drainage and excessive water shall not be allowed to pond on the surface.
- The surface shall not be pebbly, tracked, rutted or otherwise disturbed by the equipment deploying overlying materials or other traffic. Pockets, holes, or discontinuities shall be repaired.

- All construction stakes, hubs, or other items used for grade control shall be removed and any voids filled. Any unsuitable material shall be over-excavated to a depth of 100 mm and replaced with accepted material.
- The surface shall be maintained at sufficient moisture content to prevent desiccation during the Works.

4.10 Defects and repairs

Any areas of prepared subgrade that does not conform to the required compaction and moisture content testing criteria shall be repaired by the Contractor in accordance with Section 3.17. This includes non-conformances resulting from independent testing commissioned by the Superintendent or CQA Engineer.

The Contractor shall submit to the Superintendent for review a log containing details of any defects identified and repairs carried out.

4.11 Acceptance

The Contractor shall retain ownership and responsibility for the subgrade until Practical Completion is obtained.

The subgrade shall be accepted by the Superintendent when all of the following conditions are met:

- Required submittals are provided by the Contractor to the Superintendent and approved.
- The Contractor has submitted the required as-built surveys of the completed subgrade showing conformance with the Contract Drawings within the allowable tolerances, and this has been approved by the Superintendent.
- CQC test results showing compliance with the requirements of this Specification have been provided by the Contractor to the Superintendent and approved.
- Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved.
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met.
- The Superintendent has inspected and approved the finished surface/s.

5. Clay rich fill

5.1 General

This section contains the technical requirements for the clay rich fill. The relevant requirements for the clay rich fill in Section 3 shall be considered alongside guidance provided in this section.

The Superintendent may reject any component of the clay rich fill that do not meet or exceed the requirements of this section.

Any component of the clay rich fill rejected by the Superintendent shall be remediated at the expense of the Contractor.

5.2 Standards

5.2.1 Australian standards

Relevant Australian standards are as follows but not limited to:

- 1152 Specification for test sieves
- 1289 Methods of testing soils for engineering purposes
- 1289.2.1.1 Determination of the moisture content of a soil - oven drying method
- 1289.3.1.1 Soil classification tests - Calculation of the plasticity index of a soil
- 1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving
- 1289.3.6.3 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of fine analysis using a hydrometer
- 1289.3.8.1 Soil classification tests - Dispersion - Determination of emerson class number of a soil
- 1289.5.1.1 Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using standard compactive effort
- 1289.5.6.1 Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
- 1289.5.7.1 Soil compaction and density tests - Compaction control test - Hilf density ratio and Hilf moisture variation (rapid method)
- 1289.5.8.1 Soil compaction and density tests - Determination of field density and field moisture content of a soil using a nuclear surface moisture density gauge
- 1289.6.7.3 Methods of testing soils for engineering purposes - Soil strength and consolidation tests - Determination of permeability of a soil - Constant head method using a flexible wall permeameter
- 1726 Geotechnical site investigations
- 2868 Classification of machinery for earthmoving, construction, surface mining and agricultural purposes
- 3798 Guidelines on earthworks for commercial and residential developments
- 4419 Soil for landscaping and garden use

5.3 Submittals

5.3.1 Prior to placement of clay rich fill

The Contractor shall submit the following to the Superintendent for review and approval prior to placement of the clay rich fill:

- Survey of the underlying surface in accordance with Section 1.11.
- Work method statement for placement of the clay rich fill, including testing and repair procedures (refer Appendix A).
- Pre-qualification test results/reports demonstrating that the proposed material complies with the material property requirements of this section of the Specification (refer Section 5.4).
- Estimated quantity of material which is represented by the pre-qualification test results/reports.

5.3.2 Following placement of clay rich fill

The Contractor shall submit the following to the Superintendent for review and approval following placement of clay rich fill:

- As-built survey of the completed surface showing conforming layer thickness within the allowable tolerances
- CQC testing results/reports showing compliance with the requirements of this Specification
- Defect and repairs log, showing details of all defects identified and any repairs completed

5.4 Material

Clay rich fill shall:

- Be selectively sourced material from on-site
- Not contain any unsuitable materials identified in Section 3.4.1 unless accepted by the Superintendent
- Be well graded in accordance with AS 1726
- Comply with the acceptance criteria specified in Table 11-1

The Contractor shall supply pre-qualification testing results in accordance with the testing frequencies identified in Table 11-1 showing that the proposed material meets the requirements of this table. Samples taken shall be representative of the whole material source and shall be evenly distributed across the material source.

If required by the Superintendent, a sample of the material shall be provided (per source) and the Superintendent and/or CQA Engineer may undertake an inspection of the material source. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

Table 5-1 Acceptance criteria – clay rich fill

Property	Test method	Acceptance criteria	Minimum test frequency
Standard compaction	AS 1289.5.1.1	N/A	Greater of: 1 per 5,000 m^3 of material or 3 per source

Property	Test method	Acceptance criteria	Minimum test frequency
Moisture content	AS 1289.2.1.1	N/A	Greater of: 1 per 5,000 m^3 of material or 3 per source
Atterberg limits: - Plasticity index - Liquid limit	AS 1289.3.1.1, 3.2.1 & 3.3.1	 ≥ 10 ≤ 50	Greater of: 1 per 5,000 m^3 of material or 3 per source
Particle size distribution: - Passing 50 mm - Passing 19 mm - Passing 0.075 mm - Passing 0.002 mm	AS 1141.11,12,13 or AS 1289.3.6.1, 3.6.3	100% > 70% > 30% > 15%	Greater of: 1 per 5,000 m^3 of material or 3 per source

5.5 Preparation of receiving surface

Prior to placement of the clay rich fill, the receiving surface shall exhibit the following characteristics:

- The surface shall be smooth, flat, firm and unyielding to the satisfaction of the Superintendent.
- The surface shall not exhibit visible deformation, rutting, yielding and/or show signs of distress or instability during final proof rolling (if required).
- The surface shall be free of debris, roots, angular material (such as sharp rocks), desiccation cracks, abrupt breaks, indentations, sudden changes in grade, defects and/or imperfections that may result in damage to the overlying materials.
- No loose, coarse-grained material shall remain on the surface. If required, the surface shall be raked or graded to remove any material penetrating out of the surface.
- The surface shall promote drainage and excessive water shall not be allowed to pond on the surface.
- The surface shall not be pebbly, tracked, rutted or otherwise disturbed by the equipment deploying overlying materials or other traffic. Pockets, holes, or discontinuities shall be repaired.
- All construction stakes, hubs, or other items used for grade control shall be removed and any voids filled. Any unsuitable material shall be over-excavated to a depth of 100 mm and replaced with approved material.
- The surface shall be maintained at sufficient moisture content to prevent desiccation during the Works.

The receiving surface shall be surveyed as per the requirements of Section 1.11

Placement of the clay rich fill shall not proceed until the receiving surface has been inspected and approved by the Superintendent.

5.6 Installation

The Contractor shall prepare a work method statement for placement of the clay rich fill outlining the measures taken to moisture condition the clay rich fill prior to placement, placement methodology and proposed construction plant to be used (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and approval.

The work method statement and construction methodology for the clay rich fill shall be developed in accordance with the guidance provided below:

- The clay rich fill shall be moisture conditioned uniformly throughout the material prior to placement.
- If the clay rich fill requires significant moisture content adjustment, the Contractor shall use a moisture conditioning area to allow hydration or dehydration of material to meet moisture content requirements.
- Should the clay rich fill be too wet to permit proper compaction, all work on the portions of the clay rich fill affected shall be delayed until the material has dried to the required moisture content.
- Prior to placement, the clay rich fill shall be mixed and processed to ensure no clods greater than 50 mm diameter are present.
- The material shall be constructed with a maximum compacted thickness of 150 mm.
- The material shall be placed to the required compaction and moisture content using a sheepsfoot roller, with feet/pads that penetrate the full depth of the placed loose lift of clay rich fill.
- Prior to placement of the overlying lift, the surface of the underlying lift shall be scarified as necessary to allow sufficient bonding of the lifts and prevent a lateral zone of higher permeability to be formed.
- The surface of the clay rich fill lifts shall be maintained as necessary prior to placement of the overlying lifts or overlying materials to prevent any moisture variations outside the requirements of the Specification. The Contractor shall be required to rework areas which do not meet this requirement.
- The Contractor shall seal surfaces (by smooth drum rolling) at the end of each day to minimise the penetration of water, provide erosion protection measures and ensure drainage systems (permanent and temporary) are maintained.
- Should joints be required between adjacent lift layers or to tie-in to existing clay rich fill, the existing edge/face shall be trimmed back to remove any desiccated material such that the material exposed in the face complies with the Specification. The clay rich fill to be placed shall be benched into the existing face/edge such that no continuous alignment of the vertical joints occurs.

5.7 Compaction

All compacted clay rich fill shall be placed in compacted lifts not exceeding 150 mm at a moisture content of 0 to +3% of the optimum moisture content, to a minimum density ratio of 95% SDD. The Superintendent may modify these compaction and moisture content requirements based on the results of the material testing submitted prior to placement. Fill is to be placed to at least half of the width of the roller beyond the finished surface of the clay rich fill shown on the Contract Drawings, such that when it is trimmed back to the finished surface, all of the cut face is compacted.

5.8 Construction quality control testing

The Contractor shall undertake CQC testing of the compacted clay in accordance with Table 5-2 as a minimum. Sampling locations for testing shall be agreed with the Superintendent and CQA Engineer. Each compacted lift is required to be individually tested prior to the construction of subsequent lifts.

Table 5-2 Construction quality control testing – compacted clay

Property	Test method	Minimum test frequency
Moisture content	AS 1289.5.1.1 or AS 1289.5.7.1	Greater of: 3 per 500 m^3 or 3 per lift
Dry density	AS 1289.5.8.1 AS 1289.5.1.1 or AS 1289.5.7.1	Greater of: 3 per 500 m^3 or 3 per lift

5.9 Tolerances

The Contractor shall place the clay rich fill within the tolerances provided in Section 3.14.

5.10 Finished surface of clay rich fill

The finished surface of the clay rich fill shall exhibit the following characteristics:

- The surface shall be smooth, flat, firm and unyielding to the satisfaction of the Superintendent. The surface shall be proof rolled by the Contractor using a mechanical self-propelled smooth drum roller (or equivalent) in the presence of the Superintendent to assess the soundness and suitability of the finished surface. The surface shall not exhibit visible deformation, rutting, yielding and/or show signs of distress or instability during final proof rolling.
- The surface shall be free of debris, roots, angular material (such as sharp rocks), desiccation cracks and sudden changes in grade. If required, the surface shall be raked or graded to remove any material penetrating out of the surface greater than 10 mm.
- The surface shall promote drainage and excessive water shall not be allowed to pond on the surface.
- The surface shall not be rutted or otherwise disturbed by the equipment deploying overlying materials or other traffic.
- The surface shall be maintained at sufficient moisture content to prevent desiccation during the Works.
- Any voids resulting in the compacted clay due to extraction from tube samples (testing requirements) shall be filled with water, and then backfilled with sodium bentonite pellets, hand rammed into the void.

It is essential that the compacted clay not dry out after compaction otherwise severe desiccation can occur in which case shrinkage cracks will appear in the compacted clay and act as conduits for flow. At the discretion of the Superintendent, clay rich fill shall be removed and re-compacted after conditioning with additional moisture if shrinkage cracks appear prior to the placement of overlying material.

5.11 Defects and repairs

Any areas of placed clay rich fill that do not conform to the required compaction and moisture content testing criteria shall be repaired by the Contractor in accordance with Section 3.17 This includes non-conformances resulting from independent testing commissioned by the Superintendent or CQA Engineer.

The Contractor shall submit to the Superintendent for review details of any defects identified and repairs carried out.

5.12 Acceptance

The Contractor shall retain ownership and responsibility for the clay rich fill until Practical Completion is obtained.

The clay rich fill shall be accepted by the Superintendent when all of the following conditions are met:

- Required submittals are provided by the Contractor to the Superintendent and approved
- The Contractor has submitted the required as-built surveys of the completed clay rich fill showing conformance with the Contract Drawings within the allowable tolerances, and this has been approved by the Superintendent
- CQC test results showing compliance with the requirements of this Specification have been provided by the Contractor to the Superintendent and approved
- Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
- The Superintendent has inspected and approved the finished surface/s

6. Geonet drainage composite

6.1 General

This section contains the technical requirements for geonet drainage composite.

The Superintendent may reject any geonet drainage composite that does not meet or exceed the requirements of this section.

All geonet drainage composite rejected by the Superintendent shall be removed from the site at the Contractor's expense.

6.2 Standards

6.2.1 American Society for Testing and Materials Standards

Relevant American Society for Testing and Material (ASTM) standards are as follows:

- D1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique
- D1603 Standard Test Method for Carbon Black in Olefin Plastics
- D4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
- D4354 Standard Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing
- D4355 Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus
- D4439 Standard Terminology for Geosynthetics
- D4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity
- D4533 Standard Test Method for Trapezoid Tearing Strength of Geotextiles
- D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
- D4716 Standard Test Method for Determining the (In-Plane) Flow Rate Per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head
- D4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile
- D4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
- D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
- D5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
- D7005 Determining The Bond Strength (Ply-Adhesion) of Composites
- D7179 Standard Test Method for Determining Geonet Bearing Force

6.2.2 Geosynthetic Research Institute Standards

Relevant Geosynthetic Research Institute (GRI) standards are as follows:

- GC8 Standard Guide for Determination of the Allowable Flow Rate of a Drainage Composite

- GN2 and GC13 Standard Guide for Jointing and Attaching Geonets and Drainage Composites

6.3 Submittals

The Contractor shall be responsible for the submission of all submittals required for geonet drainage composite by this Specification.

6.3.1 Prior to delivery of geonet drainage composite to site

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of geonet drainage composite to site:

- Material properties of the proposed geonet drainage composite
- Manufacturer’s certificate of compliance stating conformance with the requirements of this Specification
- Manufacturer’s quality control and assurance procedures
- Manufacturer’s quality control and assurance test results
- Complete description of the manufacturer’s shipping, handling and storage procedures
- Manufacturer’s installation procedures and requirements
- Delivery, storage and handling log for all composite rolls to be used in the Works, including delivery dockets, roll number and identification, delivery inspection checklist, details of storage and handling and quality control and assurance certificates

6.3.2 Prior to installation of geonet drainage composite

The Contractor shall submit the following to the Superintendent for review and approval prior to installation of the geonet drainage composite:

- Work method statement for geonet drainage composite installation, including seaming and jointing, procedures for testing and repairing and other information that shall promote proper use
- Proposed panel placement drawing, showing the location and reference number of all panels, expected seams, connections and penetrations, and panel dimensions and layout and the order of panel installation
- Results of independent material conformance testing as provided by the CQA Engineer

6.3.3 Following installation of geonet drainage composite

The Contractor shall submit the following to the Superintendent for review and approval following installation of the geonet drainage composite:

- Panel placement and seaming log, providing details on date and time placed, date and time seamed, condition of receiving surface, weather conditions and precipitation events, quality assurance (QA) checks performed, and all other relevant information
- Finalised panel placement drawing showing the as-built location of all panels, seams, connections and penetrations
- Defect and repairs log, showing details of all defects identified and any repairs completed

6.4 Manufacturers Quality Control

The manufacturer shall follow a quality control program throughout the manufacturing of all geonet drainage composite approved by the Superintendent.

The frequency of sampling and testing shall be in accordance with Table 6-1.

The Superintendent may reject any geonet drainage composite rolls that have not been sampled and/or tested in accordance with this section.

All geonet drainage composite rolls rejected by the Superintendent shall be removed from the site at the Contractors expense.

6.5 Manufacturers Quality Assurance

The manufacturer shall follow a QA program throughout the manufacturing of all geonet drainage composite accepted by the Superintendent.

The frequency of sampling and testing shall be in accordance with ASTM D4354.

The Superintendent may reject any geonet drainage composite rolls that have not been sampled and/or tested in accordance with this section.

All geonet drainage composite rolls rejected by the Superintendent shall be removed from the site at the Contractors expense.

6.6 Material

All geonet drainage composite shall be new, first quality products manufactured for the Works.

The geotextile component shall be a non-woven, needle-punched, polypropylene geotextile heat bonded to the geonet during manufacture.

The resin shall be new, first quality, compounded polyethylene resin.

Geonet drainage composite shall meet or exceed the acceptance criteria specified in Table 6-1.

Table 6-1 Acceptance criteria – geonet drainage composite

Property (qualifier)	Test Method (ASTM) or AS.	Acceptance Criteria	Minimum Testing Frequency
Geotextile (before lamination)			
Mass per unit area (MARV)	D5261	270 g/m^2	every 10,000 m^2
Grab tensile strength (MARV)	D4632	900 N	every 10,000 m^2
Grab elongation (MARV)	D4632	50%	every 10,000 m^2
CBR puncture strength (MARV)	D6241	2,000 N	every 10,000 m^2
Trapezoidal tear strength (MARV)	D4533	350 N	every 10,000 m^2
Permittivity (MARV)	D4491	0.5 s^{-1}	every 50,000 m^2
Apparent opening size (MaxARV)	D4751	430 µm	every 50,000 m^2
UV stability (typical) [(3)]	D4355	50%	per formulation
Geonet (before lamination)			

[3] strength retained after 500 hours

Property (qualifier)	Test Method (ASTM) or AS.	Acceptance Criteria	Minimum Testing Frequency
Thickness at 200 kPa (min.)	D5199	8 mm	every 5,000 m^2
Density [(4)] (min.)	D1505 or D792	0.94 g/cm^3	every 5,000 m^2
Melt flow index (max.)	D1238	1.0 g/10 min	every 5,000 m^2
Carbon black content (range)	D4218 (5)	2.0 to 3.0%	every 5,000 m^2
Tensile strength (machine direction) (MARV)	D1682	7.5 kN/m	every 5,000 m^2
Transmissivity [(6)] (MARV)	D4716	1 x 10^{-3} m^2/s	every 50,000 m^2
Compressive strength (MARV)	D1621	460 kPa	every 10,000 m^2
Geonet drainage composite			
Configuration (top to bottom)		Geotextile - geonet - geotextile	
Ply adhesion (MARV)	D7005	90 N/m	every 5,000 m^2

6.7 Roll and Sample Identification

All geonet drainage composite rolls and samples shall be identified in accordance with ASTM D4873.

The Superintendent may reject any geonet drainage composite roll or sample that has not been identified in accordance with this section.

Any geonet drainage composite roll or sample rejected by the Superintendent shall be removed from the site at the Contractors expense.

6.8 Delivery, Storage and Handling

The delivery, storage and handling of all geonet drainage composite rolls and samples shall be undertaken in accordance with the manufacturer's instructions and ASTM D4873 as a minimum.

The Contractor shall inspect all geonet drainage composite rolls for defects and damage upon delivery.

The Superintendent may reject any geonet drainage composite roll or sample that has not been stored or handled in accordance with this section.

Any geonet drainage composite roll or sample rejected by the Superintendent shall be removed from the site at the Contractors expense.

6.9 Preparation of Surface to Receive Geonet Drainage Composite

The surface to receive the geonet drainage composite shall provide a dry, smooth, uniform surface that is free of defects or imperfections that may result in damage to the geonet drainage

[4] Base resin density without carbon black added

[5] Other methods such as D 1603 (tube furnace) or D 6370 (TGA) are acceptable if an appropriate correlation to D 4218 (muffle furnace) can be established.

[6] Hydraulic gradient (1 m/m), Confining stress (>230 kPa), Seating time (100 hours)

composite. The surface shall be free from abrupt breaks, sharp objects, or other foreign material that may inhibit placement of the geonet drainage composite.

All construction stakes, hubs, or other items used for grade control shall be removed and any void filled with processed material.

The surface shall not be pebbly, or tracked and rutted by equipment. Pockets, holes, or discontinuities shall be repaired. No loose, coarse-grained material shall remain on the surface.

Placement shall not proceed until the surface has been approved by the Superintendent.

6.10 Installation

The Contractor shall undertake installation in accordance with the manufacturer's instructions, the approved work method statement, GRI-GN2 and GRI-GC13, this Specification and the Contract Drawings. Any contradictions shall be clarified with the Superintendent.

The work method statement shall be developed based on the guidance provided below:

- Prior to incorporation into the works, each roll shall be inspected for damage and/or defects. If damage or defects are identified, the roll shall be inspected by the Superintendent and approved or rejected
- The protective wrapping on geonet drainage composite rolls shall be maintained at all times prior to installation
- The Contractor shall verify that the material is free from dust and dirt immediately prior to installation. Washing operations may be implemented at the discretion of the Superintendent
- Geonet drainage composite shall not be placed or seamed:
  - If moisture prevents proper subgrade preparation, panel placement or panel seaming
  - During precipitation, during periods of fog, or in the presence of excess moisture (e.g. dew, ponded water)
  - During periods of excessive winds (>30 km/h) or when gusting wind conditions interfere with handling operations
- Geonet drainage composite shall be protected from damage due to exposure to sunlight, dirt, dust and other hazards
- Equipment used shall not damage the geonet drainage composite by handling, trafficking, leakage of hydrocarbons, or by other means
- No vehicle shall be allowed to travel directly on the geonet drainage composite unless approved by the Superintendent. Prior to approval, the Contractor shall provide the Superintendent the following information:
  - Guidance from the manufacturer on suitable plant for trafficking for the proposed geonet drainage composite and confirmation that the Contractor shall only use this plant
  - Guidance from the manufacturer on suitable trafficking method for the proposed geonet drainage composite and confirmation that the Contractor shall only use this trafficking method
  - Certification from the manufacturer that the above trafficking method and plant shall not void the warranty for the proposed geonet drainage composite
- Geonet drainage composite shall not be allowed to 'bridge over' voids or low areas in the subgrade. The geonet drainage composite shall be placed to allow intimate contact with the subgrade or underlying geosynthetic

- Geonet drainage composite shall not be dragged across an unprepared surface. If the geonet drainage composite is dragged across an unprepared surface, it shall be inspected by the Superintendent and repaired or rejected if necessary
- Geonet drainage composite rolls shall be freely suspended during placement
- Where there is a geosynthetic layer below, the installation of the geonet drainage composite shall be undertaken in a manner so as not to damage the underlying layer
- Metallic ties shall not be used
- Geonet drainage composite shall not be welded to the geomembrane
- The machine direction of materials shall be placed parallel to the slope
- Strands of one layer shall not penetrate the channels of another layer
- The geotextiles above and below the geonet drainage composite shall be continuously inspected for broken needles remaining from needle-punching operations
- Sandbags or equivalent ballast shall be used as necessary to temporarily hold the geonet drainage composite in position under the foreseeable and reasonably expected wind conditions. Sandbag material shall be sufficiently close-knit to prevent soil fines from working through the bags and discharging on the geonet drainage composite
- After placement, the geonet drainage composite shall be free of irregular stressing, folds and wrinkles
- Contractor to address management of materials after placement and prior to placement to limit excessive exposure to construction plant, sun, wind and rain etc.
- The geonet drainage composite shall be covered after installation within a 10 day period

6.11 Defects and Repairs

All repairs shall be undertaken in accordance with the manufacturer's instructions and the approved work method statement. All repairs shall be verified by the Superintendent.

6.12 Acceptance

The Contractor shall retain all ownership and responsibility for all geonet drainage composite until final acceptance of all work under this Contract by the Superintendent.

Geonet drainage composite shall be accepted by the Superintendent when all of the following conditions are met:

- Installation is finished
- Adequacy of all field seams and repairs is verified by the Superintendent
- Required submittals are provided by the Contractor to the Superintendent and approved
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met

7. Sand drainage layer

7.1 General

This section contains the technical requirements for the sand drainage layer. The relevant requirements for the sand drainage layer in Section 3 shall be considered alongside guidance provided in this section.

The Superintendent may reject any component of the sand drainage layer that do not meet or exceed the requirements of this section.

Any component of the sand drainage layer rejected by the Superintendent shall be remediated at the expense of the Contractor.

7.2 Standards

7.2.1 Australian standards

Relevant Australian standards are as follows but not limited to:

- 1152 Specification for test sieves
- 1289 Methods of testing soils for engineering purposes
- 1289.2.1.1 Determination of the moisture content of a soil - oven drying method
- 1289.3.1.1 Soil classification tests - Calculation of the plasticity index of a soil
- 1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving
- 1289.3.6.3 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of fine analysis using a hydrometer
- 1289.3.8.1 Soil classification tests - Dispersion - Determination of emerson class number of a soil
- 1289.5.1.1 Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using standard compactive effort
- 1289.5.6.1 Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
- 1289.5.7.1 Soil compaction and density tests - Compaction control test - Hilf density ratio and Hilf moisture variation (rapid method)
- 1289.5.8.1 Soil compaction and density tests - Determination of field density and field moisture content of a soil using a nuclear surface moisture density gauge
- 1289.6.7.3 Methods of testing soils for engineering purposes - Soil strength and consolidation tests - Determination of permeability of a soil - Constant head method using a flexible wall permeameter
- 1726 Geotechnical site investigations
- 2868 Classification of machinery for earthmoving, construction, surface mining and agricultural purposes
- 3798 Guidelines on earthworks for commercial and residential developments
- 4419 Soil for landscaping and garden use

7.3 Submittals

7.3.1 Prior to delivery of sand drainage material to site

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of the sand drainage material to site (per material source):

- Confirm that there are no suitable material sources available on site
- Material source

- Certification that the material is VENM, ENM or material covered under the resource recovery excemption.
- Pre-qualification test results/reports demonstrating that the proposed material complies with the material property requirements of this section of the Specification (refer Section 7.4)
- Estimated quantity of material which is represented by the pre-qualification test results/reports

7.3.2 Prior to placement of sand drainage layer

The Contractor shall submit the following to the Superintendent for review and approval prior to placement of the sand drainage layer:

- Survey of the underlying surface in accordance with Section 1.11
- Work method statement for placement of the sand drainage layer, including repair procedures (refer Appendix A).

7.3.3 Following placement of sand drainage layer

The Contractor shall submit the following to the Superintendent for review and approval following placement of sand drainage layer:

- As-built survey of the completed surface showing conforming layer thickness within the allowable tolerances
- CQC testing results/reports showing compliance with the requirements of this Specification
- Defect and repairs log, showing details of all defects identified and any repairs completed.

7.4 Material

Sand drainage material shall:

- Be selectively sourced material from on-site or imported from an approved source. Imported material shall be classed as VENM or ENM or NSW EPA Resource Recovery Exemption
- Not contain any unsuitable materials identified in Section 3.4.1 unless approved by the Superintendent
- Be non-plastic, sound, durable and free-draining
- Be well graded in accordance with AS 1726
- Comply with the acceptance criteria specified in Table 7-1

The Contractor shall supply pre-qualification testing results in accordance with the testing frequencies identified in Table 7-1 showing that the proposed material meets the requirements of this table. Samples taken shall be representative of the whole material source and shall be evenly distributed across the material source.

If required by the Superintendent, a sample of the material shall be provided (per source) and the Superintendent and/or CQA Engineer may undertake an inspection of the material source. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

The Contractor shall confirm the source and parent geology of the sand fill material. Any sources with deleterious mineralogy shall be rejected as sand fill material. The Superintendent may conduct a mineralogical assessment of the sand sources at their discretion.

Table 7-1 Acceptance criteria – sand drainage material

Property	Test method	Acceptance criteria	Minimum testing frequency
Particle size distribution - Passing 4.75 mm - Passing 0.075 mm	AS 1141.11,12,13 or AS 1289.3.6.1, 3.6.3	 100% < 5%	1 per source
Sodium sulphate soundness	AS 1141.24	Maximum loss of 15%	1 per source
Constant head permeability	AS 1289.6.7.1	> 1 x 10^{-4} m/s	1 per source

7.5 Preparation of receiving surface

Prior to placement of the sand drainage layer, the underlying geosynthetic shall be free of:

- Any of debris, roots, angular material (such as sharp rocks), or loose, coarse-grained material on or immediately below the geosynthetic
- Excessive wrinkles preventing intimate contact between the underlying geosynthetics and/or foundation materials.

Placement of the sand drainage layer shall not proceed until the underlying geosynthetic has been inspected and approved by the Superintendent.

The Superintendent may reject any underlying geosynthetic or underlying foundation material which does not meet these requirements. Any geosynthetic rejected by the Superintendent shall be removed from the site at the expense of the Contractor. Any rejected foundation material shall be removed and/or remediated to the satisfaction of the Superintendent.

7.6 Installation

The Contractor shall prepare a work method statement for placement of the sand drainage layer outlining the placement methodology and proposed construction plant to be used (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and approval prior to placement.

The work method statement and construction methodology for the sand drainage layer shall be developed in accordance with the guidance provided below:

- The sand drainage layer shall be placed with a uniform particle size distribution to prevent concentration of fines. This can be achieved through conditioning of the material prior to placement

- The sand drainage layer shall be constructed in one lift with a minimum thickness of 300 mm. Plant shall not be allowed to traffic the underlying surface unless a minimum 300 mm thick sand drainage layer is present. Sand drainage layer shall be placed in areas without placed sand drainage material by unloading the material from a pad of previously placed sand drainage material
- The maximum allowable ground pressure for plant trafficking the minimum 300 mm thick sand drainage layer is 35 kPa
- Plant exceeding the allowable ground pressure requirements shall be allowed providing they work from elevated pads with a minimum thickness from the underlying surface of 1 m. These elevated pads shall be removed following completion of sand drainage material placement
- Sand drainage material shall be placed directly on the underlying geosynthetic rather than pushing in place to avoid the formation of excessive wrinkles or 'waves'
- Sand drainage material shall be placed carefully around any pipework to ensure the pipework has sufficient and uniform support
- No sand drainage material shall be placed in areas where the underlying geosynthetic is not in contact with the supporting subgrade
- Sand drainage material shall not be placed closer than 2 m from the edge of geosynthetic panels where seaming of additional geosynthetics to the edge is yet to be performed. Temporary access across such edges shall be subject to approval by the Superintendent.

7.7 Construction quality control testing

The Contractor shall undertake CQC testing of the sand drainage layer in accordance with Table 7-2 as a minimum and the relevant requirements of Section 3.13. Sampling locations for testing shall be agreed with the Superintendent and CQA Engineer.

Table 7-2 Construction quality control testing – sand drainage layer

Property	Test method	Minimum test frequency
Particle size distribution	AS 1141.3.1, AS 1141.11.1	1 per 1,000 m^3

7.8 Tolerances

The Contractor shall place the sand drainage layer within the tolerances provided in Section 3.14.

7.9 Defects and repairs

The Superintendent may direct the Contractor to remove a section of the sand drainage layer to inspect underlying materials for damage. The Contractor shall repair any damage that occurs to the underlying materials as a consequence of the placement of sand drainage layer in accordance with this Specification.

Any areas of placed sand drainage material that do not conform to the required CQC testing criteria shall be repaired by the Contractor to the satisfaction of the Superintendent. This includes non-conformances resulting from independent testing commissioned by the Superintendent or CQA Engineer.

The Contractor shall submit to the Superintendent for review details of any defects identified and repairs carried out.

7.10 Acceptance

The Contractor shall retain ownership and responsibility for the sand drainage layer until practical completion.

The sand drainage layer shall be accepted by the Superintendent when all of the following conditions are met:

- Required submittals are provided by the Contractor to the Superintendent and approved
- The Contractor has submitted the required as-built surveys of the completed sand drainage layer showing conformance with the Contract Drawings within the allowable tolerances, and this has been approved by the Superintendent
- CQC test results showing compliance with the requirements of this Specification have been provided by the Contractor to the Superintendent and approved
- Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met

8. Geosynthetic clay liner

8.1 General

This section contains the technical requirements for geosynthetic clay liner (GCL).

The Superintendent may reject any GCL that does not meet or exceed the requirements of this section.

Any GCL rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

8.2 Standards

8.2.1 Australian standards

Relevant Australian standards are as follows but not limited to:

- 1289 Methods of testing soils for engineering purposes
- 1289.3.6.2 Soil classification tests—Determination of the particle size distribution of a soil – Analysis by sieving in combination with hydrometer analysis (subsidiary method)
- 3706.1 Geotextiles - Methods of test - General requirements, sampling, conditioning, basic physical properties and statistical analysis
- 3706.4 Geotextiles - Methods of test - Determination of burst strength - California bearing ratio (CBR) - Plunger method

8.2.2 American Society for Testing and Materials standards

Relevant American Society for Testing and Material (ASTM) standards are as follows:

- D4354 Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing
- D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
- D5888 Standard Guide for Storage and Handling of Geosynthetic Clay Liners
- D5889 Standard Practice for Quality Control of Geosynthetic Clay Liners
- D6072 Standard Practice for Obtaining Samples of Geosynthetic Clay Liners
- D6102 Standard Guide for Installation of Geosynthetic Clay Liners
- D6495 Guide for Acceptance Testing Requirements for Geosynthetic Clay Liners

8.2.3 Geosynthetic Research Institute standards

Relevant Geosynthetic Research Institute (GRI) standards are as follows:

- GCL3 Specification for Test Methods, Required Properties, and Testing Frequencies of Geosynthetic Clay Liners

8.3 Submittals

8.3.1 Prior to selection of the geosynthetic clay liner manufacturer

The Contractor shall submit the following to the Superintendent for review and approval prior to selection of a GCL manufacturer (per manufacturer and product):

- Product manufacturer

- Product name
- Material data sheet showing the material properties of the proposed GCL
- A list documenting at least 40 completed facilities totalling a minimum of 200 hectares for which the manufacturer has manufactured GCL similar to this Specification. For each facility the following information shall be provided:
  - Name and purpose of the facility, its location and the date of installation
  - The name of the owner, the project manager, designer, fabricator (if any), and the installer
  - If requested, the name and telephone number of a reference contact at the facility who can discuss the project
  - The GCL type and total square metres of the installation surface
- Manufacturer's quality control and assurance procedures (including the geotextile components).

8.3.2 Prior to delivery of geosynthetic clay liner to site

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of GCL to site (per GCL product):

- Manufacturer's certificate of compliance stating conformance with the requirements of this Specification
- Manufacturer's quality control and assurance test results
- Certification that the GCL supplied for this work was manufactured as consecutive rolls from a single lot or from consecutive lots. If the GCL is not manufactured from consecutive lots, the manufacturer shall provide certification of quality and consistency of the product characteristics
- Statement on the origin of the bentonite, bentonite supplier's name and production plant, and bentonite brand name and type
- Copies of quality control certificates issued by the bentonite supplier to verify conformance with Table 8-1
- Manufacturer's certification (per 50 tonnes of product) that the bentonite form is natural sodium bentonite powder(7)
- Complete description of the manufacturer's shipping, handling and storage procedures
- Manufacturer's installation procedures and requirements
- Work method statement for GCL delivery, storage, handling and installation. This shall include seaming and jointing, procedures for testing and repairing, proposed handling equipment and restraining methods, and other information that shall promote proper use

8.3.3 Prior to installation of geosynthetic clay liner

The Contractor shall submit the following to the Superintendent for review and approval prior to installation of GCL:

[7] Bentonite powder consisting of > 80 wt% sodium as activated bentonite may be used with approval from the Superintendent. Approval shall be sought prior to construction and prior to selection of GCL manufacturer

- Delivery, storage and handling log for all GCL rolls to be used in the Works, including delivery dockets, roll number and identification, delivery inspection checklist, details of storage and handling
- Proposed panel placement drawing, showing the location and reference number of all panels and expected seams, connections and penetrations, panel dimensions and layout, and the order of panel installation
- Survey of the underlying surface in accordance with Section 1.11
- Results of independent material conformance testing as provided by the CQA Engineer.

8.3.4 Following installation of geosynthetic clay liner

The Contractor shall submit the following to the Superintendent for review and approval following installation of GCL:

- Panel placement and seaming log, providing details on panel number and associated roll number, date and time placed, date and time seamed, condition of receiving surface, weather conditions and precipitation events, QA checks performed, and all other relevant information
- Finalised panel placement drawing conforming to Hydro drawing standards showing the as-built location of all panels, seams, connections and penetrations
- Defect and repairs log, showing details of all defects identified and any repairs completed.

8.4 Manufacturer's quality control

The manufacturer shall follow a quality control program, approved by the Superintendent, throughout the manufacturing of all GCL for the Works.

Manufacturer's quality control submissions shall include:

- Date of manufacture
- Lot number, roll number, length and width
- Bentonite manufacturer quality control documentation for the particular lot of clay used in the production of the rolls delivered
- Geotextile manufacturer quality control documentation for the particular lots of geotextiles used in the production of the rolls delivered
- Cross-referencing list delineating the corresponding geotextile and bentonite lots for the materials used in the production of the rolls delivered
- Quality control program laboratory-certified reports
- The manufacturer's approved quality assurance stamp and the technician's signature.

The frequency of sampling and testing shall be in accordance with Table 8-1.

The Superintendent may reject any GCL rolls that have not been sampled and/or tested in accordance with this section.

All GCL rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

8.5 Manufacturer's quality assurance

The manufacturer shall follow a quality assurance program, approved by the Superintendent, throughout the manufacturing of all GCL for the Works.

The frequency of sampling and testing shall be in accordance with ASTM D4354.

The Superintendent may reject any GCL rolls that have not been sampled and/or tested in accordance with this section.

All GCL rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

8.6 Material

The GCL shall:

- Be new, first quality products manufactured for the Works
- Be a proprietary product comprising a layer of natural sodium bentonite powder [(8)] of uniform thickness and consistency, reinforced by stitch-bonding or needle-punching to fully integrate the cover and carrier geotextile/s and constrained by thermally locking
- Certified as needle-free by the manufacturer
- Comply with the acceptance criteria specified in Table 8-1.

The Contractor shall supply manufacturer's quality control and assurance testing results in accordance with the testing frequencies identified in Table 8-1 showing that the proposed material meets the requirements of this table. Samples taken shall be representative of the whole material source and shall be evenly distributed across the roll lots. In addition to this, manufacturer's certification (per 50 tonnes of product) that the bentonite form is natural sodium bentonite powder shall be provided for all the GCL rolls supplied.

If required by the Superintendent, a sample of the GCL shall be provided (per product) and the Superintendent and/or CQA Engineer may undertake an inspection of the manufacturer's facility. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

[8] Bentonite powder consisting of > 80 wt% sodium as activated bentonite may be used with approval from the Superintendent. Approval shall be sought prior to selection of GCL manufacturer

Table 8-1 Acceptance criteria – GCL

Property	Test method	Acceptance criteria	Minimum testing frequency
Bentonite clay			
Bentonite clay – particle size (min.)	AS 1289.3.6.2	80% passing 75 micron sieve (powdered)	every 50 tonnes
Bentonite clay – free swell index (min.)	ASTM D5890	24 mL/2g or $cm^3/2g$	every 50 tonnes
Bentonite clay – fluid loss (max.)	ASTM D5891	18 mL	every 50 tonnes
Bentonite clay – montmorillonite content (min.)	CSIRO x-ray diffraction	70%	every 50 tonnes
Bentonite clay – carbonate content (max.)	CSIRO x-ray diffraction	2 wt%	every 50 tonnes
Bentonite clay – cation exchange capacity (min.)	Methylene blue method	70 meq/100g or cmol/kg	every 50 tonnes
Geotextile			
Cover geotextile - mass (MARV) Non-woven	AS 3706.1	200 g/m^2	every 20,000 m^2
Carrier geotextile - mass (MARV) Non-woven AND woven	AS 3706.1	200/100 g/m^2	every 20,000 m^2
Durability of geotextile and reinforcing yarns (min.) [9]	Section 5.6.2 of GRI-GCL3	65%	yearly
Geosynthetic clay liner			
GCL mass per unit area @ 0% moisture (MARV) [10]	ASTM D5993	4,000 g/m^2	every 4,000 m^2
Bentonite clay mass per unit area @ 0% moisture (MARV) [4]	ASTM D5993	3,700 g/m^2	every 4,000 m^2
Bentonite clay moisture content (max.)	ASTM D5993	15%	every 4,000 m^2
California bearing ratio (CBR) burst strength (MARV)	AS 3706.4	1,500 N	every 5,000 m^2
Strip tensile strength (MARV) Machine direction	ASTM D6768	10 kN/m	every 20,000 m^2
Peel strength (MARV)	ASTM D6496	600 N/m [11]	every 4,000 m^2
Hydraulic conductivity (max.)	ASTM D5887	5×10^{-11} m/s	every 25,000 m^2

8.7 Roll and sample identification

All GCL rolls and samples shall be identified in accordance with ASTM D4873.

Each roll or panel shall carry a label which identifies, as a minimum:

- Product name, grade and name of manufacturer
- Date of manufacture, batch number
- Roll number
- Roll length
- Roll weight

[9] Value represents the minimum percent strength retained from the as-manufactured value after oven aging at 60°C for 50 days

[10] Mass of the GCL and bentonite clay shall be measured after oven drying per the stated test method

[11] Peel strength of 360 N/m may be accepted for GCL for the base of the cell only.

- Roll width
- Handling guidelines
- Reference numbers to raw material batch and laboratory certified reports
- The manufacturer's approved quality assurance stamp and the technician's signature

The Superintendent may reject any GCL rolls or samples that have not been identified in accordance with this section.

All GCL rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

8.8 Delivery, storage and handling

The Contractor shall prepare a work method statement for delivery, storage, handling and installation of GCL, including repair methods (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and approval prior to delivery of the GCL to site.

The delivery, storage and handling components of the work method statement shall be developed in accordance with the guidance provided below:

- Delivery, storage and handling of all GCL rolls and samples shall be undertaken in accordance with the manufacturer's instructions and ASTM D5888 as a minimum.
- The Contractor shall inspect all GCL rolls for defects and damage upon delivery.
- Rolls shall be delivered to site, handled and stored in such a manner that no damage occurs to the rolls.
- Rolls shall be wrapped with weather and moisture-proof wrapping to prevent any contact with water prior to installation. In the event that it is suspected that roll/s may have come into contact with water, the Superintendent shall inspect the moisture content of the bentonite of the effected roll/s and reject the roll/s if they are damaged beyond use. All GCL rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.
- Roll cores shall be sufficiently strong to ensure that they do not deflect by more than half their diameter during delivery, storage and handling.
- Rolls shall be stored in a location away from construction traffic but sufficiently close to the installation area to minimise handling. The storage area shall be level, dry, well-drained and stable, and shall protect the product from precipitation, chemicals, excessive heat, UV radiation, standing water, vandalism and animals.
- GCL roll stacks shall be limited to the height at which installation personnel can safely manoeuvre the handling equipment. The recommended maximum stack height is three rolls.
- Rolls shall be handled using a spreader stinger bar. The bar shall be capable of supporting the full weight of the rolls without significant bending. Under no circumstances shall the rolls be dragged, lifted from one end, lifted in the middle of the roll, lifted with the forks of a forklift or pushed to the ground from the delivery vehicle. The Contractor may nominate alternate handling equipment and plant for approval by the Superintendent as part of their work method statement.

The Superintendent may reject any GCL rolls that have not been delivered, stored or handled in accordance with this section.

All GCL rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

8.9 Preparation of receiving surface

Prior to placement of GCL, the receiving surface shall exhibit the following characteristics:

- The surface shall be smooth, flat, firm and unyielding to the satisfaction of the Superintendent
- The surface shall not exhibit visible deformation, rutting, yielding and/or show signs of distress or instability during final proof rolling (if required)
- The surface shall be free of debris, roots, angular material (such as sharp rocks), desiccation cracks, abrupt breaks, indentations, sudden changes in grade, defects and/or imperfections that may result in damage to the overlying materials
- No loose, coarse-grained material shall remain on the surface. If required, the surface shall be raked or graded to remove any material penetrating out of the surface greater than 10 mm
- The surface shall promote drainage and excessive water shall not be allowed to pond on the surface
- The surface shall not be pebbly, tracked, rutted or otherwise disturbed by the equipment deploying overlying materials or other traffic. Pockets, holes, or discontinuities shall be repaired
- All construction stakes, hubs, or other items used for grade control shall be removed and any voids filled. Any unsuitable material shall be over-excavated to a depth of 100 mm and replaced with approved material
- The surface shall be maintained at sufficient moisture content to prevent desiccation during the Works.

The receiving surface shall be surveyed as per the requirements of Section 1.11.

Placement of GCL shall not proceed until the receiving surface has been inspected and approved by the Superintendent.

8.10 Installation

8.10.1 General

The Contractor shall prepare a work method statement for delivery, storage, handling and installation of GCL (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and approval prior to delivery of the GCL to site.

The installation component of the work method statement shall be developed in accordance with the guidance provided below.

The Superintendent may reject any GCL rolls that have not been installed in accordance with this section.

All GCL rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

8.10.2 Weather conditions

The Contractor shall consider the weather conditions on a daily basis to confirm they are suitable for placement of GCL.

GCL shall not be placed or seamed:

- If moisture prevents proper subgrade preparation, panel placement and/or panel seaming.
- During precipitation, during hail, during periods of excessive fog, in standing water, on excessively wet surfaces, in the presence of excess moisture (such as dew and/or ponded water) and/or under any other conditions which may cause premature hydration of the GCL.
- During periods of excessive winds (>30 km/h) or when gusting wind conditions interfere with handling operations.

8.10.3 Traffic

Equipment used shall not damage the GCL by handling, trafficking, leakage of hydrocarbons, or by other means.

No vehicle shall be allowed to traffic directly on the GCL unless approved by the Superintendent. Prior to approval, the Contractor shall provide the Superintendent the following information:

- Guidance from the manufacturer on suitable plant for trafficking for the proposed GCL and confirmation that the Contractor shall only use this plant
- Guidance from the manufacturer on suitable trafficking method for the proposed GCL and confirmation that the Contractor shall only use this trafficking method
- Certification from the manufacturer that the above trafficking method and plant shall not void the warranty for the proposed GCL

8.10.4 Placement

GCL shall be placed in accordance with the following:

- The GCL shall be placed and seamed in accordance with this Specification, the Contract Drawings, the approved work method statement, the manufacturer's instructions and ASTM D6102. Any contradictions shall be clarified with the Superintendent.
- Prior to placement, each roll shall be inspected by the Contractor for damage and/or defects. If damage or defects are identified, the roll shall be inspected by the Superintendent and approved or rejected.
- The protective wrapping on the rolls shall be maintained at all times prior to installation.
- GCL shall be protected at all times from damage due to exposure to sunlight, dirt, dust, moisture and other hazards.
- GCL shall be placed such that the panels are anchored at the crest of the slope and form a continuous layer down the side walls and slopes and across the base.
- The arrangement of the GCL panels shall be in accordance with the approved panel placement drawing and any changes approved by the Superintendent.
- Installation shall progress from the highest elevations to the lowest.
- GCL shall not be allowed to ‘bridge over’ voids or low areas. The GCL shall be placed to allow intimate contact with the subgrade or underlying geosynthetic.
- GCL shall be installed without undergoing excessive buckling, wrinkling or tensioning.

- GCL shall not be dragged across an unprepared surface. If the GCL is dragged across an unprepared surface, it shall be inspected by the Superintendent and/or CQA Engineer for defects and repaired or rejected if necessary.
- Where there is a geosynthetic layer below, the installation of the GCL shall be undertaken in a matter so as not to damage the underlying layer.
- Sandbags or equivalent ballast shall be used as necessary to temporarily hold the GCL in position and prevent uplift by wind. In case of high winds, continuous loading shall be placed along edges of panels to minimise wind flow under the panels. Sandbag material shall be sufficiently close-knit to prevent soil fines from working through the bags and discharging on the GCL.
- Care should be taken to avoid contaminating the upper surface of the GCL with bentonite powder from the within the GCL.
- GCL installed on slopes shall be fixed in anchor trenches as shown on the Contract Drawings and Section 3.15. GCL panels shall be anchored as soon as possible.
- Personnel working on the GCL shall not smoke, wear damaging shoes, excessively traffic or engage in other activities which may damage the GCL. GCL in heavy traffic areas shall be protected by a geosynthetic overlay.
- GCL rolls shall be freely suspended during placement.
- The method used to unroll the GCL shall not cause bridging or excessive wrinkles.
- After placement, the GCL shall be free of excessive buckles, wrinkles, ripples, creases, folds and irregular stressing before the overlying cover material or geosynthetic is placed.

8.10.5 Seaming

GCL shall be seamed in accordance with the following:

- All seams shall be overlapped and sealed with bentonite paste.
- All seams shall be 'shingled' down-slope to promote runoff (roof tile fashion).
- End seams shall be overlapped a minimum of 500 mm and side seams shall be overlapped a minimum of 300 mm.
- For batters with a 10% grade or steeper, transverse (cross-slope) seams shall be minimised. If required, transverse seams shall be overlapped a minimum of 1,500 mm. Transverse overlaps shall be immediately anchored.
- The overlap zone shall be kept clean and shall not be contaminated with loose soil or other debris. There shall be no folds or wrinkles in the overlap zone and no plant traffic or foot traffic shall occur over the finished overlap.
- Bentonite paste shall be applied continuously across the overlap zone at a rate of 400 grams per metre.
- Bentonite used for seaming shall comply with the relevant bentonite acceptance criteria in Table 8-1.
- Care shall be undertaken to avoid contaminating the upper surface of the GCL with bentonite paste.

8.11 Protection and covering

The GCL shall be protected from damage and premature hydration due to precipitation, wind and other environmental conditions.

Covering and confinement activities shall be coordinated to ensure the following:

- On a daily basis, only those areas of GCL which can be covered to within 3 m of all edges shall be installed. All edges which are not completely covered shall be protected with anchored tarpaulins.
- The overlying polyethylene geomembrane shall be placed immediately following placement and acceptance of the GCL panels.
- The overlying confinement layer (300 mm thick drainage aggregate on the base and 300 mm thick soil confinement layer on the sidewalls) shall be placed as soon as practicable, in accordance with the GCL manufacturer's instructions or as approved by the Superintendent. Notwithstanding these requirements, the overlying confinement layer shall be placed no longer than 2 weeks following GCL placement. The 300 mm thick drainage aggregate shall be installed in accordance with the approved work method statement (refer Section 11.6).
- No vehicle shall be allowed to traffic directly on the GCL during placement of the overlying confining layer unless approved by the Superintendent (refer Section 8.10.3). The overlying confinement layer shall not be pushed or graded in a direction that may cause damage to the GCL overlaps.

If the placed GCL panels have hydrated prematurely without confinement, then the effected GCL panels shall be removed and replaced by the Contractor at their own expense.

8.12 Pipe penetrations

The GCL shall be cut in a pie-shaped configuration at pipe penetrations.

A second GCL layer shall be installed over the first GCL, made using a new piece of GCL of the same material type and thickness with a minimum 500 mm overlap beyond the penetration area in each direction.

Bentonite paste shall be applied across the overlap zone around the penetration area at a rate of 400 grams per metre. Bentonite used for repairs shall comply with the relevant bentonite acceptance criteria in Table 8-1.

8.13 Defects and repairs

The Contractor shall be responsible for inspecting the placed GCL to identify any damage or faults in the material. The Superintendent and/or CQA Engineer may also undertake inspections of the placed GCL to identify any damage or faults in the material. Any areas of GCL damaged during installation shall be repaired in accordance with the manufacturer's instructions and the approved work method statement. All repairs shall be verified by the Superintendent.

Repairs shall be made using a new piece of GCL of the same material type and thickness with a minimum 500 mm overlap beyond the repair area in each direction.

Bentonite paste shall be applied across the overlap zone around the repair area at a rate of 400 grams per metre. Bentonite used for repairs shall comply with the relevant bentonite acceptance criteria in Table 8-1.

The Contractor shall submit to the Superintendent for review a log containing details of any defects identified and repairs carried out.

8.14 Acceptance

The Contractor shall retain all ownership and responsibility for all GCL until practical completion.

The GCL shall be accepted by the Superintendent when all of the following conditions are met:

- Required submittals are provided by the Contractor to the Superintendent and approved
- Adequacy of all field seams, penetrations and repairs is verified by the Superintendent
- Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
- The Superintendent has inspected and approved the finished surface/s.

9. PE geomembrane

9.1 General

This section contains the technical requirements for all polyethylene (PE) products including HDPE and LLPDE.

The Superintendent may reject any PE geomembrane that does not meet or exceed the requirements of this section.

Any PE geomembrane rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

9.2 Standards

9.2.1 American Society for Testing and Materials Standards

Relevant American Society for Testing and Material (ASTM) standards are as follows:

- D792 Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D1004 Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
- D1204 Standard Test Method for Linear Dimensional Changes of Non-rigid Thermoplastic Sheeting or Film at Elevated Temperature
- D1238 Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
- D1505 Standard Test Method for Density of Plastics by the Density Gradient Technique
- D1603 Standard Test Method for Carbon Black in Olefin Plastics
- D3895 Standard Test Method for Oxidative-Induction Time of Polyolefins by Differential Scanning Calorimetry
- D4218 Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique
- D4354 Standard Practice for Sampling of Geosynthetics and Rolled Erosion Control Products(RECPs) for Testing
- D4437 Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
- D4439 Standard Terminology for Geosynthetics
- D4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
- D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
- D5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
- D5397 Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test
- D5596 Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics
- D5641 Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber

- D5721 Standard Practice for Air-Oven Aging of Polyolefin Geomembranes
- D5820 Standard Practice for Pressurized Air Channel Evaluation of Dual Seamed Geomembranes
- D5885 Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High Pressure Differential Scanning Calorimetry
- D5994 Standard Test Method for Measuring the Core Thickness of Textured Geomembranes
- D6370 Standard Test Method for Rubber-Compositional Analysis by Thermogravimetry (TGA)
- D6392 Standard Test Method for Determining the Integrity of Non-Reinforced Geomembrane Seams Produced Using Thermo-Fusion Methods
- D6395 Standard Practice for Non-destructive testing of Geomembrane Seams using Spark Test
- D6693 Standard Test Method for Determining Tensile Properties of Non-Reinforced Polyethylene and Non-Reinforced Flexible Polypropylene Geomembranes
- D7238 Test Method for Effect of Exposure of Unreinforced Polyolefin Geomembrane Using Fluorescent UV Condensation Apparatus
- D7466 Standard Test Method for Measuring Asperity Height of Textured Geomembranes

9.2.2 Geosynthetic Research Institute Standards

Relevant Geosynthetic Research Institute (GRI) standards are as follows:

- GM9 Standard Practice for Cold Weather Seaming of Geomembranes
- GM10 Specification for the Stress Crack Resistance of Geomembrane Sheet
- GM13 Standard Specification for Test Methods, Test Properties, and Testing Frequency for High Density Polyethylene (HDPE) Smooth and Textured Geomembranes
- GM14 Standard Guide for Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes
- GM17 Standard Specification for Test Methods, Test Properties, and Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes
- GM19 Standard Specification for Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes
- GM20 Standard Guide for Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using Control Charts
- GM29 Standard Practice for Field Integrity Evaluation of Geomembrane Seams (and Sheet) Using Destructive and/or Non-destructive Testing

9.3 Submittals

9.3.1 Prior to selection of the polyethylene geomembrane manufacturer

The Contractor shall submit the following to the Superintendent for review and approval prior to selection of a PE geomembrane manufacturer (per manufacturer and product):

- Product manufacturer
- Product name

- Material data sheet showing the material properties of the proposed PE geomembrane
- A list documenting no less than 40 completed facilities totalling a minimum of 200 hectares for which the manufacturer has manufactured PE geomembrane similar to this Specification. For each facility the following information shall be provided:
  - Name and purpose of the facility
  - The location and date of installation
  - The name of the owner, the project manager, designer, fabricator (if any), and the installer
  - If requested, the name and telephone number of the contact at the facility who can discuss the project
  - The PE geomembrane type, thickness, and total square metres of the installation surface
- Documentation indicating that the polymer supplier has previously produced a minimum of 1,000 tonne of polymer of the same composition as that proposed for use in the manufacture of the PE geomembrane for the Works
- Manufacturer's quality control and assurance procedures

9.3.2 Prior to delivery of polyethylene geomembrane to site

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of PE geomembrane to site (per PE geomembrane product):

- Manufacturer's certificate of compliance outlining conformance with the requirements of this Specification
- Manufacturer's quality control and assurance test results
- Certification that the PE geomembrane supplied for this work was manufactured as consecutive rolls from a single lot or from consecutive lots. If the PE geomembrane is not manufactured from consecutive lots, the resin manufacturer shall provide certification of quality and consistency of the resin characteristics
- Statement on the origin of the resin, its identification (type and lot number), resin supplier's name and production plant, resin brand name and type, and the maximum amount of recycling polymer material added to the raw resin
- Copies of quality control certificates issued by the resin supplier which shall include testing conducted to verify conformance with Table 10-1
- Certifications that the PE geomembrane and extrudate produced for the Works have the same properties and are of the same resin
- Complete description of the manufacturer's shipping, handling and storage procedures
- Manufacturer's installation procedures and requirements
- Work method statement for PE geomembrane delivery, storage, handling and installation. This shall include seaming and jointing, welding, procedures for testing and repairing, proposed handling equipment and restraining methods, and other information that shall promote proper use

9.3.3 Prior to installation of polyethylene geomembrane

The Contractor shall submit the following to the Superintendent for review and approval prior to installation of the PE geomembrane:

- Delivery, storage and handling log for all PE geomembrane rolls to be used in the Works, including delivery dockets, roll number and identification, delivery inspection checklist, details of storage and handling.
- Proposed panel placement drawing, showing the location and reference number of all panels and expected seams, connections and penetrations, panel dimensions and layout, and the order of panel installation.
- Survey of the underlying surface in accordance with Section 1.11.
- Results of independent material conformance testing as provided by the CQA Engineer.

9.3.4 Following installation of polyethylene geomembrane

The Contractor shall submit the following to the Superintendent for review and approval following installation of the PE geomembrane:

- Panel placement log, providing details on panel number and associated roll number, date and time placed, condition of receiving surface, weather conditions and precipitation events, QA checks performed, and all other relevant information
- Trial weld log, recording all trial welds and testing undertaken
- Field welding log providing details of all field welding undertaken, including:
  - Weld type
  - Weld ID number
  - ID numbers of panels to be joined
  - Name of welder
  - Details of equipment used
  - Ambient air temperature
  - Time of day
  - Geomembrane surface temperature
  - Weld temperature
  - Any problems or issues arising during welding.
- Field sampling and testing results, including non-destructive and destructive tests
- Results of electrical leak location survey as provided by the CQA Engineer (refer Section 9.13)
- Finalised panel placement drawing showing the as-built location of all panels, seams, connections and penetrations
- Defects and repairs log, showing details of all defects identified and repairs completed

9.4 Manufacturer's quality control

The manufacturer shall follow a quality control program, approved by the Superintendent, throughout the manufacturing of all PE geomembrane for the Works.

Manufacturer's quality control submissions shall include:

- Date of manufacture

- Lot number, roll number, length and width
- Manufacturer quality control documentation for the particular lot of resin used in the production of the rolls delivered
- Cross-referencing list delineating the corresponding resin used in the production of the rolls delivered
- Quality control program laboratory-certified reports
- The manufacturer's approved quality assurance stamp and the technician's signature

The frequency of sampling and testing shall be in accordance with Table 10-1.

The Superintendent may reject any PE geomembrane rolls that have not been sampled and/or tested in accordance with this section.

All PE geomembrane rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

9.5 Manufacturer's quality assurance

The manufacturer shall follow a quality assurance program, approved by the Superintendent, throughout the manufacturing of all PE geomembrane for the Works.

The frequency of sampling and testing shall be in accordance with ASTM D4354.

The Superintendent may reject any PE geomembrane rolls that have not been sampled and/or tested in accordance with this section.

All PE geomembrane rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

9.6 Material

The PE geomembrane shall:

- Be manufactured of new, first-quality resin and shall be compounded and continuously manufactured specifically for the Works. The resin manufacturer shall certify each batch for the acceptance criteria listed in Table 9-1
- Comply with the acceptance criteria specified in Table 9-1
- Not contain more than 1 percent non-volatile pigment or fillers other than carbon black
- Not be factory seamed

The Contractor shall supply manufacturer's quality control and assurance testing results in accordance with the testing frequencies identified in Table 9-1 showing that the proposed material meets the requirements of this table. Samples taken shall be representative of the whole material source and shall be evenly distributed across the roll lots.

If required by the Superintendent, a sample of the PE geomembrane shall be provided (per product) and the Superintendent and/or CQA Engineer may undertake an inspection of the manufacturer's facility. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

Table 9-1 Acceptance criteria – PE geomembrane

Property	Test method	Acceptance criteria			Minimum testing frequency
		Base and sidewall liner Pond liner	Cap geomembrane	Sacrificial geomembrane	
		2 mm HDPE (double side textured)	2 mm LLDPE double side textured)	1 mm LLDPE (Smooth)	
Resin (12)					
Density (HDPE min., LLDPE max.)	ASTM D1505 or D792 (method B)	0.932 g/cm^3	0.926 g/cm^3	0.926 g/cm^3	per resin lot
Melt index (maximum) (13)	ASTM D1238	1.0 g/10 min	1.0 g/10 min	1.0 g/10 min	per resin lot
Sheet					
Thickness (min. average)	ASTM D5199 (smooth) ASTM D5994 (textured)	1.9 mm	1.9 mm	1.0 mm	every roll
Thickness (min.) - Lowest individual of 10 readings - Lowest individual of 10 readings	ASTM D5199 (smooth) ASTM D5994 (textured)	- 1.8 mm	- 1.7 mm	0.9 mm -	every roll
Asperity height (min. average) (14) (15)	ASTM D7466	0.45 mm	0.25 mm	-	every 2nd roll
Density (HDPE min., LLDPE max.)	ASTM D1505 or D792 (method B)	0.94 g/cm^3	0.939 g/cm^3	0.939 g/cm^3	90,000 kg
Tensile properties (min. average) (16) - yield strength - break strength - yield elongation - break elongation	ASTM D6693	31 N/mm 27 N/mm 13% 200%	- 21 N/mm - 250%	- 27 N/mm - 800%	9,000 kg
2% modulus (max.)	ASTM D5323	-	840 N/mm	420 N/mm	per each formulation
Tear resistance (min. average)	ASTM D1004	266 N	200 N	100 N	20,000 kg
Puncture resistance (min. average)	ASTM D4833	711 N	400 N	250 N	20,000 kg
Multi-axial break resistance	ASTM D5617	15%	-	-	per each formulation

[12] Base resin density without carbon black or additives added

[13] Conducted at 190 °C with 2.16 kg mass applied

[14] Alternate the measurement side for double sided textured sheet

[15] Of 10 readings; 8 out of 10 must be $\geq$ 0.29 mm, and lowest individual reading must be $\geq$ 0.21 mm

[16] Machine direction (MD) and cross machine direction (XMD) average values should be on the basis of five test specimens each direction:

- HDPE yield elongation is calculated using a gauge length of 33 mm
- HDPE break elongation is calculated using a gauge length of 50 mm
- LLDPE break elongation is calculated using a gauge length of 50 mm at 50 mm/min

Property	Test method	Acceptance criteria			Minimum testing frequency
		Base and sidewall liner Pond liner	Cap geomembrane	Sacrificial geomembrane	
		2 mm HDPE (double side textured)	2 mm LLDPE double side textured)	1 mm LLDPE (Smooth)	
Notched Constant tensile load [17]	ASTM D5397	1000 hours	-	-	90,000 kg
Axi-symmetric break resistance (min.)	ASTM D5617	-	30%	30%	per each formulation
Dimensional stability	ASTM D1204	±2%	±2%	±2%	90,000 kg
Carbon black content (range)	ASTM D4218 [18]	2 to 3%	2 to 3%	2 to 3%	9,000 kg (HDPE) or 20,000 kg (LLDPE)
Carbon black dispersion (category) [19]	ASTM D5596	Note 19	Note 19	Note 19	20,000 kg
Oxidative induction time (OIT) (min. average) [20] - standard OIT AND - high pressure OIT	ASTM D3895 ASTM D5885	>160 min >800 min	100 min 400 min	100 min 400 min	90,000 kg
Oven aging at 85°C (min. average) - standard OIT AND - high pressure OIT	ASTM D5721 ASTM D3895 ASTM D5885	- 80% retained at 90 days	35% retained at 90 days 60% retained at 90 days	35% retained at 90 days 60% retained at 90 days	per each formulation
UV resistance (min. average) [21] - high pressure OIT [22]	ASTM D7238 ASTM D5885	80% retained after 1600 hours	35% retained after 1600 hours	35% retained after 1600 hours	per each formulation

[17] The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation as being used for the textured sheet materials. The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing

[18] Other methods such as ASTM D1603 (tube furnace) or ASTM D6370 (TGA) are acceptable if an appropriate correlation to ASTM D4218 (muffle furnace) can be established

[19] Dispersion only applies to near spherical agglomerates. 9 of 10 views shall be Category 1 or 2. No more than 1 view from Category 3.

[20] Samples to be evaluated at 30 and 60 days to compare with the 90 day response

[21] The condition of the test should be 20 hour UV cycle at 75 °C followed by 4 hour condensation at 60 °C

[22] UV resistance is based on percent retained value regardless of the original high pressure OIT value

9.7 Roll and sample identification

All PE geomembrane rolls and samples shall be identified in accordance with ASTM D4873.

Each roll or panel shall carry a label which identifies, as a minimum:

- Product name, grade and name of manufacturer
- Date of manufacture, batch number
- Material thickness
- Roll number
- Roll length
- Roll weight
- Roll width
- Handling guidelines
- Reference numbers to raw material batch and laboratory certified reports
- The manufacturer's approved quality assurance stamp and the technician's signature

The Superintendent may reject any PE geomembrane rolls or samples that have not been identified in accordance with this section.

All PE geomembrane rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

9.8 Delivery, storage and handling

The Contractor shall prepare a work method statement for delivery, storage, handling and installation of PE geomembrane, including repair methods (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and comment prior to delivery of the PE geomembrane to site.

The delivery, storage and handling components of the work method statement shall be developed in accordance with the guidance provided below:

- Delivery, storage and handling of all PE geomembrane rolls and samples shall be undertaken in accordance with the manufacturer's instructions and ASTM D4873 as a minimum.
- Rolls shall be delivered to site, handled and stored in such a manner that no damage occurs to the rolls.
- Roll cores shall be sufficiently strong to ensure that they do not deflect by more than half their diameter during delivery, storage and handling.
- Rolls shall be stored in a location away from construction traffic but sufficiently close to the installation area to minimise handling. The storage area shall be level, dry, well-drained and stable, and shall protect the product from precipitation, chemicals, excessive heat, UV radiation, standing water, vandalism and animals.
- PE geomembrane roll stacks shall be limited to the height at which installation personnel can safely manoeuvre the handling equipment. The recommended maximum stack height is three rolls.

- Rolls shall be handled using a spreader stinger bar. The bar shall be capable of supporting the full weight of the rolls without significant bending. Under no circumstances shall the rolls be dragged, lifted from one end, lifted in the middle of the roll, lifted with the forks of a forklift or pushed to the ground from the delivery vehicle. The Contractor may nominate alternate handling equipment and plant for approval by the Superintendent as part of their work method statement.
- The Contractor shall inspect all PE geomembrane rolls for defects and damage upon delivery.

The Superintendent may reject any PE geomembrane rolls that have not been delivered, stored or handled in accordance with this section.

All PE geomembrane rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

9.9 Preparation of receiving surface

9.9.1 For soil receiving surface

Prior to placement of PE geomembrane, the receiving surface shall exhibit the following characteristics:

- The surface shall be smooth, flat, firm and unyielding to the satisfaction of the Superintendent.
- The surface shall not exhibit visible deformation, rutting, yielding and/or show signs of distress or instability during final proof rolling (if required).
- The surface shall be free of debris, roots, angular material (such as sharp rocks), desiccation cracks, abrupt breaks, indentations, sudden changes in grade, defects and/or imperfections that may result in damage to the overlying materials.
- No loose, coarse-grained material shall remain on the surface. If required, the surface shall be raked or graded to remove any material penetrating out of the surface greater than 10 mm.
- The surface shall promote drainage and excessive water shall not be allowed to pond on the surface.
- The surface shall not be pebbly, tracked, rutted or otherwise disturbed by the equipment deploying overlying materials or other traffic. Pockets, holes, or discontinuities shall be repaired.
- All construction stakes, hubs, or other items used for grade control shall be removed and any voids filled. Any unsuitable material shall be over-excavated to a depth of 100 mm and replaced with approved material.
- The surface shall be maintained at sufficient moisture content to prevent desiccation during the Works.

The receiving surface shall be surveyed as per the requirements of Section 1.11.

Placement of PE geomembrane shall not proceed until the receiving surface has been inspected and approved by the Superintendent.

9.9.2 For geosynthetic receiving surface

Prior to placement of PE geomembrane, the underlying geosynthetic shall be free of:

- Any of debris, roots, angular material (such as sharp rocks), or loose, coarse-grained material on or immediately below the geosynthetic
- Excessive wrinkles preventing intimate contact between the geosynthetic and PE geomembrane
- Any GCL panels that have hydrated prematurely without confinement
- For GCL receiving surfaces, excessive bentonite powder and/or paste on the surface

The foundation material underlying the geosynthetic shall:

- Be smooth, flat, firm and unyielding to the satisfaction of the Superintendent
- Be free of abrupt breaks, indentations and/or sudden changes in grade
- Promote drainage and excessive water shall not be allowed to pond on the surface of the geosynthetic

Placement of PE geomembrane shall not proceed until the underlying geosynthetic has been inspected and approved by the Superintendent. The overlying PE geomembrane shall be placed immediately following acceptance of the geosynthetic panels to protect the underlying geosynthetic.

The Superintendent may reject any underlying geosynthetic or underlying foundation material which does not meet these requirements. Any geosynthetic rejected by the Superintendent shall be removed from the site at the expense of the Contractor. Any rejected foundation material shall be removed and/or remediated to the satisfaction of the Superintendent.

9.10 Installation

9.10.1 General

The Contractor shall prepare a work method statement for delivery, storage, handling and installation of PE geomembrane (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and comment prior to delivery of the PE geomembrane to site.

The installation component of the work method statement shall be developed in accordance with the guidance provided below.

The Superintendent may reject any PE geomembrane rolls that have not been installed in accordance with this section.

All PE geomembrane rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

9.10.2 Weather conditions

The Contractor shall consider the weather conditions on a daily basis to confirm they are suitable for placement of PE geomembrane.

PE geomembrane shall not be placed or seamed:

- If moisture prevents proper subgrade preparation, panel placement and/or panel seaming
- During precipitation, during hail, during periods of excessive fog, during periods of excessive dust, in standing water, on excessively wet surfaces, in the presence of excess moisture (such as dew and/or ponded water)

- During periods of excessive winds (>30 kph) or when gusting wind conditions interfere with handling operations
- When sheet temperatures are lower than 0° or higher than 65° as measured by a calibrated infrared thermometer or surface thermocouple

9.10.3 Traffic

Equipment used shall not damage the PE geomembrane by handling, trafficking, leakage of hydrocarbons, or by other means.

No vehicle shall be allowed to travel directly on the PE geomembrane unless approved by the Superintendent. Prior to approval, the Contractor shall provide the Superintendent the following information:

- Guidance from the manufacturer on suitable plant for trafficking for the proposed PE geomembrane and confirmation that the Contractor shall only use this plant
- Guidance from the manufacturer on suitable trafficking method for the proposed PE geomembrane and confirmation that the Contractor shall only use this trafficking method
- Certification from the manufacturer that the above trafficking method and plant shall not void the warranty for the proposed PE geomembrane

9.10.4 Placement

PE geomembrane shall be placed in accordance with the following:

- The PE geomembrane shall be placed and seamed in accordance with this Specification, the Contract Drawings, the approved work method statement and the manufacturer's instructions. Any contradictions shall be clarified with the Superintendent.
- Prior to placement, each roll shall be inspected by the Contractor for damage and/or defects, including tears, abrasion, indentation, cracks, thin spots or any other faults or defects. If damage or defects are identified, the roll shall be inspected by the Superintendent and approved or rejected.
- PE geomembrane shall be protected from damage due to exposure to sunlight, dirt, dust and other hazards.
- PE geomembrane shall be placed such that the panels are anchored at the crest of the slope and form a continuous layer down the side walls and slopes and across the base.
- The arrangement of the PE geomembrane panels shall be in accordance with the approved panel placement drawing and any changes approved by the Superintendent.
- Installation shall progress from the highest elevations to the lowest.
- PE geomembrane rolls shall be placed in an orderly fashion which shall minimise or prevent surface water from flowing below previously installed PE geomembrane.
- PE geomembrane shall not be allowed to ‘bridge over’ voids or low areas. The PE geomembrane shall be placed to allow intimate contact with the subgrade or underlying geosynthetic.
- PE geomembrane shall be installed without undergoing excessive buckling, wrinkling or tensioning.
- PE geomembrane shall not be dragged across an unprepared surface. If the PE geomembrane is dragged across an unprepared surface, it shall be inspected for defects and repaired or rejected if necessary.

- Where there is a geosynthetic layer below, the installation of the PE geomembrane shall be undertaken in a matter so as not to damage the underlying layer.
- Sandbags or equivalent ballast shall be used as necessary to temporarily hold the PE geomembrane in position and prevent uplift by wind. In case of high winds, continuous loading shall be placed along edges of panels to minimise wind flow under the panels. Sandbag material shall be sufficiently close-knit to prevent soil fines from working through the bags and discharging on the PE geomembrane.
- Only those PE geomembrane rolls which can be seamed or permanently anchored on at least two sides on the same day shall be placed on a daily basis. All other sides shall be temporarily anchored.
- PE geomembrane installed on slopes shall be fixed in anchor trenches as shown on the Contract Drawings and Section 3.15. PE geomembrane panels shall be anchored as soon as possible. The Geosynthetic Installer shall program anchor trenches backfilling when the temperature is coolest to minimise effects of material expansion.
- Personnel working on the PE geomembrane shall not smoke, wear damaging shoes, excessively traffic or engage in other activities which may damage the PE geomembrane. PE geomembrane in heavy traffic areas shall be protected by a geosynthetic overlay.
- PE geomembrane shall be cut from each roll with an approved hook blade knife with flat zones on each end.
- PE geomembrane rolls shall be freely suspended during placement.
- The method used to unroll the PE geomembrane shall not cause bridging, excessive wrinkles, scores, scratches and/or crimps.
- Folds and wrinkles caused by PE geomembrane panel placement or thermal expansion shall be minimised.
- After placement, the PE geomembrane shall be free of excessive buckles, wrinkles, ripples, creases, folds and irregular stressing before the overlying cover material or geosynthetic is placed.

9.10.5 Seaming

PE geomembrane shall be seamed in accordance with the following guidance.

General

- The PE geomembrane shall be field seamed into a continuous sheet across the Works by using either dual hot wedge fusion welding or extrusion welding seams.
- Dual hot wedge fusion welding shall be the preferred method of welding and shall be used for primary welds between adjacent PE geomembrane panels. Extrusion welding shall only be used for detailed work, repair work, or in areas inaccessible for dual hot wedge fusion welding (where approved by the Superintendent).
- PE geomembrane placement shall be limited to that which can be seamed in one day.
- Trial seams shall be completed each day as per Section 9.11.
- All seams shall be ‘shingled’ down-slope to promote runoff (roof tile fashion).
- All field seaming operations shall be supervised by the Seaming Foreman and no field seams shall be made without the Seaming Foreman present.

- Prior to welding, the prepared weld surfaces shall be free of dust, dirt, debris, markings foreign material and any other potential contaminants that would inhibit welding. Where contamination does occur, the prepared surfaces shall be thoroughly cleaned and the weld completed.
- There shall be no free moisture in the weld area during welding. If free moisture is located in the weld area, mitigation measures during seaming shall be employed as approved by the Superintendent.
- The Geosynthetic Installer shall have an independently calibrated handheld temperature measuring device to confirm the temperatures of each and every welding machine prior to the commencement of any test or field welds. All information regarding the results gained from the temperature device shall be recorded for each welding machine.
- Any electric generators used in welding shall be placed on a smooth base such that no damage occurs to the underlying PE geomembrane.
- Adjacent to anchor trenches, seaming shall extend up the panels a minimum of 300 mm past the crest of the anchor trench.

Weld locations

PE geomembrane panel placement shall take into consideration the site geometry including:

- Field seams shall be orientated parallel to the line of maximum slope.
- For batters with a 10% grade or steeper, transverse (cross-slope) seams shall not be permitted.
- No cross seams shall be allowed within 1,500 mm of the toe of any slope.
- In corners and odd shaped geometric locations, the number and total length of field seams shall be minimised.
- Seams shall not be located at low points.
- All cross seams shall be offset at least 600 mm from the cross seam of the adjacent panel and be extrusion or wedge welded where they intersect.
- All primary welds used to connect panel ends to sheets shall form T-joins (tees). These T-connections shall have a distance of at least 500 mm. The welding seams of the PE geomembrane cannot cross (no cruciform connections).

Dual hot wedge fusion welding

- The dual hot wedge fusion welding shall be conducted using the split head wedge fusion weld method, fusing the upper and lower overlapped PE geomembrane panels.
- The welding equipment shall be capable of continuously monitoring and controlling the temperature in the zone of contact where the machine is actually fusing the PE geomembrane so as to ensure that changes to environmental conditions shall not adversely affect the integrity of the weld.
- Seams shall have a finished overlap of a minimum of 150 mm for dual hot wedge fusion welding but in any event, sufficient overlap shall be provided to allow peel tests to be performed on the seam.
- The dual hot wedge fusion welding shall form two contact fusion areas of a minimum width of 15 mm and a 5 mm minimum wide void between each of the separate parallel weld zones.

Extrusion welding

- The extruder may be a combination sheet pre-heat and extruder type or a combination dynamic mixing assembly and extruder type.
- The extrudate shall be manufactured from the same resin type used in the manufacture of the relevant PE geomembrane being welded. All physical properties shall be identical to those possessed by the raw PE geomembrane material. The Geosynthetic Installer shall provide certification from the manufacturer that the relevant PE geomembrane and extrudate produced for the Works have the same properties and are of the same resin for each batch.
- During welding, the Geosynthetic Installer shall be responsible for regularly checking, calibrating and recording of:
  - Preheat air flow and temperature at the nozzle
  - Extrudate flow and temperature at the barrel outlet
- Seams shall have a finished overlap of a minimum of 75 mm for extrusion welding but in any event, sufficient overlap shall be provided to allow peel tests to be performed on the seam.
- The minimum width of the surface extruded bead shall be 30 mm.
- Prior to welding, oxidation by-products shall be removed from the weld area by grinding or buffing. Grind marks shall not be deeper than 10% of the PE geomembrane thickness. Seam grinding shall be been completed less than one hour before seam welding. The end of welds more than five minutes old shall be ground to expose new material before restarting a weld.
- Prior to welding, the extruder shall be purged until all the heat-degraded extrudate is removed.
- Welding shall be undertaken in one direction only.
- A smooth insulating plate or fabric shall be placed beneath the hot welding apparatus after use.

Pipe boots

- Pipe boots may be constructed in the factory or in the field in accordance with the detail shown on the Contract Drawings from relevant PE geomembrane conforming to this Specification.

9.11 Trial seams

Trial seams shall be performed on fragment pieces of PE geomembrane to verify that seaming conditions are satisfactory and to supply test specimens for the CQA program.

Trial seams shall be conducted at the beginning of each seaming period and at least once each four hours for each seaming apparatus used that day. Trial seams shall be repeated if any welding stoppage exceeds one hour and if weather conditions change. Trial seams shall be made under the identical conditions as the actual seams.

Each seamer shall make at least one trial seam each day for each seam method for each seaming equipment apparatus to be used that day.

Trial seams shall be a minimum of 1,350 mm by 300 mm with seam centred.

The trial seam sample shall be cut into three subsamples (450 mm by 300 mm with seam centred).

The two subsamples from each end shall immediately be tested onsite for peel and shear strength.

If either specimen does not meet the acceptance criteria, the seamer and seaming apparatus and/or methods shall not be accepted and shall not be used for seaming until the deficiencies are corrected and two consecutive trial seams are successful.

The central portion of the trial seam sample shall be labelled and provided to the CQA Engineer for destructive testing at the CQA Engineer's Independent Testing Firm. A minimum one trial seam sample per day shall be subjected to destructive testing. The Superintendent may reduce the frequency of trial seam destructive testing at the CQA Engineer's Independent Testing Firm, in consultation with the CQA Engineer, if the field tensiometer appears adequate for assuring trial seam quality.

If a trial seam sample records a non-conforming result for a test conducted at the CQA Engineer's Independent Testing Firm, a destructive test seam sample shall be taken by the Contractor from the seams completed by the seamer during the shift related to the considered trial seam. These samples shall be forwarded to the CQA Engineer's Independent Testing Firm by the Contractor and, if they recording non-conforming test results, the length of seam represented by the test sample shall be rejected.

The conditions of this section are considered as met for a given seam if a destructive seam test sample has already been taken from the considered seam(s).

9.12 Field seam sampling and testing

9.12.1 General

Testing parameters, requirements and anticipated schedules shall be continuously reviewed by the Contractor to ensure that adequate personnel and proper equipment shall be available.

Field seam sampling and testing shall be performed after seaming to verify that the mechanical characteristics of the seams do not compromise the PE geomembrane integrity.

Test results shall be provided to the Superintendent in accordance with Section 1.8.

9.12.2 Destructive seam testing

Destructive seam samples shall be taken and tested in accordance with Table 9-2.

Repair patches shall be extrusion welded over the areas where destructive seam samples have been taken and shall be subjected to non-destructive testing.

The location of each destructive seam sample shall be up to the discretion of the Superintendent and CQA Engineer and designated on a copy of the panel placement drawing, along with the date and time of sampling and the sample number.

Destructive test samples shall be a minimum of 1350 mm by 300 mm with seam centred.

The destructive seam sample shall be cut into 3 subsamples (450 mm by 300 mm with seam centred).

The two subsamples from each end shall be taken and tested on-site for peel and shear strength.

If both on-site subsamples meet the acceptance criteria of Table 9-2, the central portion of the test sample shall be labelled and provided to the CQA Engineer for destructive testing at the CQA Engineer's Independent Testing Firm.

If either on-site or off-site test results do not meet the acceptance criteria listed in Table 9-2, the length of seam represented by the test sample shall be rejected.

Table 9-2 Destructive seam testing requirements

Test description	Test method	Minimum test frequency	Acceptance criteria [23,24]
Peel strength [25]	ASTM D6392	1 test per 150 m [26] (or part thereof)	As per GM19
Shear strength	ASTM D6392	1 test per 150 m (or part thereof)	As per GM19

9.12.3 Non-destructive seam testing

All seams shall be non-destructively tested over the entire length of seam by at least one of the methods in Table 9-3. The tests shall be undertaken no earlier than one hour after welding. In addition to the above tests, the welds shall be visually inspected to assess the quality of the workmanship and the appearance of the welded seam.

Table 9-3 Non-destructive seam testing requirements

Test description	Test method	Minimum test frequency	Acceptance criteria
Vacuum box	ASTM D5641	All seams shall be tested by at least one of these three test methods as appropriate	No imperfections
Air pressure [27]	ASTM D5820		Refer Table 9-4
Spark test	ASTM D6365		No spark

Table 9-4 Air pressure test schedule

Geomembrane thickness	Minimum pressure	Maximum pressure	Maximum pressure differential [28]
1.0 mm	170 kPa	210 kPa	25 kPa
1.5 mm	190 kPa	250 kPa	20 kPa
2.0 mm	210 kPa	250 kPa	10 kPa
2.5 mm	210 kPa	250 kPa	10 kPa
3.0 mm	210 kPa	250 kPa	10 kPa

9.12.4 Pipe boot seam testing

All pipe boot seams shall be spark tested with acceptable pipe boots showing no spark.

Alternative testing methods may be allowed at the discretion of the Superintendent.

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[23] All destructive test results shall be based on Film-Tear Bond (FTB) criteria. All samples which produce seam failures shall be considered unacceptable

[24] A minimum of one series of destructive tests shall be performed each day that seaming is performed

[25] Peel strength testing shall be performed on both Weld A and Weld B

[26] When ambient air temperatures during seaming operations are less than 10 ºC, testing frequency shall be increased to one test per 75 linear meters

[27] All hypodermic needle punctures shall be repaired as per the requirements of this Specification

[28] Observe and record the pressure 5 min after the initial reading. If the loss of pressure exceeds that shown, or if the pressure does not stabilize, the faulty area should be located and repaired

9.12.5 Non-conforming test results

If any test specimen does not meet the acceptance criteria listed, the test series shall be considered unacceptable and all material or length of seam represented by the test series shall be rejected. The Geosynthetic Installer may, at no additional compensation, take additional samples for quality control testing in an attempt to minimise the amount of material represented by the non-conforming test result.

In the event of discrepancies between the CQA Engineer's test results and the Contractor's test results, the Contractor shall be responsible for arranging a third independent testing firm to verify test results.

An acceptable length of seam shall be defined as a length of seam which lies between conforming destructive test locations and has passed non-destructive seam testing.

9.12.6 Field testing summary

The Geosynthetic Installer shall prepare a field testing summary for all installed PE geomembrane. For each PE geomembrane layer, a separate copy of the panel placement drawing shall be utilised for this summary and shall indicate the PE geomembrane layer represented. On each sheet, the following information shall be recorded:

- The location, date, sample number and test result (conforming/non-conforming) of each destructive test series.
- The location, identification number and date of each non-destructive air pressure seam test including the length of the tested seam and the result of the test (conforming/non-conforming).
- The location, date and lengths of non-destructive vacuum box testing performed on a daily basis and the result of the tests (conforming/non-conforming).
- The location, identification number and date of each non-destructive spark test including the length of the tested seam and the result of the test (conforming/non-conforming).

9.13 Electrical leak location survey

9.13.1 General

Following the installation of each PE geomembrane layer, the Leak Location Contractor engaged by the CQA Engineer shall conduct an electrical leak location survey to detect leaks in the PE geomembrane.

9.13.2 Preparation and support

The Contractor shall be responsible for preparing the survey area for the leak location survey. The Contractor shall be responsible for completing installation work around the edge of each PE geomembrane layer that provides electrical isolation of the PE geomembrane for the electrical leak location surveys. The Contractor is to discuss installation procedures with the Leak Location Contractor prior to commencement. The Superintendent may provide further details on this procedure if requested.

The Contractor shall ensure the PE geomembrane surface is clean and dry prior to the survey.

9.13.3 Repairs

The Geosynthetic Installer shall be responsible for repairing any leaks found. Repairs shall be undertaken in accordance with Section 10.13.

After the leak is repaired, the Leak Location Contractor shall retest the area to ensure the leak was repaired and that there are no other leaks in the vicinity of the repair.

9.14 Defects and repairs

The Contractor shall be responsible for inspecting the placed PE geomembrane to identify any damage or faults in the material. The Superintendent and/or CQA Engineer may also undertake inspections of the placed PE geomembrane to identify any damage or faults in the material. Any areas of PE geomembrane damaged during installation shall be repaired by the Contractor. All repairs shall be verified by the Superintendent.

The Contractor shall prepare a work method statement for delivery, storage, handling and installation of PE geomembrane (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and comment prior to delivery of the geomembrane to site.

The installation component of the work method statement shall include work methods for defects and repairs, developed in accordance with the guidance provided below:

- All repairs shall be undertaken in accordance with this Specification, the approved work method statement and the manufacturer's instructions. Any contradictions shall be clarified with the Superintendent. All repairs shall be verified by the Superintendent.
- Patches and cap strips shall have rounded edges (minimum radius of 75 mm), shall be made of the same geomembrane and shall extend a minimum of 150 mm beyond the edge of defects. All patches shall be of the same compound and thickness as the PE geomembrane being patched over. Patches shall be seamed using extrusion (fusion) welding.
- Punctures, pin holes, blisters, small tears and localised imperfections shall be repaired using a patch.
- Large tears and lengths of seam shall be repaired using a cap strip. No re-seaming over existing seams shall be permitted.
- Tears which lie on slopes greater than 5% or which lie in areas of stress and have sharp ends shall have all sharp ends rounded prior to repair.
- The PE geomembrane below large patches and cap strips shall be cut as necessary to prevent moisture or gas collection between sheets.
- Excessive wrinkles which exist at the end of seaming operations and which may become creased during backfilling shall be cut and re-seamed. Excessive wrinkles shall be defined as a wrinkle which at the time of covering, and in the opinion of the Superintendent, meets any of the following criteria:
  - Is nominally >200 mm in height
  - May fold during backfilling
  - May adversely impede the flow along the surface of the geomembrane
- ‘Fishmouths’ or wrinkles at the seam overlaps shall be cut along the ridge of the wrinkle in order to achieve a flat overlap. The cut ‘fishmouths’ or wrinkles shall be seamed and any portion where the overlap is inadequate shall then be patched with an oval or round patch of the same geomembrane extending a minimum of 150 mm beyond the cut in all directions. All corners of the patch shall be rounded with a 25 mm minimum radius.
- All repair seams shall be made in accordance with the requirements of Section 9.10.5.

- Each repair shall be required to pass non-destructive tests (refer Section 9.12.3). Large cap strips may require destructive testing (refer Section 9.12.2), as directed by the Superintendent.

The Contractor shall submit to the Superintendent for review a log containing details of any defects identified and repairs carried out.

9.15 Acceptance

The Contractor shall retain all ownership and responsibility for all PE geomembrane until Practical Completion

PE geomembrane shall be accepted by the Superintendent when all of the following conditions are met:

- Required submittals are provided by the Contractor to the Superintendent and approved
- Adequacy of all field seams, penetrations and repairs is verified by the Superintendent
- The electrical leak location survey has been completed and all required repairs have been completed by the Contractor
- Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
- The Superintendent has inspected and approved the finished surface/s

10. Geotextile

10.1 General

This section contains the technical requirements for geotextile.

The Superintendent may reject any geotextile that does not meet or exceed the requirements of this section.

Any geotextile rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

10.2 Standards

10.2.1 Australian Standards

Relevant Australian standards are as follows but not limited to:

- 2001.2.3 Methods of test for textiles - Physical tests - Determination of breaking force and extension of textile fabrics
- 3704 Geosynthetics-Glossary of Terms
- 3705 Geotextiles-Identification, marking and general data
- 3706.3 Determination of tearing strength - Trapezoidal method
- 3706.4 Determination of burst strength - California bearing ratio (CBR) - Plunger method
- 3706.7 Determination of pore-size distribution - Dry-sieving method
- 3706.9 Determination of permittivity, permeability and flow rate

10.2.2 American Society for Testing and Materials Standards

Relevant American Society for Testing and Material (ASTM) standards are as follows:

- D4354 Standard Practice for Sampling of Geosynthetics and Rolled Erosion Control Products (RECPs) for Testing
- D4355 Standard Test Method for Deterioration of Geotextiles from Exposure to Ultraviolet Light and Water
- D4439 Standard Terminology for Geosynthetics
- D4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity
- D4533 Standard Test Method for Trapezoid Tearing Strength of Geotextiles
- D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
- D4751 Standard Test Method for Determining Apparent Opening Size of a Geotextile
- D4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
- D4873 Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples
- D5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics
- D5514 Standard Test Method for Large Scale Hydrostatic Puncture Testing of Geosynthetics

- D6767 Standard Test Method for Pore Size Characteristics of Geotextiles by Capillary Flow Test

10.2.3 Geosynthetic Research Institute Standards

Relevant Geosynthetic Research Institute (GRI) standards are as follows:

- GT12(a) Test Methods and Properties for Nonwoven Geotextiles Used as Protection (or Cushioning) Materials
- GT13(a) Test Methods and Properties for Geotextiles Used as Separation Between Subgrade Soil and Aggregate

10.3 Submittals

10.3.1 Prior to selection of the geotextile manufacturer

The Contractor shall submit the following to the Superintendent for review and approval prior to selection of a geotextile manufacturer (per manufacturer and product):

- Product manufacturer
- Product name
- Material data sheet showing the material properties of the proposed geotextile
- Manufacturer's quality control and assurance procedures

10.3.2 Prior to delivery of geotextile to site

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of geotextile to site (per geotextile product):

- Manufacturer's certificate of compliance outlining conformance with the requirements of this Specification.
- Manufacturer's quality control and assurance test results.
- Certification that the geotextile supplied for this work was manufactured as consecutive rolls from a single lot or from consecutive lots. If geotextile is not manufactured from consecutive lots, the manufacturer shall provide certification of quality and consistency of the product characteristics.
- Statement on the origin and identification of the fibres and polymers, including the supplier's name and production plant.
- Complete description of the manufacturer's shipping, handling and storage procedures.
- Manufacturer's installation procedures and requirements.
- Work method statement for geotextile delivery, storage, handling and installation. This shall include seaming and jointing, procedures for testing and repairing, proposed handling equipment and restraining methods, and other information that shall promote proper use.
- Results of compression testing (refer Section 10.7).

10.3.3 Prior to installation of geotextile

The Contractor shall submit the following to the Superintendent for review and approval prior to installation of the geotextile:

- Delivery, storage and handling log for all geotextile rolls to be used in the Works, including delivery dockets, roll number and identification, delivery inspection checklist, details of storage and handling.
- Proposed panel placement drawing, showing the location and reference number of all panels and expected seams, connections and penetrations, panel dimensions and layout, and the order of panel installation.
- Results of independent material conformance testing as provided by the CQA Engineer.

10.3.4 Following installation of geotextile

The Contractor shall submit the following to the Superintendent for review and approval following installation of the geotextile:

- Panel placement log, providing details on panel number and associated roll number, date and time placed, condition of receiving surface, weather conditions and precipitation events, QA checks performed, and all other relevant information.
- Finalised panel placement drawing showing the as-built location of all panels, seams, connections and penetrations.
- Defects and repairs log, showing details of all defects identified and repairs completed.

10.4 Manufacturer's quality control

The manufacturer shall follow a quality control program, approved by the Superintendent, throughout the manufacturing of all geotextile for the Works.

Manufacturer's quality control submissions shall include:

- Date of manufacture
- Lot number, roll number, length and width
- Polymer quality control documentation used in the production of the rolls delivered
- Fibre quality control documentation used in the production of the rolls delivered
- Geotextile manufacturer quality control documentation for the particular lots of geotextiles used in the production of the rolls delivered
- Quality control program laboratory-certified reports
- The manufacturer's approved quality assurance stamp and the technician's signature

The frequency of sampling and testing shall be in accordance with Table 10-1.

The Superintendent may reject any geotextile rolls that have not been sampled and/or tested in accordance with this section.

All geotextile rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

10.5 Manufacturer's quality assurance

The manufacturer shall follow a quality assurance program, approved by the Superintendent, throughout the manufacturing of all geotextile for the Works.

The frequency of sampling and testing shall be in accordance with ASTM D4354.

The Superintendent may reject any geotextile rolls that have not been sampled and/or tested in accordance with this section.

All geotextile rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

10.6 Material

The geotextile shall:

- Be manufactured of new, first-quality products manufactured for the Works
- Certified as needle-free by the manufacturer
- Comply with the acceptance criteria specified in Table 10-1.

The Contractor shall supply manufacturer's quality control and assurance testing results in accordance with the testing frequencies identified in Table 10-1 showing that the proposed material meets the requirements of this table. Samples taken shall be representative of the whole material source and shall be evenly distributed across the roll lots.

If required by the Superintendent, a sample of the geotextile shall be provided (per product) and the Superintendent and/or CQA Engineer may undertake an inspection of the manufacturer's facility. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

Table 10-1 Acceptance criteria – geotextile

Property	Test method	Acceptance criteria			Minimum testing frequency
		Separation geotextile	Protection geotextile [29]	Drainage geotextile	
Woven/Non-woven	-	Non-woven	Non-woven	Non-woven	-
Polymer	-	Polyester	Polyester	Polyester	-
Formation	-	Needle punched	Needle punched	Needle punched	-
Mass per unit area (MARV)	AS 3706.4	-	1,080 g/m^2	1,080 g/m^2	every 2,500 m^2
Grab tensile strength (MARV)	AS 3706.2b	1,100 N	2,250 N	2,250 N	every 5,000 m^2
Grab elongation (MARV)	AS 3706.2b	50%	50%	50%	every 5,000 m^2
Trapezoidal tear strength (MARV)	AS 3706.3	400 N	960 N	960 N	every 5,000 m^2
CBR burst strength (MARV)	AS 3706.4	2,250 N	7,560 N	7,560 N	every 5,000 m^2
Permittivity (MARV)	AS 3706.9	0.5 s^{-1}	-	-	every 5,000 m^2

[29] Preliminary specification only. Refer Section 10.7

Property	Test method	Acceptance criteria			Minimum testing frequency
		Separation geotextile	Protection geotextile [29]	Drainage geotextile	
Pore size (MaxARV)	ASTM D6767	120 µm	-	-	every 5,000 m^2
UV stability (typical) [30]	ASTM D4355	50%	50%	50%	per each formulation

10.7 Compression testing

The protection geotextile shall be capable of limiting strain within the underlying PE geomembrane to less than 6%.

The proposed protection geotextile shall be assessed by the Contractor by undertaking compression testing in accordance ASTM D5514 at 230 kPa, with the proposed overlying drainage aggregate and proposed underlying PE geomembrane(s). The results of the compression testing shall be provided to the Superintendent to verify the proposed protection geotextile can meet the PE geomembrane strain acceptance criteria.

The Contractor shall provide manufacturer's quality control and assurance test results for the protection geotextile material used in compression testing (tested for all the parameters identified in Table 10-1) to confirm the material properties of the geotextile. In addition to this requirement, the Superintendent may organise independent testing of this protection geotextile to verify the material properties of the geotextile. The Contractor shall provide sufficient samples of the material to allow this testing to occur.

If requested by the Contractor, alternate protection arrangements may be considered at the discretion of the Superintendent.

A preliminary specification for the protection geotextile is included in Table 10-1 for undertaking bidding purposes only.

10.8 Roll and sample identification

All geotextile rolls and samples shall be identified in accordance with AS 3705.

Each roll or panel shall carry a label which identifies, as a minimum:

- Product name, grade and name of manufacturer
- Date of manufacture, batch number
- Material thickness
- Roll number
- Roll length
- Roll weight
- Roll width
- Handling guidelines
- Reference numbers to raw material batch and laboratory certified reports

[30] Strength retained after 500 hours

- The manufacturer's approved quality assurance stamp and the technician's signature

The Superintendent may reject any geotextile rolls or samples that have not been identified in accordance with this section.

All geotextile rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

10.9 Delivery, storage and handling

The Contractor shall prepare a work method statement for delivery, storage, handling and installation of geotextile, including repair methods (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and comment prior to delivery of the geotextile to site.

The delivery, storage and handling components of the work method statement shall be developed in accordance with the guidance provided below:

- Delivery, storage and handling of all geotextile rolls and samples shall be undertaken in accordance with the manufacturer's instructions and ASTM D4873 as a minimum.
- Rolls shall be delivered to site, handled and stored in such a manner that no damage occurs to the rolls.
- Rolls shall be wrapped with weather and moisture-proof wrapping to prevent any contact with water prior to installation. In the event that it is suspected that roll/s may have come into contact with water, the Superintendent shall inspect the moisture content of the effected roll/s and reject the roll/s if they are damaged beyond use. All geotextile rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.
- Roll cores shall be sufficiently strong to ensure that they do not deflect by more than half their diameter during delivery, storage and handling.
- Rolls shall be stored in a location away from construction traffic but sufficiently close to the installation area to minimise handling. The storage area shall be level, dry, well-drained and stable, and shall protect the product from precipitation, chemicals, excessive heat, UV radiation, standing water, vandalism and animals.
- Geotextile roll stacks shall be limited to the height at which installation personnel can safely manoeuvre the handling equipment. The recommended maximum stack height is three rolls.
- Rolls shall be handled using a spreader stinger bar. The bar shall be capable of supporting the full weight of the rolls without significant bending. Under no circumstances shall the rolls be dragged, lifted from one end, lifted in the middle of the roll, lifted with the forks of a forklift or pushed to the ground from the delivery vehicle. The Contractor may nominate alternate handling equipment and plant for approval by the Superintendent as part of their work method statement.
- The Contractor shall inspect all geotextile rolls for defects and damage upon delivery.

The Superintendent may reject any geotextile rolls that have not been delivered, stored or handled in accordance with this section.

All geotextile rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

10.10 Preparation of receiving surface

Prior to placement of geotextile, the receiving surface shall exhibit the following characteristics:

- The surface shall be smooth, flat, firm and unyielding to the satisfaction of the Superintendent.
- The surface shall not exhibit visible deformation, rutting, yielding and/or show signs of distress or instability during final proof rolling (if required).
- The surface shall be free of debris, roots, angular material (such as sharp rocks), desiccation cracks, abrupt breaks, indentations, sudden changes in grade, defects and/or imperfections that may result in damage to the overlying materials.
- No loose, coarse-grained material shall remain on the surface. If required, the surface shall be raked or graded to remove any material penetrating out of the surface greater than 10 mm.
- The surface shall promote drainage and excessive water shall not be allowed to pond on the surface.
- The surface shall not be pebbly, tracked, rutted or otherwise disturbed by the equipment deploying overlying materials or other traffic. Pockets, holes, or discontinuities shall be repaired.
- All construction stakes, hubs, or other items used for grade control shall be removed and any voids filled. Any unsuitable material shall be over-excavated to a depth of 100 mm and replaced with approved material.
- The surface shall be maintained at sufficient moisture content to prevent desiccation during the Works.

Where geotextile is being placed over a geosynthetic material, the underlying geosynthetic shall be free of excessive wrinkles preventing intimate contact between the underlying geosynthetics and/or foundation materials.

The receiving surface shall be surveyed as per the requirements of Section 1.11.

Placement of geotextile shall not proceed until the receiving surface has been inspected and approved by the Superintendent.

The Superintendent may reject any underlying geosynthetic or underlying foundation material which does not meet these requirements. Any geosynthetic rejected by the Superintendent shall be removed from the site at the expense of the Contractor. Any rejected foundation material shall be removed and/or remediated to the satisfaction of the Superintendent.

10.11 Installation

10.11.1 General

The Contractor shall prepare a work method statement for delivery, storage, handling and installation of geotextile (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and comment prior to delivery of the geotextile to site.

The installation component of the work method statement shall be developed in accordance with the guidance provided below.

The Superintendent may reject any geotextile rolls that have not been installed in accordance with this section.

All geotextile rolls rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

10.11.2 Weather conditions

The Contractor shall consider the weather conditions on a daily basis to confirm they are suitable for placement of geotextile.

Geotextile shall not be placed or seamed:

- If moisture prevents proper subgrade preparation, panel placement and/or panel seaming.
- During precipitation, during hail, during periods of excessive fog, during periods of excessive dust, in standing water, on excessively wet surfaces, in the presence of excess moisture (such as dew and/or ponded water).
- During periods of excessive winds (>30 kph) or when gusting wind conditions interfere with handling operations.

10.11.3 Traffic

Equipment used shall not damage the geotextile by handling, trafficking, leakage of hydrocarbons, or by other means.

No vehicle shall be allowed to travel directly on the geotextile unless approved by the Superintendent. Prior to approval, the Contractor shall provide the Superintendent the following information:

- Guidance from the manufacturer on suitable plant for trafficking for the proposed geotextile and confirmation that the Contractor shall only use this plant
- Guidance from the manufacturer on suitable trafficking method for the proposed geotextile and confirmation that the Contractor shall only use this trafficking method
- Certification from the manufacturer that the above trafficking method and plant shall not void the warranty for the proposed geotextile

10.11.4 Placement

Geotextile shall be placed in accordance with the following:

- The geotextile shall be placed and seamed in accordance with this Specification, the Contract Drawings, the approved work method statement and the manufacturer's instructions. Any contradictions shall be clarified with the Superintendent.
- Prior to placement, each roll shall be inspected by the Contractor for damage and/or defects, including tears, abrasion, indentation, cracks, thin spots or any other faults or defects. If damage or defects are identified, the roll shall be inspected by the Superintendent and approved or rejected.
- Geotextile shall be protected from damage due to exposure to sunlight, dirt, dust and other hazards.
- Geotextile shall be placed such that the panels are anchored at the crest of the slope and form a continuous layer down the side walls and slopes and across the base.
- The arrangement of the geotextile panels shall be in accordance with the approved panel placement drawing and any changes approved by the Superintendent.
- Installation shall progress from the highest elevations to the lowest.

- Geotextile rolls shall be placed in an orderly fashion which shall minimise or prevent surface water from flowing below previously installed geotextile.
- Geotextile shall not be allowed to 'bridge over' voids or low areas. The geotextile shall be placed to allow intimate contact with the subgrade or underlying geosynthetic.
- Geotextile shall be installed without undergoing excessive buckling, wrinkling or tensioning.
- Geotextile shall not be dragged across an unprepared surface. If the geotextile is dragged across an unprepared surface, it shall be inspected for defects and repaired or rejected if necessary.
- Where there is a geosynthetic layer below, the installation of the geotextile shall be undertaken in a manner so as not to damage the underlying layer.
- Sandbags or equivalent ballast shall be used as necessary to hold the geotextile in position and prevent uplift by wind. In case of high winds, continuous loading shall be placed along edges of panels to minimise wind flow under the panels. Sandbag material shall be sufficiently close-knit to prevent soil fines from working through the bags and discharging on the geotextile.
- Only those geotextile rolls which can be seamed or permanently anchored on at least two sides on the same day shall be placed on a daily basis. All other sides shall be temporarily anchored.
- Geotextile installed on slopes shall be fixed in anchor trenches as shown on the Contract Drawings and Section 3.15. Geotextile panels shall be anchored as soon as possible.
- Personnel working on the geotextile shall not smoke, wear damaging shoes, excessively traffic or engage in other activities which may damage the geotextile. Geotextile in heavy traffic areas shall be protected by a geosynthetic overlay.
- Geotextile rolls shall be freely suspended during placement.
- The method used to unroll the geotextile shall not cause bridging, excessive wrinkles, scores, scratches and/or crimps.
- After placement, the geotextile shall be free of excessive buckles, wrinkles, ripples, creases, folds and irregular stressing.

10.11.5 Seaming

Geotextile shall be seamed in accordance with the following:

- Geotextile seams shall be formed by overlapping the edges of the geotextile panels by a minimum of 200 mm and thermally bonding the seam or sewing the seam together with continuous stitches located a minimum of 100 mm from the overlapped edges. A two-thread, double-locked stitch shall be used. The proposed seaming method shall be in accordance with the manufacturer's instructions.
- Equipment used for thermal bonding and/or sewing shall be inspected and approved by the Superintendent prior to use. If requested by the Superintendent, the Geosynthetic Installer shall prepare a trial seam for inspection and/or testing prior to approval.
- The Contractor shall ensure that the seaming method does not result in damage to the underlying geosynthetics.
- Sewing procedures shall conform to the manufacturer's instructions. Spot sewing shall not be allowed.

- Thread used to sew panels of geotextile together shall be polymeric thread with physical and chemical-resistance properties that equal or exceed those of the geotextile. The thread colour shall contrast with the geotextile colour and shall be approved for use by the manufacturer.
- Adhesive may be used to seam the geotextile subject to approval from the Superintendent. The adhesive shall be approved by the manufacturer for use in seaming their product. If requested by the Superintendent, the Geosynthetic Installer shall prepare a trial seam for inspection and/or testing prior to approval.
- Seams shall provide seam strength which equals or exceeds 75% of parent material strength when tested in accordance with AS 3706.2 (parent material strength) and AS 3706.6 (seam strength). The Superintendent may organise independent testing of the completed seams to verify conformance with this requirement. The Geosynthetic Installer shall repair any locations where samples are taken in accordance with Section 10.13.

10.12 Protection and covering

The protection geotextile shall be protected from damage due to overexposure to UV radiation. Covering activities shall be coordinated to ensure the following:

- The overlying confinement layer (300 mm thick drainage aggregate on the base and in the cap, and 300 mm thick soil confining layer on the sidewalls) shall be placed as soon as practicable, in accordance with the protection geotextile instructions or as approved by the Superintendent. Notwithstanding these requirements, the overlying confinement layer shall be placed no longer than 2 weeks following protection geotextile placement. The 300 mm thick drainage aggregate shall be installed in accordance with the approved work method statement (refer Section Appendix A).
- No vehicle shall be allowed to traffic directly on the protection geotextile during placement of the overlying confining layer unless approved by the Superintendent (refer Section 8.10.3). The overlying confinement layer shall not be pushed or graded in a direction that may cause damage to the protection geotextile seams.

In the opinion of the Superintendent, if the placed protection geotextile panels are damaged extensively due to overexposure to UV radiation, then the effected protection geotextile panels shall be removed and replaced by the Contractor at their own expense.

10.13 Defects and repairs

The Contractor and shall be responsible for inspecting the placed geotextile to identify any damage or faults in the material. The Superintendent and/or CQA Engineer may also undertake inspections of the placed geotextile to identify any damage or faults in the material. Any areas of geotextile damaged during installation shall be repaired by the Contractor. All repairs shall be verified by the Superintendent.

Any geotextile that has been damaged (by tears, holes or otherwise) during installation shall be repaired by patching a new piece of geotextile of the same material type and thickness with a minimum 300 mm overlap beyond the repair area in each direction. Any soil or other foreign material that may have penetrated the damaged geotextile onto the surface of the underlying layer or within the underlying layer shall first be removed to the satisfaction of the Superintendent before any repair work is undertaken.

Seaming of geotextile repair patches shall be undertaken in accordance with Section 10.11.3.

The Contractor shall submit to the Superintendent for review a log containing details of any defects identified and repairs carried out.

10.14 Acceptance

The Contractor shall retain all ownership and responsibility for all geotextile until Practical Completion.

Geotextile shall be accepted by the Superintendent when all of the following conditions are met:

- Required submittals are provided by the Contractor to the Superintendent and approved
- Adequacy of all field seams, penetrations and repairs is verified by the Superintendent
- The Superintendent is satisfied that sufficient sandbags or equivalent ballast have been placed across the surface of any geotextile to be left exposed at the completion of the Works
- Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
- The Superintendent has inspected and approved the finished surface/s

11. Drainage aggregate

11.1 General

This section contains the technical requirements for the drainage aggregate. The relevant requirements for the drainage aggregate in Section 3 shall be considered alongside guidance provided in this section.

The Superintendent may reject any component of the drainage aggregate that do not meet or exceed the requirements of this section.

Any component of the drainage aggregate rejected by the Superintendent shall be remediated at the expense of the Contractor.

11.2 Standards

11.2.1 Australian standards

Relevant Australian standards are as follows but not limited to:

- 1141.3.1 Methods for Sampling and Testing Aggregates – Sampling of aggregates and rock
- 1141.11 Methods for Sampling and Testing Aggregates – Particle size distribution/dry sieve
- 1289.6.7.1 Methods for Testing Soils for Engineering Purposes – Determination of the permeability of a soil

11.3 Submittals

11.3.1 Prior to delivery of drainage aggregate to site

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of the drainage aggregate to site (per material source):

- Material source
- Certification that the material is VENM or ENM or NSW EPA Resource Recovery Exemption appropriate for use as drainage aggregate
- Pre-qualification test results/reports demonstrating that the proposed material complies with the material property requirements of this section of the Specification (refer Section 11.4)
- Estimated quantity of material which is represented by the pre-qualification test results/reports
- Information on the parent geology of the material

11.3.2 Prior to placement of drainage aggregate

The Contractor shall submit the following to the Superintendent for review and approval prior to placement of the drainage aggregate:

- Survey of the underlying surface in accordance with Section 1.11
- Work method statement for placement of the clay rich fill layer, including testing and repair procedures (refer Appendix A)

11.3.3 Following placement of drainage aggregate

The Contractor shall submit the following to the Superintendent for review and approval following placement of drainage aggregate:

- As-built survey of the completed surface showing conforming layer thickness within the allowable tolerances
- CQC testing results/reports showing compliance with the requirements of this Specification
- Defect and repairs log, showing details of all defects identified and any repairs completed

11.4 Material

11.4.1 Drainage aggregate

Drainage aggregate shall:

- Be selectively sourced material from on-site or imported from an approved source. Imported material shall be classed as VENM or ENM or NSW EPA Resource Recovery Exemption
- Not contain any unsuitable materials identified in Section 3.4.1 unless approved by the Superintendent
- Be rounded to sub-rounded
- Be clean, hard, sound and durable material that will maintain the required performance under the maximum loads likely to be imposed on it in service
- Be non-reactive in mildly acidic conditions
- Have a calcium carbonate content of less than 8.5% by mass
- Have an effective angle of internal friction of greater than 35 degrees
- Be relatively uniform in grain size
- Comply with the acceptance criteria specified in Table 11-1

The Contractor shall supply pre-qualification testing results in accordance with the testing frequencies identified in Table 11-1 showing that the proposed material meets the requirements of this table. Samples taken shall be representative of the whole material source and shall be evenly distributed across the material source.

If required by the Superintendent, a sample of the material shall be provided (per source) and the Superintendent and/or CQA Engineer may undertake an inspection of the material source. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

The Superintendent may organise independent testing of the material to verify conformance with the requirements of this section.

Table 11-1 Acceptance criteria – drainage aggregate

Property	Test method	Acceptance criteria	Minimum test frequency
Constant head permeability	AS 1289.6.7.1[31]	> 10^{-3} m/s	Greater of: 1 per 10,000 m^3 of material or 3 per source
Particle size distribution: - Passing 50 mm - Passing 19 mm - Passing 0.075 mm	AS 1141.11,12,13 or AS 1289.3.6.1, 3.6.3	100% ≤ 10% ≤ 3%	Greater of: 1 per 1,000 m^3 of material or 3 per source

11.4.2 Recycled drainage aggregate

Recycled drainage aggregate shall:

- Be selectively sourced material from on-site or imported from an approved source. Imported material shall be asbestos free and be tested for the presence of other materials in accordance with RTA test method T276.
- Not contain any unsuitable materials identified in Section 3.4.1 unless approved by the Superintendent
- Be clean, hard, sound and durable material that will maintain the required performance under the maximum loads likely to be imposed on it in service
- Have an effective angle of internal friction of greater than 35 degrees
- Comply with the acceptance criteria specified in Table 11-1

The Contractor shall supply pre-qualification testing results in accordance with the testing frequencies identified in Table 11-1 showing that the proposed material meets the requirements of this table. Samples taken shall be representative of the whole material source and shall be evenly distributed across the material source.

If required by the Superintendent, a sample of the material shall be provided (per source) and the Superintendent and/or CQA Engineer may undertake an inspection of the material source. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

The Superintendent may organise independent testing of the material to verify conformance with the requirements of this section.

Table 11-2 Acceptance criteria – drainage aggregate

Property	Test method	Acceptance criteria	Minimum test frequency
Particle size distribution: - Passing 50 mm - Passing 19 mm - Passing 0.075 mm	AS 1141.11,12,13 or AS 1289.3.6.1, 3.6.3	100% ≤ 10% ≤ 3%	Greater of: 1 per 1,000 m^3 of material or 3 per source

[31] The intrinsic permeability of the testing apparatus shall be established prior to testing the drainage aggregate and reported with the test results to verify the testing apparatus is suitable for this test

11.5 Preparation of receiving surface

Prior to placement of drainage aggregate, the underlying geosynthetic shall be free of:

- Any of debris, roots, angular material (such as sharp rocks), or loose, coarse-grained material on or immediately below the geosynthetic
- Excessive wrinkles preventing intimate contact between the underlying geosynthetics and/or foundation materials

The foundation material underlying the geosynthetic shall:

- Be smooth, flat, firm and unyielding to the satisfaction of the Superintendent
- Be free of abrupt breaks, indentations and/or sudden changes in grade
- Promote drainage and excessive water shall not be allowed to pond on the surface of the geosynthetic

Placement of drainage aggregate shall not proceed until the underlying geosynthetic has been inspected and approved by the Superintendent.

The Superintendent may reject any underlying geosynthetic or underlying foundation material which does not meet these requirements. Any geosynthetic rejected by the Superintendent shall be removed from the site at the expense of the Contractor. Any rejected foundation material shall be removed and/or remediated to the satisfaction of the Superintendent.

11.6 Installation

The Contractor shall prepare a work method statement for placement of the drainage aggregate outlining the placement methodology and proposed construction plant to be used (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and approval prior to commencement of the required field trial.

A field trial shall be undertaken by the Contractor to verify the Contractor's proposed construction methodology for the drainage aggregate, in accordance with Section 17. The Contractor shall adjust the placement method as necessary based on the results of the field trial.

The work method statement and construction methodology for the drainage aggregate shall be developed in accordance with the guidance provided below:

- The drainage aggregate shall be placed with a uniform particle size distribution to prevent concentration of fines. This can be achieved through conditioning of the material prior to placement.
- The drainage aggregate shall be constructed in one lift with a minimum thickness of 300 mm. Plant shall not be allowed to traffic the underlying surface unless a minimum 300 mm thick drainage aggregate layer is present. Drainage aggregate shall be placed in areas without placed drainage aggregate by unloading the material from a pad of previously placed drainage aggregate.
- The maximum allowable ground pressure for plant trafficking the minimum 300 mm thick drainage aggregate layer is 35 kPa.
- Plant exceeding the allowable ground pressure requirements shall be allowed providing they work from elevated pads with a minimum thickness from the underlying surface of 1 m. These elevated pads shall be removed following completion of drainage aggregate placement.

- Aggregate shall be placed directly on the underlying geosynthetic rather than pushing in place to avoid the formation of excessive wrinkles or 'waves'.
- Drainage aggregate shall be placed in a manner which does not result in excessive particle breakdown or crushing.
- Drainage aggregate shall be placed carefully around any pipework to ensure the pipework has sufficient and uniform support.
- No aggregate shall be placed in areas where the underlying geosynthetic is not in contact with the supporting subgrade.
- Drainage aggregate shall not be placed closer than 2 m from the edge of geosynthetic panels where seaming of additional geosynthetics to the edge is yet to be performed. Temporary access across such edges shall be subject to approval by the Superintendent.

11.7 Construction quality control testing

The Contractor shall undertake CQC testing of the drainage aggregate in accordance with Table 11-3 as a minimum and the relevant requirements of Section 3.13. Sampling locations for testing shall be agreed with the Superintendent and CQA Engineer.

Table 11-3 Construction quality control testing – drainage aggregate

Property	Test method	Minimum test frequency
Particle size distribution	AS 1141.3.1, AS 1141.11.1	1 per 1,000 m^3

11.8 Tolerances

The Contractor shall place the drainage aggregate within the tolerances provided in Section 3.14.

11.9 Defects and repairs

The Superintendent may direct the Contractor to remove a section of the aggregate to inspect underlying materials for damage. The Contractor shall repair any damage that occurs to the underlying materials as a consequence of the placement of drainage aggregate in accordance with this Specification.

Any areas of placed drainage aggregate that do not conform to the required CQC testing criteria shall be repaired by the Contractor to the satisfaction of the Superintendent. This includes non-conformances resulting from independent testing commissioned by the Superintendent or CQA Engineer.

The Contractor shall submit to the Superintendent for review details of any defects identified and repairs carried out.

11.10 Acceptance

The Contractor shall retain ownership and responsibility for the drainage aggregate until Practical Completion.

The drainage aggregate shall be accepted by the Superintendent when all of the following conditions are met:

- Required submittals are provided by the Contractor to the Superintendent and approved

- The Contractor has submitted the required as-built surveys of the completed drainage aggregate showing conformance with the Contract Drawings within the allowable tolerances, and this has been approved by the Superintendent
- CQC test results showing compliance with the requirements of this Specification have been provided by the Contractor to the Superintendent and approved
- Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
- The Superintendent has inspected and approved the finished surface/s

12. PE pipework

12.1 General

This section contains the technical requirements for polyethylene (PE) pipework and fittings.

The Superintendent may reject any PE pipework and fittings that does not meet or exceed the requirements of this section.

Any PE pipework and fittings rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

12.2 Standards

12.2.1 Australian Standards

Relevant Australian standards are as follows but not limited to:

- 1463 Polyethylene Pipe Extrusion Compounds
- 1646 Elastomeric Seals for Water Works Purposes
- 2033 Installation of Polyethylene Pipe Systems
- 2698.2 Plastic Pipes and Fittings for Irrigation and Rural Applications Polyethylene Rural Pipes
- 2700 Colour Standards for General Purposes
- 4129 Fittings for Polyethylene Pipes for Pressure Applications
- 4130 Polyethylene Pipes for Pressure Applications
- 4131 Polyethylene Compounds for Pressure Pipes and Fittings

12.2.2 Water Services Association of Australia

Relevant Water Services Association of Australia standards are as follows:

- 02-2002
- 03-2002

12.3 Submittals

12.3.1 Prior to delivery of PE pipework to site

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of PE pipework to site (per PE pipework product):

- Product manufacturer.
- Product name.
- Manufacturer’s certificate of compliance outlining conformance with the requirements of this Specification.
- Manufacturer’s quality control and assurance procedures.
- Manufacturer’s quality control and assurance test results.
- Complete description of the manufacturer’s shipping, handling and storage procedures.
- Manufacturer’s installation procedures and requirements.

- Work method statement for PE pipework delivery, storage, handling and installation. This shall include jointing, procedures for testing and repairing, proposed handling equipment and restraining methods, and other information that shall promote proper use.

12.3.2 Prior to installation of PE pipework

The Contractor shall submit the following to the Superintendent for review and approval prior to installation of the PE pipework:

- Delivery, storage and handling log for all PE pipework to be used in the Works, including delivery dockets, pipework identification, details of storage and handling.

12.3.3 Following installation of PE pipework

The Contractor shall submit the following to the Superintendent for review and approval following installation of the PE pipework:

- As-built survey of all pipework showing conforming lines and levels
- Defects and repairs log, showing details of all defects identified and repairs completed

12.4 Material

The materials used for the PE pipework and fittings shall be in accordance with the Contract Drawings.

If required by the Superintendent, a sample of the PE pipework shall be provided (per product) and the Superintendent and/or CQA Engineer may undertake an inspection of the manufacturer's facility. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

12.5 Delivery, storage and handling

The Contractor shall prepare a work method statement for delivery, storage, handling and installation of PE pipework and fittings, including repair methods (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and comment prior to delivery of the PE pipework to site.

The delivery, storage and handling components of the work method statement shall be developed in accordance with the guidance provided below:

- Delivery, storage and handling of all PE pipework and fittings shall be undertaken in accordance with the manufacturer's instructions.
- PE pipework shall be delivered to site, handled and stored in such a manner that no damage occurs to the PE pipework.
- PE pipework shall be stored in a location away from construction traffic but sufficiently close to the installation area to minimise handling. The storage area shall be level, dry, well-drained and stable, and shall protect the product from chemicals, excessive heat, UV radiation, vandalism and animals.
- The Contractor shall inspect all PE pipework and fittings for defects and damage upon delivery.

The Superintendent may reject any PE pipework and fittings that have not been delivered, stored or handled in accordance with this section.

All PE pipework and fittings rejected by the Superintendent shall be removed from the site and replaced at the expense of the Contractor.

12.6 Installation

12.6.1 General

The Contractor shall prepare a work method statement for delivery, storage, handling and installation of PE pipework and fittings (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and comment prior to delivery of the PE pipework to site.

The installation component of the work method statement shall be developed in accordance with the guidance provided below:

- The PE pipework and fittings shall be placed and seamed in accordance with this Specification, the Contract Drawings, AS 2033, the approved work method statement and the manufacturer's instructions. Any contradictions shall be clarified with the Superintendent.
- Prior to placement, each pipe/fitting shall be inspected by the Contractor for damage and/or defects. If damage or defects are identified, the PE pipework shall be inspected by the Superintendent and approved or rejected.
- Perforations shall be drilled to the size, number and location indicated on the Contract Drawings. Perforated pipework shall be thoroughly cleaned of drilling wastes or other foreign matter and any hanging beads removed before installation.
- PE pipework shall be installed in a manner so as to provide for expansion and contraction as recommended by the manufacturer.
- PE pipework shall be placed on an even bed of supporting material in accordance with the Contract Drawings.
- PE pipework shall lay free on the base with no induced strain. Where there is evidence of induced pipe strain, the Contractor shall be required to eliminate the strain. The Contractor shall also remove and replace any fitting, which induces a torque or strain to the pipe.
- PE pipework shall be cut in a manner so as to ensure square ends. Burrs at cut ends shall be removed prior to installation so that a smooth unobstructed flow be obtained.
- Pipe joints shall be butt-fusion welded in accordance with the manufacturer’s instructions.
- PE pipework and fittings shall be held firmly in position and protected from damage while drainage aggregate or other backfilling material is being placed.
- All pipe and fittings shall be clean upon installation and kept so during the progress of the Works.
- Any PE pipework that becomes either partially or fully clogged and/or damaged before final acceptance shall be cleaned/repaired to the satisfaction of the Superintendent, and/or replaced.

12.7 Defects and repairs

The Contractor and shall be responsible for inspecting the placed PE pipework and fittings to identify any damage or faults in the material. The Superintendent and/or CQA Engineer may also undertake inspections of the placed PE pipework and fittings to identify any damage or faults in the material. Any areas of PE pipework damaged during installation shall be repaired by the Contractor in accordance with the manufacturer’s instructions. All repairs shall be verified by the Superintendent.

The Contractor shall submit to the Superintendent for review a log containing details of any defects identified and repairs carried out.

12.8 Acceptance

The Contractor shall retain all ownership and responsibility for all PE pipework and fittings until Practical Completion.

PE pipework and fittings shall be accepted by the Superintendent when all of the following conditions are met:

- Required submittals are provided by the Contractor to the Superintendent and approved
- The Contractor has submitted the required as-built surveys of the completed PE pipework and fittings showing conformance with the Contract Drawings, and this has been approved by the Superintendent
- Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
- The Superintendent has inspected and approved the installed PE pipework and fittings

13. Soil confining layer

13.1 General

This section contains the technical requirements for the soil confining layer. The relevant requirements for earthworks in Section 3 shall be considered alongside guidance provided in this section.

The Superintendent may reject any component of the soil confining layer that does not meet or exceed the requirements of this section.

Any component of the soil confining layer rejected by the Superintendent shall be remediated at the Contractors expense.

13.2 Standards

13.2.1 Australian Standards

Relevant Australian standards are as follows :

- 1141.3 Methods for Sampling and Testing Aggregates – Sampling of aggregates and rock.
- 1141.11 Methods for Sampling and Testing Aggregates – Particle size distribution/dry sieve
- 1289.6.7.1 Methods for Testing Soils for Engineering Purposes – Determination of the permeability of a soil

13.3 Submittals

13.3.1 Prior to placement of soil confining layer

The Contractor shall submit the following to the Superintendent for review and approval prior to placement of the soil-confining layer:

- A 20 kg sample of the proposed material.
- Pre-qualification test results/reports demonstrating that the proposed fill material complies with the material property requirements of this Specification
- Estimated quantity of material which is represented by the pre-qualification test results/reports (per source)
- Survey of the underlying surface in accordance with Section 1.11
- Work method statement for the placement of soil confining layer, including testing and repair procedures
- Completion and acceptance of the soil confining layer field trial, in accordance with Section 18

13.3.2 Following placement of soil confining layer

The Contractor shall submit the following to the Superintendent for review and approval following placement of the soil confining layer:

- As-built survey of the completed surface showing conforming layer thickness within the allowable tolerances
- Defect and repairs log, showing details of all defects identified and any repairs completed.

13.4 Material

Soil confining layer material shall comprise of select fill.

13.5 Delivery, storage and handling

If sand fill is to be stockpiled, it shall be stored and handled to prevent debris, pockets of clay and other deleterious or organic materials from being mixed into it.

The Contractor shall be responsible for storage and handling of the sand fill once delivered to site. The sand fill shall not become contaminated with soil and/or fines. Contaminated sand fill shall be rejected by the Superintendent and removed from the site at the Contractors expense.

13.6 Preparation of surface to receive soil confining layer

Placement of the soil confining layer shall not be undertaken until placement, installation and testing of the layers below are complete and accepted by the Superintendent.

Prior to placement of the soil confining layer, the receiving surface shall be cleared of any debris and/or foreign material.

The receiving surface shall be surveyed as per the requirements of Section 1.11.

Placement of the soil confining layer shall not proceed until the receiving surface has been approved by the Superintendent.

13.7 Installation

The Contractor shall prepare a work method statement for placement of the soil confining layer outlining the measures taken to prevent damage to the underlying lining system.

The protection aggregate shall be placed in a manner and with appropriate equipment such that damage does not occur to the previously installed liner layers.

The work method statement shall be developed based on the guidance provided below:

- The maximum allowable ground pressure for plant trafficking the soil confining layer is 35 kPa and in accordance with the outcome of the field trial.
- Plant exceeding the allowable ground pressure requirements shall be allowed providing they work from elevated pads with a minimum thickness from the liner of 1 m.
- Trafficking with heavy machinery shall be avoided after placement.
- Soil confining layer material shall be placed from the bottom of the slopes and pushed upward.
- No soil confining layer material shall be placed in areas where the geosynthetics are not in contact with the supporting subgrade.
- Soil confining layer material shall be placed parallel to the direction of the geosynthetic lapped seams.
- Soil confining layer material shall not be placed closer than 2 m from the edge of geosynthetic sheets where seaming of additional geosynthetics to the edge is yet to be performed. Temporary access across such edges shall be subject to Superintendent approval.

13.8 Defects and repairs

The Superintendent may direct the Contractor to remove a section of the soil confining layer to inspect underlying layers for damage.

The Contractor shall repair any damage that occurs to the underlying layers as a consequence of the placement of sand fill in accordance with the provisions of this Specification.

The Contractor shall submit to the Superintendent for review details of any defects identified and repairs carried out.

13.9 Acceptance

The Contractor shall retain ownership and responsibility for the soil confining layer until Practical Completion.

The soil confining layer shall be accepted by the Superintendent when all of the following conditions are met:

- Required thickness of the soil confining layer has been achieved within the allowable tolerances as confirmed by survey data
- Required submittals are provided by the Contractor to the Superintendent and approved
- Details of all defects identified and repairs performed have been submitted to the Superintendent for review and approval
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
- The Superintendent has inspected and approved the finished surface

14. Waste placement

14.1 General

This section contains the technical requirements for waste placement.

14.2 Submittals

Prior to waste placement, the Contractor shall submit a work method statement for waste placement with consideration to the requirements outlined in this Specification, including though not necessarily limited to:

- Scheduling
- Supply
- Numbers, types, and sizes of equipment proposed to perform hauling and placement
- Anticipated challenges and mitigation measures
- Methods for maintaining adequate survey control during placement operations
- Method of material placement and compaction
- Trimming and final surface preparation
- Contaminated water management procedures detailing: methods and equipment to handle contaminated water during placement operations as specified herein and washing/decontamination methods, disposal methods, all with reference to relevant regulations

14.3 Waste material

The Contractor shall excavate and transport designated waste materials to achieve the final lines and levels as shown on the Contract Drawings. The Contractor shall note that waste materials vary substantially in composition, type, size, hazard, and compactibility, which will impact waste placement method and effectiveness. The Contractor shall perform waste placement for all designated waste materials to the requirements of this specification.

The Contractor shall separate any clean cover material from waste material, taking care not to contaminate the clean cover material or imported materials with waste material. The separated clean cover material shall be transported to the approved stockpile area and stockpiled separate from other materials. The clean cover material may be reused as part of the Works, subject to approval by the Superintendent. The Superintendent shall inspect and approve any clean cover material stockpiles prior to reuse.

All excavated waste material shall be transported to a nominated location as directed by Superintendent. All excavated waste materials will be immediately relocated to the nominated locations.

Stockpiling of waste materials is prohibited.

All exposed waste materials or waste materials used as select waste (fill) are to be covered with a minimum of 150 mm of suitable fill material by the end of each working day. This includes waste materials relocated to locations nominated by the Superintendent. A suitable alternative approach may be used for covering subject to approval by the Superintendent.

The Contractor shall manage waste material placement such that no waste materials are deposited in areas not designated for waste materials.

14.4 Placement

14.4.1 General

Filling shall be undertaken in accordance with the Contract Drawings. Waste placement shall commence at the high end of each sub-cell and progress eastward.

Waste shall be placed to minimise the entrainment of leachate or surface water within the waste and the formation of void spaces. The placement of waste shall be undertaken to ensure ponding is minimised.

The amount of waste exposed during operations shall be minimised.

All waste batters shall be no steeper than 1 (vertical) in 3 (horizontal).

Waste placement shall be undertaken such that pre-capping contours are suitable for placement of the final capping layer.

14.4.2 Protection of lining system

Waste shall be placed in near horizontal layers across the entire area of the cell in horizontal lifts over the entire footprint.

Placement of the waste against the basal and sidewall liner system shall be undertaken so as to avoid damage to the lining systems. Specifically, no landfill compactor shall be allowed within 6 horizontal metres of the sidewall lining system at any time.

Waste placed against the sidewall shall be placed on existing waste and pushed against the sidewall. All pushing shall be towards the slope. No waste or other materials shall be pushed down the slope of the sidewall.

The liner protection layer across the sidewall lining system shall be maintained through operations. Inspections of the protection layer shall be undertaken following any rainfall event or periods of high wind speeds and any scouring or other damage to the layer shall be rectified.

No traffic is permitted on the separation geotextile over the leachate collection system, with the first layer of waste to be end tipped form the previously placed waste layer.

14.4.3 Compaction and lift thickness

Compaction of the waste shall be undertaken to ensure a global in-situ waste density of 1.6 tonnes of waste per cubic metre of landfill airspace consumed. Based on the equipment utilised, the moisture condition and type of waste the maximum uncompacted waste layer shall be adjusted by the operator to ensure this requirement is met.

In-situ compaction shall be confirmed by weekly surveys of the previously filled areas as a minimum.

Test filling

The Contractor shall perform test filling, with adherence to the initial waste lift requirements of this specification, to determine acceptable placement and compaction methods to produce completed treated sediment fill that satisfies the requirements of this section.

The test fill will be constructed on a horizontal surface within the limits of the waste containment cell at a location agreed upon by the Contractor and the Superintendent.

To ensure the test fill will accurately represent the performance during full-scale production, the following guidelines will be followed:

1. Construction of the test fill will use a variety of the waste materials, equipment, and procedures as proposed for waste placement
2. The test fill will be constructed at least four times wider than the construction compactor drum width to be used for the waste placement or 15 metres minimum (whichever is greater).
3. The test fill will be long enough to allow construction equipment to achieve normal operating speed before reaching the test area or 25 metres minimum (whichever is greater).
4. The test fill will be constructed with at least compactible three lifts to evaluate the methodology used to tie lifts together such that the global in-situ waste density of 1.6 tonnes of waste per cubic metre is achieved.

The Contractor shall conduct a survey of the test fill and record the following for Superintendent review and approval during the test filling: compaction equipment type, configuration and weight, the speed of compaction equipment travelling over the test filling area, the lift thicknesses, compaction procedures, and number of passes for compaction equipment, in-situ waste density achieved with any calculations and survey results.

14.4.4 Initial waste lift requirements

The initial lift of waste (the ‘fluffy layer’) shall be:

- Mixed with dry construction and demolition waste (ideally fines or other non-protruding materials) to provide a suitable protective layer
- Placed by tracked plant, such as a bulldozer, to avoid high point loads that could potentially damage the base liner
- A minimum of 1.5 metre for a Cat 826 Series Compactor (or similar) and 2 metres for an Cat 836 Series Compactor (or similar) to allow for placement of subsequent lifts by a landfill compactor
- Free from protruding objects that can pierce the liner
- Placed in a manner to ensure the separation geotextile overlying the drainage aggregate remains fit for purpose.

As soon as is feasible, a working platform should be established with or on top of the first waste lift, sufficient in size to allow for truck and plant manoeuvring.

14.4.5 Sidewall sacrificial geomembrane

The sidewall liner sacrificial geomembrane shall be maintained to prevent erosion of the soil confining layer. The sidewall liner to be placed per geomembrane placement requirements of this report. Any damage to the layer during operations which allows water to enter the soil confining layer shall be repaired as outlined in Section 12.7.

The sidewall liner sacrificial geomembrane shall be progressively removed as waste filling progresses.

14.4.6 Covering

Daily cover shall be placed progressively over areas of exposed waste. All waste shall be covered at the end of the working day. Intermediate cover shall be placed in areas where waste is to be exposed for periods of generally 90 days or longer.

Where possible daily and intermediate cover shall be stripped back for reuse before the waste is placed over the previously filled areas. Recovered cover material that is contaminated with waste may only be used for internal bunds to delineate the working face, or other engineering purposes where it is not exposed.

14.4.7 Setback from key-in locations

Where the internal bund requires later removal to facilitate extension of operations to new areas (at pipe penetrations), waste (including any required cover) shall not be placed within 1.5 metres of the termination of the liner at the toe of the bund.

14.4.8 Surface water diversion

As far as practicable, surface water shall be excluded from the landfilled waste.

14.4.9 Leachate collection system

The operation depth of leachate in the cell shall be limited to no more than 300 mm except during large storm events. Where the level of leachate exceeds 300 mm it shall be lowered to 300 mm as soon as is practicable.

14.4.10 Groundwater collection system

The groundwater collection system shall be effectively operated, checked and maintained during waste placement.

14.4.11 Contaminated water management

The Contractor shall conduct contaminated water management in accordance with the approved work method statement procedures of this specification. The methods, procedures and equipment required to conduct contaminated water management are the responsibility of the Contractor.

14.5 Access ramp

The surfaces of the access ramps shall be monitored for wear and any damage shall be repaired.

A smooth transition shall be maintained at the interface at the access ramp and the landfilled waste. These will remain in the cell and not removed.

14.6 Internal bund at pipe penetration

At the time of connection of each eastern sub-cell to the adjacent western sub-cell the leachate pipe and collection layer shall be made continuous to allow leachate to pass through to the leachate collection sumps.

The connection shall be made by:

- Removal of any stormwater and deleterious material within the sump area
- Repair of any damage to the protection geotextile in the base of the sump area
- Removal of the pipe end cap at the pipe penetration

- Removal of the geomembrane and protection geotextile layers over the staging bund at the pipe penetration to expose drainage aggregate within the staging bund
- Connection of the upstream and downstream pipes by moving the installed pipe sleeve
- Removal of the sandbags
- Backfilling of the sump area with the additional drainage aggregate
- Installation of separation geotextile to fully enclose the drainage aggregate layer

15. Seal bearing layer

15.1 General

This section contains the technical requirements for the seal bearing layer. The relevant requirements for the seal bearing layer in Section 3 shall be considered alongside guidance provided in this section.

The Superintendent may reject any component of the seal bearing layer that do not meet or exceed the requirements of this section.

Any component of the seal bearing layer rejected by the Superintendent shall be remediated at the expense of the Contractor.

15.2 Standards

15.2.1 Australian standards

Relevant Australian standards are as follows but not limited to :

- 1152 Specification for test sieves
- 1289 Methods of testing soils for engineering purposes
- 1289.2.1.1 Determination of the moisture content of a soil - oven drying method
- 1289.3.1.1 Soil classification tests - Calculation of the plasticity index of a soil
- 1289.3.6.1 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of analysis by sieving
- 1289.3.6.3 Soil classification tests - Determination of the particle size distribution of a soil - Standard method of fine analysis using a hydrometer
- 1289.3.8.1 Soil classification tests - Dispersion - Determination of emerson class number of a soil
- 1289.5.1.1 Soil compaction and density tests - Determination of the dry density/moisture content relation of a soil using standard compactive effort
- 1289.5.6.1 Soil compaction and density tests - Compaction control test - Density index method for a cohesionless material
- 1289.5.7.1 Soil compaction and density tests - Compaction control test - Hilf density ratio and Hilf moisture variation (rapid method)
- 1289.5.8.1 Soil compaction and density tests - Determination of field density and field moisture content of a soil using a nuclear surface moisture density gauge
- 1289.6.7.3 Methods of testing soils for engineering purposes - Soil strength and consolidation tests - Determination of permeability of a soil - Constant head method using a flexible wall permeameter
- 1726 Geotechnical site investigations
- 2868 Classification of machinery for earthmoving, construction, surface mining and agricultural purposes
- 3798 Guidelines on earthworks for commercial and residential developments
- 4419 Soil for landscaping and garden use

15.3 Submittals

15.3.1 Prior to placement of seal bearing layer

The Contractor shall submit the following to the Superintendent for review and approval prior to placement of the seal bearing layer:

- Pre-qualification test results/reports demonstrating that the proposed material complies with the material property requirements of this section of the Specification (refer Section 11.4)
- Estimated quantity of material which is represented by the pre-qualification test results/reports
- Survey of the underlying surface in accordance with Section 1.11
- Work method statement for placement of the seal bearing layer, including testing and repair procedures (refer Appendix A)

15.3.2 Following placement of seal bearing layer

The Contractor shall submit the following to the Superintendent for review and approval following placement of seal bearing layer:

- As-built survey of the completed surface showing conforming layer thickness within the allowable tolerances
- CQC testing results/reports showing compliance with the requirements of this Specification
- Defect and repairs log, showing details of all defects identified and any repairs completed

15.4 Material

Seal bearing material shall:

- Be selectively sourced material from on-site or imported from an approved source. Imported material shall be classed as VENM or ENM or NSW EPA Resource Recovery Exemption appropriate for use as seal bearing material
- Not contain any unsuitable materials identified in Section 3.4.1 unless approved by the Superintendent
- Be well graded in accordance with AS 1726
- Comply with the acceptance criteria specified in Table 15-1

The Contractor shall supply pre-qualification testing results in accordance with the testing frequencies identified in Table 15-1 showing that the proposed material meets the requirements of this table. Samples taken shall be representative of the whole material source and shall be evenly distributed across the material source.

If required by the Superintendent, a sample of the material shall be provided (per source) and the Superintendent and/or CQA Engineer may undertake an inspection of the material source. The Contractor shall cooperate fully with the Superintendent and CQA Engineer to allow this inspection to occur.

Table 15-1 Acceptance criteria – seal bearing material

Property	Test method	Acceptance criteria	Minimum test frequency
Particle size distribution: - Passing 19 mm - Passing 0.075 mm	AS 1141.11,12,13 or AS 1289.3.6.1, 3.6.3	100% > 25%	Greater of: 1 per 5,000 m^3 of material or 3 per source
Atterberg limits: - Plasticity index - Liquid limit	AS 1289.3.1.1, 3.2.1 & 3.3.1	8 – 35 ≤ 50	Greater of: 1 per 5,000 m^3 of material or 3 per source
California Bearing Ratio (CBR)	AS1289.5.7.1	≥ 5	Greater of: 1 per 5,000 m^3 of material or 3 per source
Emerson class	AS 1289.3.8.1	> 3	Greater of: 1 per 5,000 m^3 of material or 3 per source
% Organic content	AS 1289.4.1.1 or Walkley Black method	< 2%	1 per source
pH	AS 1289.4.3.1 or USEPA 9045 (1:5 solution)	4.5 – 8.5	1 per source
Ratio of Monovalent to Divalent Cations (RMD) [32]	ASTM 6141 and Rayment and Lyons 2011 15A1 [33]	> 0.15 $M^{0.5}$	1 per source

15.5 Preparation of receiving surface

Prior to placement of the seal bearing layer, the underlying geosynthetic shall be free of:

- Any of debris, roots, angular material (such as sharp rocks), or loose, coarse-grained material on or immediately below the geosynthetic
- Excessive wrinkles preventing intimate contact between the geosynthetic and the seal bearing layer

The foundation material underlying the geosynthetic shall:

- Be smooth, flat, firm and unyielding to the satisfaction of the Superintendent
- Be free of abrupt breaks, indentations and/or sudden changes in grade
- Promote drainage and excessive water shall not be allowed to pond on the surface of the geosynthetic

Placement of seal bearing layer shall not proceed until the underlying geosynthetic has been inspected and approved by the Superintendent. The seal bearing layer shall be placed immediately following acceptance of the geosynthetic panels to protect the underlying geosynthetic.

[32] RMD shall be calculated using exchangeable cation test results for material with respect to procedure outlined in Kolstad, D. C., Benson, C. H., and Edil, T. D. (2004). 'Hydraulic conductivity and swell of nonprehydrated GCLs permeated with multispecies inorganic solutions.' *J. Geotech. Geoenviron. Eng.*, 130(12), 1236–1249

[33] Methods for conducting exchangeable cation testing

The Superintendent may reject any underlying geosynthetic or underlying foundation material which does not meet these requirements. Any geosynthetic rejected by the Superintendent shall be removed from the site at the expense of the Contractor. Any rejected foundation material shall be removed and/or remediated to the satisfaction of the Superintendent.

15.6 Installation

The Contractor shall prepare a work method statement for placement of the seal bearing layer outlining the measures taken to moisture condition the seal bearing material prior to placement, placement methodology and proposed construction plant to be used (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and approval prior to placement.

The work method statement and construction methodology for the seal bearing layer shall be developed in accordance with the guidance provided below:

- The seal bearing material shall be moisture conditioned uniformly throughout the material prior to placement.
- If the seal bearing material requires significant moisture content adjustment, the Contractor shall use a moisture conditioning area to allow hydration or dehydration of material to meet moisture content requirements.
- Should the seal bearing material be too wet to permit proper compaction, all work on the portions of the seal bearing material affected shall be delayed until the material has dried to the required moisture content.
- The material shall be constructed in one layer or 300 mm maximum lifts where the depth is insufficient, to the lines and grades indicated.
- The surface of the seal bearing material lifts shall be maintained as necessary prior to placement of the overlying lifts or overlying materials to prevent any moisture variations outside the requirements of the Specification. The Contractor shall be required to rework areas which do not meet this requirement.
- The Contractor shall seal surfaces (by smooth drum rolling) at the end of each day to minimise the penetration of water, provide erosion protection measures and ensure drainage systems (permanent and temporary) are maintained.

15.7 Compaction

All seal bearing material shall be placed and compacted to the requirements of Section 3.12.

15.8 Construction quality control testing

The Contractor shall undertake CQC testing for the seal bearing layer in accordance with Section 3.13.

15.9 Tolerances

The Contractor shall place the seal bearing layer within the tolerances provided in Section 3.14.

15.10 Finished surface

The finished surface of the seal bearing layer shall exhibit the following characteristics:

- The surface shall be smooth, flat, firm and unyielding to the satisfaction of the Superintendent. The surface shall be proof rolled by the Contractor using a mechanical self-propelled smooth drum roller (or equivalent) in the presence of the Superintendent to assess the soundness and suitability of the finished surface. The surface shall not exhibit visible deformation, rutting, yielding and/or show signs of distress or instability during final proof rolling.
- The surface shall be free of debris, roots, angular material (such as sharp rocks), desiccation cracks and sudden changes in grade. If required, the surface shall be raked or graded to remove any material penetrating out of the surface greater than 10 mm.
- The surface shall promote drainage and excessive water shall not be allowed to pond on the surface.
- The surface shall not be rutted or otherwise disturbed by the equipment deploying overlying materials or other traffic.
- The surface shall be maintained at sufficient moisture content to prevent desiccation during the Works.

15.11 Defects and repairs

Any areas of placed seal bearing layer that do not conform to the required compaction and moisture content testing criteria shall be repaired by the Contractor in accordance with Section 3.17. This includes non-conformances resulting from independent testing commissioned by the Superintendent or CQA Engineer.

The Contractor shall submit to the Superintendent for review details of any defects identified and repairs carried out.

15.12 Acceptance

The Contractor shall retain ownership and responsibility for the seal bearing layer until Practical Completion

The seal bearing layer shall be accepted by the Superintendent when all of the following conditions are met:

- Required submittals are provided by the Contractor to the Superintendent and approved
- The Contractor has submitted the required as-built surveys of the completed seal bearing layer showing conformance with the Contract Drawings within the allowable tolerances, and this has been approved by the Superintendent
- CQC test results showing compliance with the requirements of this Specification have been provided by the Contractor to the Superintendent and approved
- Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
- The Superintendent has inspected and approved the finished surface/s

16. Revegetation layer

16.1 General

This section contains the technical requirements for the revegetation layer. The relevant requirements for the revegetation layer in Section 3 shall be considered alongside guidance provided in this section.

The Superintendent may reject any component of the revegetation layer that do not meet or exceed the requirements of this section.

Any component of the revegetation layer rejected by the Superintendent shall be remediated at the expense of the Contractor.

All revegetation layer materials will be selectively sourced material from on-site (as agreed with the Superintendent). Where the import of earthworks materials is required, the Contractor shall import materials as directed by the Superintendent and CQA Engineer.

16.2 Standards

16.2.1 Australian standards

Relevant Australian standards are as follows but not limited to:

- 1289 Methods of Testing Soils for Engineering Purposes
- 4419 Soils for Landscaping and Garden Use

16.3 Submittals

16.3.1 Prior to placement of subsoil and topsoil

The Contractor shall submit the following to the Superintendent for review and approval prior to placement of the subsoil and topsoil materials:

- Survey of the underlying surface in accordance with Section 1.11
- Work method statement for placement of the revegetation layer, including testing and repair procedures (refer Appendix A)

16.3.2 Prior to seeding and sowing

The Contractor shall submit the following to the Superintendent for review and approval following placement of seal bearing layer:

- Proposed seed mix
- As-built survey of the completed soil layers showing conforming layer thickness within the allowable tolerances
- CQC testing results/reports for the completed soil layers showing compliance with the requirements of this Specification
- Defect and repairs log for the soil layers, showing details of all defects identified and any repairs completed
- Statement from the supplier/s showing conformance of the seed mixes with the requirements of the Technical Specification

16.4 Material

16.4.1 Subsoil

Subsoil material shall:

- Be selectively sourced material from on-site or imported.
- Not contain any unsuitable materials identified in Section 3.4.1 unless approved by the Superintendent
- Be well graded in accordance with AS 1726
- Comply with the acceptance criteria specified in Table 16-1

Subsoil shall be a low organic matter material that is well balanced chemically and is not saline, sodic, excessively acidic, calcium deficient or dispersive. The subsoil material is intended to provide improved rooting depth and reduce the likelihood of water logging.

The Contractor shall supply pre-qualification testing results in accordance with the testing frequencies identified in Table 16-1 showing that the proposed material meets the requirements of this table. Samples taken shall be representative of the whole material source and shall be evenly distributed across the material source.

If required by the Superintendent, a sample of the material shall be provided (per source) and the Superintendent and/or CQA Engineer may undertake an inspection of the material source.

Table 16-1 Acceptance criteria – subsoil

Property	Test method	Acceptance criteria	Minimum testing frequency
Particle size distribution: - Passing 37.5 mm - Passing 13.2 mm - Passing 2.36 mm - Passing 0.075 mm - Passing 0.002 mm	AS1141.11,12,13 or AS1289.3.6.1, 3.6.3	100% 95 – 100% 80 – 100% 20 – 50% 10 – 30%	Greater of: 1 per 5,000 m^3 of material or 3 per source
Atterberg limits: - Plasticity index - Liquid limit	AS1289.3.1.1, 3.2.1 & 3.3.1	8 – 35 < 50	Greater of: 1 per 5,000 m^3 of material or 3 per source
Emerson class	AS1289.3.8.1	> 4	Greater of: 1 per 5,000 m^3 of material or 3 per source
% Organic content	AS 1289.4.1.1 or Walkley Black method	Nominally 2-3%	Greater of: 1 per 10,000 m^3 of material or 3 per source
pH	AS 1289.4.3.1 or USEPA 9045 (1:5 solution)	5.5 – 6.8	Greater of: 1 per 10,000 m^3 of material or 1 per source

16.4.2 Topsoil

Topsoil shall be selectively sourced from onsite-qualification test results from a NATA Accredited Laboratory to show the proposed material meets these requirements.

If required by the Superintendent, a sample of the material shall be provided (per source) and the Superintendent and/or CQA Engineer may undertake an inspection of the material source.

16.4.3 Seed mix

The Contractor shall submit their proposed seed mix to the Superintendent for approval prior to use.

16.5 Preparation of surface to receive revegetation layer

Prior to placement of the revegetation layer, the receiving surface shall be cleared of any debris and/or foreign material.

The receiving surface shall be surveyed as per the requirements of Section 1.11.

Placement of the revegetation layer shall not proceed until the receiving surface has been approved by the Superintendent.

16.6 Installation

16.6.1 Subsoil

The subsoil shall be placed and installed following placement of the geonet drainage geocomposite. Placement of the material will proceed from the toe to the crest of the slope. A minimum cover of 450 mm should be maintained between construction equipment and the underlying geosynthetic layers at all time. Subsoil shall be spread evenly in one layer over the designated areas. The initial lift will consist of a lift with a maximum compacted layer thickness of 500 mm in accordance with the, compaction and moisture content requirements

Surface water shall not be permitted to drain into the geonet drainage geocomposite beneath placed subsoil.

Compaction of the lift will be accomplished after spreading using either a pneumatic or vibratory roller. Sheepsfoot rollers will not be used for initial compaction.

16.6.2 Topsoil

The Contractor shall cover trucks transporting the topsoil material to prevent loss of material during transport. The Contractor shall ensure trucks do not allow loss of material through tailgates or other parts of the truck body.

The Contractor shall take responsibility for the placing procedures adopted whether those nominated or its own.

Topsoil shall be spread evenly in one layer over the designated areas and compacted lightly and uniformly so that the finished surface is smooth and free of stones or other lumps, weeds, rubbish and other deleterious material brought to the surface. Excessive compaction shall be avoided.

Once placed, the topsoil surface shall be thoroughly watered. Regular watering shall be conducted by the Contractor to minimise establishment time for the vegetation and mitigate any erosion risks. Watering shall continue to be conducted until the vegetation has been established to the satisfaction of the Superintendent.

The equipment used for placing and spreading of materials shall be suitable for the purpose. Low pressure tyred vehicles shall be used. Graders and other high pressure tyred vehicles equipment shall not be used. The Contractor shall vary the routes of vehicles and other plant passing over completed areas of each soil profile layer to avoid areas of excess compaction.

The Contractor shall prevent areas of excess compaction from being caused by constructional plant. Compact lightly and uniformly. The Contractor shall avoid differential subsidence and produce a finished topsoil surface which is:

- At design levels
- Smooth and free from stones or lumps of soil
- Graded to drain freely, without ponding
- Graded evenly into adjoining ground surfaces
- Ready for planting

16.7 Seeding and sowing

Seeding and sowing shall be completed in accordance with the Landscape Management Plan and the following guidance (as a minimum):

- Grass seed will be sown in accordance with the supplier's requirements and/or achieve a minimum 80% cover per square meter (whichever is greater)
- Seeding outside of the specified areas must be prevented
- After sowing the topsoil surface will be lightly raked to cover the surface and the area watered immediately
- Watering will continue throughout the establishment period in accordance with the supplier's requirements
- This area shall be protected from pedestrians or animals until the grass has established, and from vehicles or heavy plant at all times

16.8 Maintenance

The Contractor shall be responsible for maintaining the revegetation for a maintenance period of 12 months. A maintenance program shall be undertaken by the Contractor to assist vegetation establishment. This shall include activities such as watering, herbicide spraying and general maintenance.

The Contractor shall submit their proposed maintenance program for the revegetation to the Superintendent for approval prior to seeding.

16.9 Defects and repairs

Any areas of placed revegetation layer that do not conform to the required, establishment, erosion control, compaction and moisture content testing criteria shall be repaired by the Contractor in accordance with Section 3.17.

The Contractor shall submit to the Superintendent for review details of any defects identified and repairs carried out.

16.10 Acceptance

The Contractor shall retain ownership and responsibility for the layer until Practical Completion.

The revegetation layer shall be accepted by the Superintendent when all of the following conditions are met:

- Required lines, levels and thickness of the seal bearing layer has been achieved within the allowable tolerances as confirmed by survey data

- Required submittals are provided by the Contractor to the Superintendent and approved
- CQC test results have been received and show compliance with the requirements of this Specification
- Details of all defects identified and repairs performed have been submitted to the Superintendent and approved
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
- The Superintendent has inspected and approved the finished surface following a minimum 12 weeks vegetation establishment period

17. Field trial – drainage aggregate

17.1 General

This section contains the technical requirements for undertaking the field trial for the drainage aggregate. The relevant requirements in Section 3 shall be considered alongside guidance provided in this section.

All materials used for test sections shall be removed upon completion of the field trial and disposed of by the Contractor unless otherwise approved by the Superintendent.

17.2 Submittals

17.2.1 Prior to conducting the field trial

The Contractor shall submit the following to the Superintendent for review and approval prior to conducting the field trial:

- Work method statement for field trial methodology, including proposed location of the field trial
- Work method statement for installation of the drainage aggregate

17.2.2 Following completion of the field trial

The Contractor shall submit the following to the Superintendent for review and approval following completion of the field trial:

- A report containing the methods, details and results of the field trial
- Updated work method statement for installation of the drainage aggregate based on the results of the field trail

17.3 Method

The Contractor shall conduct a field trial of the drainage aggregate for each source of drainage aggregate material and protection geotextile arrangement. The purpose of the field trial is to evaluate the impact to the PE from the Contractor's proposed drainage aggregate placement method and performance of the protection geotextile.

17.3.1 Proposed placement method

The Contractor shall submit a work method statement outlining the proposed placement method of the drainage aggregate to the Superintendent prior to undertaking the field trial.

The work method statement shall include details of the following as a minimum:

- Method of transportation of drainage aggregate to placement location
- Method of spreading drainage aggregate
- Method of lift thickness control
- Details of plant and equipment to be used during placement, including calculation of ground pressure and proposed drainage aggregate thickness limits during trafficking
- Details of temporary pads or access tracks for plant exceeding allowable ground pressure limits
- Approximate number of passes for each item of plant on the drainage aggregate layer

17.3.2 Field trial of placement method

The field trial shall be supervised by the following personnel as a minimum:

- Contractor
- Geosynthetic Installer
- Superintendent
- CQA Engineer

The field trial may be constructed within the proposed layer area, or in an area approved by the Superintendent. The Contractor shall nominate the proposed location of the field trial for approval prior to undertaking the trial.

The field trial shall measure approximately 10 m by 20 m, unless otherwise approved by the Superintendent. Should the Superintendent approve construction of the field trial outside of the proposed drainage aggregate layer area, the Contractor shall construct the field trial on an area consistent with those represented on the Contract Drawings, and the areas of drainage aggregate shall be constructed using the methods, materials and equipment to be used during construction of the permanent drainage aggregate layer.

The complete underlying material profile shall be installed for the field trial to provide meaningful and complete results. The underlying materials for the field trial shall be installed as per the methods used to install the permanent underlying materials.

The drainage aggregate shall be placed as per the work method statement outlined in Section 17.3.1. The field trial shall mimic the actual placement method and real-world conditions. Any variations from this work method statement shall result in a non-conforming field trial unless approved by the Superintendent.

The Superintendent may direct additional passes or turning manoeuvres to be performed at their discretion to fully test the effectiveness of the protection geotextile.

17.3.3 Exhumation and inspection of the underlying geosynthetics

Prior to removal of the drainage aggregate, the layer thickness shall be recorded in order to compare the degree of damage to the thickness of the drainage aggregate.

Following completion of the field trial, the underlying PE geomembrane shall be exposed.

Most of the material may be removed using an excavator; however, care shall be taken to avoid doing any further damage to the underlying geosynthetics. Within 100 mm of the PE geomembrane, the material shall be removed by hand excavation to avoid damage to the PE geomembrane.

Once the material has been removed, the PE geomembrane shall be inspected for damage. The PE geomembrane shall be inspected over the length of the field trial test area.

Damage to the PE geomembrane shall include any holes, creases, indentations or scratches. Undamaged geomembrane shall be unblemished.

The location of the damage shall be recorded and compared to the drainage aggregate thickness at that point.

Where it is clear that there is no damage to any layers of the underlying geosynthetics as agreed with the Superintendent, the thickness of the drainage aggregate and associated plant and equipment used at that point shall be recorded.

17.3.4 Reporting and update of the proposed placement method

The Contractor shall submit a report to the Superintendent outlining the major findings from the field trial. The Contractor shall update the proposed placement method to reflect the findings of the field trial.

The Superintendent shall review and approve the updated placement method prior to placement of the permanent drainage aggregate layer. The report and updated placement method shall be provided to the Superintendent 10 working days prior to placement of the drainage aggregate.

18. Field trial – soil confining layer

18.1 General

This section contains the technical requirements for undertaking the field trial for the soil confining layer. The relevant requirements in Section 3 shall be considered alongside guidance provided in this section.

All materials used for test sections shall be removed upon completion of the field trial and disposed of by the Contractor unless otherwise approved by the Superintendent.

18.2 Submittals

18.2.1 Prior to conducting the field trial

The Contractor shall submit the following to the Superintendent for review and approval prior to conducting the field trial:

- Work method statement for field trial methodology, including proposed location of the field trial
- Work method statement for installation of the soil confining layer

18.2.2 Following completion of the field trial

The Contractor shall submit the following to the Superintendent for review and approval following completion of the field trial:

- A report containing the methods, details and results of the field trial
- Updated work method statement for installation of the soil confining layer based on the results of the field trail

18.3 Method

The Contractor shall conduct a field trial of the soil confining layer for each source of material and underlying material arrangement. The purpose of the field trial is to evaluate the Contractor’s proposed soil confining layer placement method and performance of the protection measures on the PE.

18.3.1 Proposed placement method

The Contractor shall submit a work method statement outlining the proposed placement method of the soil confining layer to the Superintendent prior to undertaking the field trial.

The work method statement shall include details of the following as a minimum:

- Method of transportation of soil confining layer material to placement location
- Method of spreading soil confining layer material
- Method of lift thickness control
- Details of plant and equipment to be used during placement, including calculation of ground pressure and proposed soil confining layer material thickness limits during trafficking
- Details of temporary pads or access tracks for plant exceeding allowable ground pressure limits

- Approximate number of passes for each item of plant on the soil confining layer, including consideration for trafficking required for placement of layers above

18.3.2 Field trial of placement method

The field trial shall be supervised by the following personnel as a minimum:

- Contractor
- Geosynthetic Installer
- Superintendent
- CQA Engineer

The field trial may be constructed within the proposed layer area, or in an area approved by the Superintendent. The Contractor shall nominate the proposed location of the field trial for approval prior to undertaking the trial.

The field trial shall measure approximately 10 m by 20 m, unless otherwise approved by the Superintendent. Should the Superintendent approve construction of the field trial outside of the proposed layer area, the Contractor shall construct the field trial on an area consistent with those represented on the Contract Drawings, and the areas of soil confining layer material shall be constructed using the methods, materials and equipment to be used during construction of the permanent soil confining layer.

The soil confining layer material shall be placed from the bottom of any slope and pushed upward.

The complete underlying material profile shall be installed for the field trial to provide meaningful and complete results. The underlying materials for the field trial shall be installed as per the methods used to install the permanent underlying materials.

The soil confining layer shall be placed as per the work method statement outlined in Section 18.3.1. The field trial shall mimic the actual placement method and real-world conditions. Any variations from this work method statement shall result in a non-conforming field trial unless approved by the Superintendent.

The Superintendent may direct additional passes or turning manoeuvres to be performed at their discretion to fully test the effectiveness of the protection geotextile.

18.3.3 Exhumation and inspection of the underlying geosynthetics

Prior to removal of the soil confining layer material, the layer thickness shall be recorded in order to compare the degree of damage to the thickness of the soil confining layer.

Following completion of the field trial, the underlying PE geomembrane shall be exposed.

Most of the material may be removed using an excavator; however, care shall be taken to avoid doing any further damage to the underlying geosynthetics. Within 100 mm of the PE geomembrane, the material shall be removed by hand excavation to avoid damage to the PE geomembrane.

Once the material has been removed, the PE geomembrane shall be inspected for damage. The PE geomembrane shall be inspected over the length of the field trial test area.

Damage to the PE geomembrane shall include any holes, creases, indentations or scratches. Undamaged geomembrane shall be unblemished.

The location of the damage shall be recorded and compared to the soil confining layer thickness at that point.

Where it is clear that there is no damage to any layers of the underlying geosynthetics as agreed with the Superintendent, the thickness of the soil confining layer and associated plant and equipment used at that point shall be recorded.

18.3.4 Reporting and update of the proposed placement method

The Contractor shall submit a report to the Superintendent outlining the major findings from the field trial. The Contractor shall update the proposed placement method to reflect the findings of the field trial.

The Superintendent shall review and approve the updated placement method prior to placement of the permanent soil confining layer. The report and updated placement method shall be provided to the Superintendent 10 working days prior to placement of the soil confining layer.

19. Stormwater drainage

19.1 General

This section contains the technical requirements for drainage elements including open drainage channels and underground culverts.

All drainage provided is to maintain the cross-sectional flow areas, slopes and lining types indicated in the design drawings to allow for the design flow conveyance and resistance to scour.

19.2 Standards

Relevant Australian standards are as follows but not limited to:

- AS3500 – Plumbing and Drainage
- AS3725 –Design and Installation of buried concrete pipes
- AS3725 Supplement 1
- AS2758.1 – Concrete aggregates
- AS1141 – Methods for Sampling and Testing Aggregates
- Australian Rainfall and Runoff A Guide to Flood Estimation

19.3 Submittals

19.3.1 Prior to delivery of materials

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of drainage materials to site:

- Product details, information and certificates for any culverts to be installed
- Details of any bedding and haunch material for stormwater drainage
- Details including particle size distribution curve and specific gravity for placed rock.
- A work method statement including details of the following as a minimum: scheduling, supply and quality control, method of installation, surface preparation, trimming and final surface preparation, defects and repairs, and quality control testing

19.4 Materials and Installation

19.4.1 Erosion Control Matting

Erosion control matting is to be provided in locations specified in design drawings. Matting to be “Grassroots” product supplied by Geofabrics Australasia or equivalent. Hydroseeding to be provided underneath matting Erosion control matting to be installed in accordance with manufacturers guidelines including Matting Installation Guide available from the supplier.

19.4.2 Topsoil

Topsoil in drainage channels is to be supplied and installed in accordance with general topsoil requirements detailed in Sections 16.4.2 and 16.6.2

19.4.3 Placed Rock

Rock is to be provided in channels as specified in the design drawings. Rock selection and installation is to maximise stability of channel under high velocities and must include the following:

- Selection of rock sizing, mass and grading as specified in design drawings
- Selection of rocks with an angular shape (not round) to maximise interlocking
- Selection of hard, dense and durable rocks with a specific gravity of approximately 2.65
- Placement of rocks in layers with large rocks placed first and smaller rocks fitted tightly in-between larger rocks to maximise interlocking

19.4.4 Crushed rock bedding

All bedding and haunch material used in rock lined channels shall be crushed rock material complying with the requirements of AS2758.1 and AS1141.

All proposed bedding and haunch material for stormwater drainage shall be subject to approval by the Superintendent.

Standard bedding and haunch material shall be of 10.0 mm nominal size.

In wet or unstable ground conditions where the trench bottom requires further stabilizing, additional bedding of 20 mm and/or 30 mm nominal size (as directed by the Superintendent), shall be placed below the standard bedding to a depth determined by the Superintendent. Where ordered by the Superintendent an approved filter fabric shall be used in conjunction with the additional bedding.

The bed and haunch material shall be compacted for the full width of the trench by two passes of a vibrating plate or hand tamping method to the satisfaction of the Superintendent.

19.4.5 Culverts

Delivery & Handling

Pipes shall be delivered, stacked and handled in accordance with the manufacturer's recommendations. Any box culvert which is damaged during installation or during compaction of fill shall be replaced by the Contractor at the Contractor's cost.

Jointing & Assembly

Pipes and fittings shall be installed and joined in accordance with the manufacturer's recommendations. Pipes shall be laid with the female end placed upstream.

Joints in box culvert segments shall be made using cement mortar to provide as thin a joint as possible. The external faces of the units shall be bandaged with 'Denso Tape 600' or approved equivalent 200 mm wide lapped by at least 100 mm.

Lifting holes in pipes and culverts shall be plugged with mortar, precast tapered plugs mortar or tape surrounded, or other approved means prior to backfill material being placed.

Cutting operations for concrete pipe and box culverts shall provide neat end surfaces. The cut surfaces shall be given two coats of a tar epoxy paint.

Joints shall not be made under water. The trench shall be de-watered to facilitate joint making and inspection. Precautions shall be taken to prevent erosion of joint material by moving currents of water.

Completed cement mortar joints shall be kept damp and protected from the direct rays of the sun until backfilling takes place.

Installation Condition and Support

Installation shall be in accordance with AS 3725 and AS 3725 Supplement 1 with Type HS3 support. Unless specifically noted otherwise, all pipes shall be installed in trench condition (either negative projection or induced trench). For trench installation condition in an embankment, the embankment must be completed to the underside of the sub-grade prior to the commencement of the excavation for the pipe unless the Superintendent's Representative directs a change to embankment installation condition and the pipe class is amended accordingly.

Where the prior placement of embankment fill is required to provide for Type HS3 Support, the fill shall be placed and compacted as part of earthworks construction specified in Section 2.3.

In water charged soil or made up ground, drainage shall be bedded on reinforced concrete lintels at least 150 mm thick supported on piers or piles as specified and located at intervals not exceeding 3 m or suspended from slabs.

Minimum cover to box culverts shall be 500 mm under trafficable areas and 450 mm elsewhere UNO.

Precast components

Pre-cast concrete headwalls to box culverts shall be supplied and installed in accordance with the manufacturer's specification. Quality certification to the appropriate Australian Standards must be supplied by the manufacturer and submitted to the Superintendent's Representative prior to incorporation into the works.

Fill Construction

Lifting holes on all units shall be sealed by the Contractor to a standard of full structural integrity and durability before commencement of backfilling.

All box culverts shall be bedded on a continuous underlay of sand, not less than 75 mm thick in other than rock and 200 mm thick in rock after compaction. The sand shall be graded in accordance with AS3500 (latest edition) and compacted to at least 90% of the maximum dry density and shall be graded evenly to the required gradient of the pipeline.

In wet or unstable ground conditions where the trench bottom requires further stabilising, additional bedding of 20 mm and/or 30 mm nominal size aggregate (as directed by the Superintendent's Representative), shall be placed below the standard bedding to a depth determined by the Superintendent's Representative. Where ordered by the Superintendent's Representative an approved filter fabric shall be used in conjunction with the additional bedding.

The bed material shall be compacted for the full width of the trench by a minimum of two passes of a vibrating plate or hand tamping method to the satisfaction of the Superintendent's Representative.

Chases shall be formed where necessary to prevent sockets, flanges or the like from bearing on the trench bottom or the underlay.

Fill construction includes all operations associated with the preparation of the foundation areas on which fill material is to be placed, the placing and compacting of approved material within areas from which Unsuitable Material has been removed, the placing and compacting of fill material and of materials of specified quality in nominated zones and all other activities required to produce filled areas as specified to the alignment, grading, levels and dimensions shown on the Contract drawings. The Superintendent's Representative may order the removal of any Unsuitable Material prior to commencing construction operations.

General Fill Material

General fill material shall be inorganic, non-perishable well graded material with a maximum particle size of 75 mm and particle size not exceeding two-thirds of the compacted layer thickness, plasticity index □ 55%. General fill excludes material containing a sulphur content exceeding 0.5%.

Where excavated material is to be used for filling, the material shall be tested according to this Section 5. Test results must be approved by the Superintendent's Representative, following a visual inspection, prior to use of fill material.

Select/Engineered Fill:

Select/Engineered fill shall be granular material complying with the following:

- Particle size: 75 mm maximum
- Proportion passing 0.075 mm sieve: 25% maximum
- Plasticity index: > 2%, < 15%
- Hardcore: Graded hard material capable of being compacted to an even stable surface
- Particle size: 120 mm maximum
- Proportion exceeding particle size of 50 mm: 75% minimum

Selected/Engineered filling materials shall be free from:

- Organic soils
- Materials contaminated through past site usage
- Materials which contain substances which can be dissolved or leached out, or which undergo volume change or loss of strength when disturbed and exposed to moisture
- Silts or silt-like materials
- Fill containing wood, metal, plastic, boulders or other deleterious material
- Clays of high plasticity
- Material containing large particles after compaction
- Over-wet materials
- Gravels or rock fill which leave voids
- Saline soils
- Carbonate soils
- Demolition rubble

Unsuitable Material

Unsuitable Material, defined as material below sub-grade in excavations, below structures in excavations and below natural surface under embankments with fill liable to subsidence, ground containing cavities, faults or fissures, ground contaminated by harmful substances or ground which is or becomes soft, wet or unstable, might be encountered beneath proposed structures such as footings, slabs and roads which the Superintendent's Representative considers to be unsuitable for embankment or pavement support in its present position and likely to remain so despite dewatering or drying out of the subject area.

Unsuitable Material can be identified visually or through proof rolling.

It shall be the responsibility of the Contractor to notify the Superintendent’s Representative, of areas where treatment of Unsuitable Material may be required and to demonstrate to the satisfaction of the Superintendent’s Representative the unsuitability of that material.

Unsuitable Material does not include that which:

- Has become saturated due to the Contractor having neglected to protect the work by providing adequate drainage; or.
- Otherwise suitable material in a wet condition which can be removed, dried out and reused.

Material, which is deemed to be unsuitable shall be excavated and disposed of in suitable areas onsite or removed from site. Seek the Superintendent’s Representatives instruction.

Material deemed unsuitable for pavement construction may include:

- Alluvium (soft silts with some organics)
- Organic soils, severely root-affected subsoils and peat
- Material with a particle size greater than 300 mm
- Fill which contains wood, metal, plastics, boulders or other deleterious material

After removal of the Unsuitable Material, the floor of the excavation shall be inspected by the Superintendent’s Representative to determine whether a sufficient depth of Unsuitable Material has been removed, prior to backfilling with replacement material.

19.5 Maintenance

The Contractor shall be responsible for monitoring and maintaining the drainage network for a period of 12 months, in particular with relation to revegetation of channels, scour and the condition of the network after significant rainfall events. A maintenance program shall be undertaken by the Contractor and should be submitted to the Superintendent for approval.

19.6 Defects and Repairs

All repairs shall be undertaken in accordance with the manufacturer’s instructions and the approved work method statement. All repairs shall be verified by the Superintendent. The drainage system was designed to convey a minimum of the 20-year ARI peak flow rate, with the exception of the rock lined channels where rock sizing was sized based on the 10-year ARI peak flow rate. For storm events in excess of these erosion or other related damage may result to channels and surrounding areas. An inspection of all drainage lines is to be undertaken during major events which could have possibly exceeded design storm events. The inspection should include observation for any signs of overflow from the system and any resulting damage. Repairs should be undertaken as required.

19.7 Acceptance

The Contractor shall retain all ownership and responsibility for the drainage network until Practical Completion.

20. Minor concrete works

20.1 General

This section applies to minor plain and reinforced concrete work. Concrete workmanship and materials must be in accordance with AS 3600 – Concrete Structures Code.

20.2 Standards

20.2.1 Australian standards

Relevant Australian standards are as follows but not limited to:

- AS 1012 Methods of testing concrete
- AS 1275 Metal screw threads for fasteners
- AS 1379 Specification and supply of concrete
- AS 1478 Chemical admixtures for concrete, mortar and grout – Admixtures for concrete
- AS/NZS 1554.3 Structural steel welding – Welding of reinforcing steel
- AS 2350 Methods of Testing Portland and Blended Cements
- AS 2758.1 Aggregates and rock for engineering purposes – Concrete aggregates
- AS 3582.1 Supplementary cementitious materials for use with Portland and blended cement - Fly-ash
- AS 3582.2 Supplementary cementitious materials for use with Portland and blended cement - Slag - Ground granulated iron blast-furnace
- AS 3583 Methods of test for supplementary cementitious materials for use with Portland and blended cement
- AS 3600 Concrete structures
- AS 3610 Formwork for concrete
- AS 3735 Concrete structures retaining liquids
- AS 3799 Liquid membrane-forming curing compounds for concrete
- AS 4100 Steel Structures
- AS/NZS 4671 Steel reinforcing materials
- AS/NZS 4680 Hot-dip galvanised (zinc) coatings on fabricated ferrous articles

20.3 Submittals

20.3.1 Prior to selection of concrete mix

The Contractor shall submit the following to the Superintendent for review and approval prior to the selection of a concrete mix:

- Concrete mix designs and material supply
- Concrete trial mix testing program
- Manufacturers' or suppliers' recommendations

20.3.2 Prior to delivery of materials to site

The Contractor shall submit the following to the Superintendent for review and approval prior to the delivery of materials to site:

- Product data
- Material source
- Pre-qualification test results/reports demonstrating that the proposed material complies with the material property requirements of this section of the Specification (refer **Error! Reference source not found.**)
- Estimated quantity of material which is represented by the pre-qualification test results/reports
- Delivery Docket for each batch of concrete containing the following information:
  - Method of placement and climate conditions during pour
  - Name of concrete delivery supervisor
  - Project assessment carried out each day
  - The amount of water, if any, added at the Site
  - The concrete element or part of the Work for which the concrete was ordered, and where it was placed
  - The total amount of water added at the plant and the maximum amount permitted to be added at the Site

Table 20-1 Material certification requirements

Material	Document Type	Minimum Requirement
Cement (including supplementary cementitious materials)	NATA accredited Test Certificates	Information in accordance with the requirements of Section **Error! Reference source not found.** and AS 3972. Na2O equivalence of cement
Fly ash	NATA accredited Test Certificates	Information in accordance with Appendix C of AS 3582.1
Slag	NATA accredited Test Certificates	Information in accordance with Appendix C of AS 3582.2
Aggregates	NATA accredited Test Certificates	Aggregate properties shall be in accordance with the relevant Australian Standards and shall comply with the requirements of AS 2758.1 except where noted below:
	Report	Petrographic examination in accordance with ASTM C295 with particular reference to the likelihood of alkali reactive aggregates.
Water	Report	Justification for acceptance in accordance with Section 2.4 of AS 1379
Admixtures	Product Data Sheets	Product Name Active Ingredients Approved dose rates Certificates of compliance to the requirements of AS 1478
Curing Compounds	Product Data Sheets	Product name Approved dose rates Certificate of compliance with the requirements of Section 3 of AS 3799
Concrete	NATA accredited Test Certificates	Sulphate and chloride ion content (AS 1012 Method 20)
Site Drilled Anchors	Product Data Sheet	Compliance with Drawings and durability requirements

20.3.3 Prior to installation of concrete structure

The Contractor shall submit the following to the Superintendent for review and approval prior to the installation of concrete structures:

- Contractors Work Method Statement
- Product/design substitution or modification

20.3.4 Following installation of concrete structure

The Contractor shall submit the following to the Superintendent for review and approval after the installation of concrete structures:

- Contractors' Inspection and Test Records

20.4 Formwork

The materials, design and construction of formwork must comply with AS 3610 and Section 19 of AS 3600.

The Contractor must design, fabricate, erect and strip formwork. Refer to Section 2 of AS 3610.

20.4.1 Types of Formwork

General

The types of formwork must be determined by the Contractor to achieve the surface finishes and the shapes, lines, levels and dimensions of the concrete work required by the drawings and this Specification.

Unless shown otherwise on the Drawings, forms must be filleted for corners. The face of the bevel in each case must be 20 mm and must form a straight line at 45 degrees to the faces of the forms. Drip grooves must be provided continuously around soffit edges to the dimensions and locations as detailed on the Drawings.

All materials to be used in the formwork must comply with the appropriate Australian Standards or in their absence the appropriate American or British Standards.

Void Formers

The material and construction used for the forming of voids, blockouts and the like must be of sufficient strength to prevent deformation or destruction under the load of wet concrete and construction loads and such as to prevent leakage of wet concrete or water into the voids. The formers must be so positioned and secured that they will not be dislodged during the concreting and will produce the required void within the tolerances stipulated in this specification. Care must be taken to resist the buoyancy effects of the wet concrete on the formwork.

If the void former is to remain in place it must be of lightweight construction not heavier than allowed for in the design of the element and unless fully surrounded and protected by concrete or the ground, it must also be incombustible.

Void formers used to form a space to allow for differential movement between structural elements must be of adequate strength to support the weight of the wet concrete and must have sufficient plasticity to permit the movement specified. Void formers must not be manufactured from absorbent material.

Void formers must be removed from the poured concrete by the Contractor leaving a clean penetration as shown on the Drawings and in accordance with the deviances nominated by this Specification. After the removal of void formers the concrete, which forms the extent of the void, must be within 10 mm of its theoretical position.

Permanent or Lost Formwork

Where it is not possible or practicable to remove formwork from formed surfaces, permanent or lost formwork must be used. Such formwork must be of sufficient strength and rigidity to support the weight of the wet concrete and construction loads and must be incombustible.

Permanent formers containing Calcium Chloride must not be used.

Where such formwork is also acting as a part of a construction joint it must be capable of transmitting any shear at the joint by indentation, penetration or the like.

The Superintendent must agree to the use of permanent or lost formwork.

20.4.2 Minimum Formwork Stripping Times

Refer to Section 5 of AS 3610 and Section 19 of AS 3600.

The requirements for minimum formwork stripping times are as set out in AS 3610 and Section 19 of AS 3600 where these are more stringent than the relevant requirements of AS 3610.

20.4.3 Stacked Materials

Materials must not be stacked on formwork or on concrete work supported by formwork.

20.4.4 Restraint of Formwork

Formwork must not be braced against previously cast concrete. Framed bracing must be constructed between formwork supports.

20.4.5 Sequence of Pours

The proposed sequence of pours must be submitted to the Superintendent for approval.

20.4.6 Inserts and Penetrations

Inserts or penetrations not specifically detailed on the Drawings must not be located without the approval of the Superintendent.

20.4.7 Permanent Formwork

Formwork that is required to remain permanently in the structure must be incombustible and must be free from calcium chloride.

20.4.8 Critical Face of Elements

The critical face must be the surface exposed to view.

20.4.9 Surface Finishes

Refer to Section 3 of AS 3610. The following surface finishes must be achieved:

Area	Surface Finish
Areas viewed as a whole (e.g. exposed external walls and internal walls of sewerage and stormwater drainage structures)	3
Areas concealed from view (e.g. hidden external walls, backs of sewerage and stormwater drainage structures)	4
Totally concealed areas where the only requirement is structural adequacy (i.e. footings etc.)	5

20.4.10 Construction

Refer to Section 5 of AS 3610.

20.4.11 Tolerances for Structures and Formwork

Refer to Section 19.5 of AS 3600 and Section 5 of AS 3610.

For formed surfaces the tolerances given in AS 3610 take precedence, unless those in Section 19.5 of AS 3600 are more stringent. For unformed plane surfaces, the flatness tolerances must not be greater than the relevant values in Clause 19.5.2 of AS 3600 and the methods for measuring them must be in accordance with AS 3610.

20.5 Reinforcement

Refer to Section 19 of AS 3600.

20.5.1 Samples

The Contractor must supply samples of materials when requested by the Superintendent and after agreement, subsequent work must be identical in appearance and quality to the reviewed sample.

20.5.2 Materials

Reinforcing Bar, Wire or Fabric

Reinforcing bar, wire or fabric must conform to the requirements of AS/NZS4671 as appropriate to the particular type and grade of reinforcement.

Identification and Testing of Reinforcement

Reinforcement must be readily identifiable as to grade and origin.

Copies of Manufacturer's test certificates as required by and in accordance with AS/NZS4671 as appropriate to the type and grade of reinforcement must be provided, if requested.

Reinforcement, which does not conform to this Specification, shall be rejected.

Incidental Materials – Bar Chairs etc. and Tie Wire

Bar chairs, spacers or stools must be made of plastic, concrete or of welded hard-drawn steel wire provided with plastic tips.

Tie wire must be black annealed 1.25 mm diameter wire, or alternatively approved clips may be used.

Sufficient quantities of the above must be supplied by the Contractor and delivered with the reinforcement, as directed by the Superintendent.

20.5.3 Fabrication

Bending, Splicing and Welding of Reinforcement

Reinforcement must be bent or straightened in a manner that will not damage it and to the requirements of Clause 19.2.3 of AS 3600.

The dimensions of splices, hooks and bends must conform to Clause 19.2.3.2 of AS 3600.

When splices not already shown on the Drawings are found necessary, the details of the proposed splices must be submitted for review by the Superintendent before use.

A lapped splice for welded mesh in tension shall be made so the two outermost cross-bars spaced at not less than 100 mm or 50 mm apart for plain or deformed bars, respectively, of one sheet of mesh overlap the two outermost cross-bars of the sheet being lapped as shown in the figure below. The minimum length of the overlap shall equal 100 mm.

Reinforcement must not be welded nor shall the use of tack welding be permitted in the manufacture of reinforcement cages without the specific agreement for use by the Superintendent. This Clause 0 does not apply to welding during manufacture of the wire fabric.

Reinforcing bar which has been supplied bent must not be subject to further cutting or bending without approval of the Superintendent. The use of heat for bending or rebending of galvanised reinforcement will not be permitted.

Heating or welding of reinforcement must be carried out only if agreed to by the Superintendent. Welding of reinforcing bars must satisfy the requirements of AS1554.3.

Where reinforcement is shown staggered no more than 50% of the reinforcement must be lapped at any one section unless otherwise specified.

Fabrication Tolerances

Reinforcement must be fabricated to the shape and dimensions shown on the Drawings and within the tolerances specified in Clause 19.2.2 of AS 3600.

Surface Condition

The surface condition of reinforcement must be supplied free from loose mill scale, loose rust, clay, mud, oil, grease and other coatings, which would reduce the bond between the concrete and the reinforcement.

Protective Coated Reinforcement

Unless otherwise shown on the Drawings, if an element is specified to contain protective coated reinforcement, the same coating type must be applied to all that elements' reinforcement and embedded ferrous metal items, including tie wires, stools, spacers, plates, ferrules and the like and other embedded metals must be protected by a suitable coating.

Galvanised Reinforcement

Where shown on the Drawings, reinforcement must be hot dipped galvanised in accordance with AS 4680. Reinforcement to be galvanised must be passivated in a 0.2% sodium dichromate solution applied by the galvaniser or alternatively chromium trioxide must be added to the concrete mix in the ratio of 300 ppm by weight of mixing water (0.3 grams per litre).

The galvanised coating must conform to AS 4680 and must have a minimum coating of 700 grams/square metre. Where galvanised reinforcement is welded, it is to be descaled and regalvanised following the recommendation contained in Appendix F of AS4680.

The use of heat for bending or re-bending of galvanised reinforcement will not be permitted.

20.5.4 Delivery, Unloading and Storage

Delivery

Fabricated reinforcing steel must be bundled and securely tied to ensure that it does not sustain damage during delivery or unloading.

Each bundle or piece must be identified by a wired-on metallic tag showing the 'mark' of that bundle. The 'mark' must refer to the bending schedule.

A different coloured tag must be used to identify each of the separate modules on the project.

Reinforcement must be delivered to the Site by the Contractor.

Unloading & Storage on Site

Fabricated reinforcing steel must be unloaded and stored on site in such a manner that it does not sustain damage or become contaminated by material liable to influence its effectiveness as reinforcing in concrete.

20.5.5 Bending Schedules

Bending schedules must be prepared by the Contractor, indicating shapes, dimensions and details of bar reinforcement.

20.5.6 Reinforcement Development Lengths

Unless noted otherwise on Drawings, the reinforcement development and cog lengths must be as below:

Bar Size	Development of Lap Length (mm)	Cog Length (mm)
N12	400	200
N16	500	250
N20	650	300
N24	850	350
N28	1150	400
N32	1400	450
N36	1700	550

20.5.7 Placing of Reinforcement Steel

Tolerances

Reinforcement must be placed within the tolerances specified in Clause 17.5.3 of AS 3600, the Drawings and this Specification.

Alignment

Reinforcement must be free from bends not required on the Drawings, kinks and similar defects and must be securely fastened and maintained in position.

Support of Reinforcement

Reinforcement must be securely held in position by using spacers or stools made of plastic or plastic tipped metal, by metal hangers or by other agreed means with the Superintendent. Reinforcement must not be held in position by bare steel supports which extend to the surface of the concrete. Reinforcement must not be supported on pieces of wood, brick, aggregate or like material.

Sufficient means of support must be provided to ensure that the reinforcement does not sag between supports and to allow the reinforcement to be walked upon without damage.

The concrete cover to reinforcement nominated on the Drawings and this Specification must be maintained at all times.

Reinforcement must be tied at intersections with black annealed 1.25 mm diameter iron wire. The free ends of the wire must be bent inwards toward the centre of the section of the concrete.

Reinforcement in suspended slabs and in concrete pavements must be supported by bar chairs etc. at a maximum spacing of 750 mm.

Reinforcement for concrete slabs poured on ground in conjunction with a vapour barrier must be supported on bar chairs which are supported on spreader plates sufficient to prevent the bar chair puncturing the vapour barrier.

In reinforcement in the form of a mat, each bar must be secured at alternate intersections and at other points as required.

Each beam ligature must be secured to a bar in each corner of the ligature and all longitudinal column reinforcement secured to all ligatures at every intersection.

Lifting of reinforcement through wet concrete will not in any circumstances be permitted.

20.5.8 Cores and Embedments

The supply and fixing of cores and embedments is included in other sections of this Specification. Reinforcement must not be cut to provide space for core holes or embedments. Reinforcement may be moved slightly to allow fitting of cores. Agreement from the Superintendent must be obtained.

20.5.9 Protection of Other Works

The Contractor is responsible at all times for the protection of work completed by others throughout the duration of the Works.

20.5.10 Inspections

The Contractor must give a minimum 24 hours' notice to the superintendent of the reinforcement, forms and embedment being completed and ready for inspection prior to pouring of concrete.

The inspection of the reinforcement does not relieve the Contractor of its responsibility to carry out its own inspection and to ensure compliance with the Contract.

The Contractor must allow sufficient time for these inspections and time to complete any necessary rectification work and subsequent re-inspection.

20.6 Concrete

The following Clause must be read in conjunction with the Drawings and the applicable specifications and relevant Australian Standards.

20.6.1 Schedule of Concrete Mixes

Unless otherwise noted on Drawings, concrete mixes must be as below:

Element/Location	Class/Grade	f'c at 28 days (Mpa)	Aggregate size (mm)	Slump (mm)
All reinforced concrete	N40	40	20	80 +/- 15

20.6.2 Concrete Supply and Placement

The Contractor must select materials and design concrete mixes. The Contractor must design and produce finished concrete and concrete work that is in accordance with this Specification.

20.6.3 Materials

Cement

Cement must be Type GP - General Purpose Portland Cement complying with AS 3972.

Fly Ash

Fly ash must not be used as an additive to cement, unless it can be established to the satisfaction of the Superintendent that aggregates for the concrete mix are unlikely to have the potential to create an environment for an aggregate/alkali reaction.

The proportion of fly ash must be 25% by weight of the total combined weight of fly ash and cement.

Fly ash must satisfy the requirements of AS 3582.1 and AS 3583.

Fine and Coarse Aggregates

Fine and coarse aggregates must satisfy the requirements of AS1141 and AS2758.1. The maximum coarse aggregate size must be 20 mm.

Water

The water used in mixing concrete must be clean and free from injurious amounts of oil, acid, alkali, organic matter or other deleterious substances and must be of potable quality.

Admixtures

Chemical admixtures in concrete may be used only with the written acceptance of the Superintendent. Admixtures may satisfy the requirements of AS1478. Fly ash is not considered an admixture under the terms of this Clause.

20.6.4 Concrete Mix Design

The concrete mix design including details of the materials must be submitted to and agreed by the Superintendent prior to pouring of any concrete.

Certificate of Tests of Materials

The following certificates from a laboratory registered with NATA must be produced by the Contractor, upon request by the Superintendent.

- Cement - certificates as in Appendix A of AS1315. Certificates of results of Autoclave Expansion Test as in ASTM C151.
- Aggregates - certificates of results of tests set out in AS2758 Part 1.
- Admixtures and fly ash - Certificates that the admixture or fly ash complies with the requirements of AS1478 or AS3582, respectively for acceptance testing and uniformity.

Ready Mixed Concrete

Identification certificate as per Clause 1.7.3 of AS1379.

Certificates are required for:

- Characteristic compressive strength at 28 days
- Slump prior to addition of super plasticiser
- Shrinkage values after 56 days
- Values for modulus of rupture (if requested)
- Abrasion resistance - Chaplin Testing (if requested)

Water

If not from a town water supply evidence is required, supplied by the Contractor, that the water contains no matter harmful to concrete, reinforcement or other embedded items.

20.6.5 Ready Mixed Concrete and Pumped Concrete

Ready mixed concrete and pumped concrete may be used, provided that it satisfies the requirements of this Specification and of AS1379.

20.6.6 Site Mixed Concrete

Site mixed concrete must not be used.

20.6.7 Grout

Grout must consist of Portland cement and water or of Portland cement, sand and water.

An additive designed to produce fluidity and for expansion of the grout may be used, subject to the Superintendent agreement, provided that additives containing aluminium powder, chlorides or nitrates are not be used.

Sand, if used, must satisfy the requirements of AS2758 except that the grading may be modified to obtain increased workability. The water content must be the minimum necessary for proper placement.

20.6.8 Mixing and Delivery

Supervision

Concrete must be produced under the supervision of a qualified and experienced Engineer employed by the Contractor and deemed acceptable to the Superintendent. The mix designs must conform to the requirements set in Clause 20.6.1 in this Specification.

Concrete Quality

All concrete produced must conform to this Specification and to the referenced standards.

The characteristic compressive strengths at 28 days, and types of concrete, slump and maximum size of aggregates required for the various parts of the work must be as shown on the Drawings. The characteristic compressive strength at 28 days shall be denoted by the symbol f'c. Any required early age mean strength shall be shown on the Drawings and denoted by fcm.

All concrete mixes must be designed to achieve or exceed 45% of the 28 day characteristic compressive strength at 3 days and 75% of the 28 day characteristic compressive strength at 7 days.

The mass per unit volume of hardened concrete shall be in the range from 2400 kg/m^3 to 2500 kg/m^3 when determined in accordance with AS1012 Part 12.

The Contractor is wholly responsible for producing the concrete which will have the properties specified.

The proportions of aggregate and cement for the concrete must be such as will produce a mix which will work readily into corners and angles of the forms and around reinforcement with the method of placement employed on the work but without permitting the material to segregate, or excess free water to collect on the surface.

The proportioning must be such as to ensure that the resultant concrete will be sound, dense, durable and of the strength and other properties specified.

The Contractor must submit for agreement with the Superintendent, a minimum of 14 days prior to the placement of the concrete, the proposed mix proportions for each grade of concrete to be used in the project along with test results indicating that the proposed mix will satisfy the requirements of this Specification.

Information to be supplied for assessment must include:

- Source of supply of all materials including cement, aggregates, fly ash and any admixtures.
- Mix proportion by weight per cubic metre of all constitutes including water and water/cement ratio.
- Characteristic compressive strength at 28 days, f'c.
- Early age mean strength, fcm (if applicable).
- Slump.
- Shrinkage of concrete at 56 days.
- Assessment of maximum long term shrinkage values.
- Suitability of aggregates to meet specified abrasion resistance requirements (if required).
- Hardened concrete density values.
- Time available between mixing and placing concrete to ensure design parameters are met.
- Structural elements being poured.

After all ingredients of the concrete have been mixed no further water is to be added.

Sampling and Testing

All concrete will be subject to both production and project assessment in accordance with AS1379.

Sampling and testing of concrete for compliance must be in accordance with AS1379.

All sampling must be carried out in accordance with Section 5 and Appendix B of AS1379 by a person approved by NATA for this purpose.

Testing and curing of samples must be carried out in a laboratory registered with NATA for this purpose and agreed to by the Superintendent.

Slump tests must be undertaken in accordance with AS1379.

A slump cone and at least two test cylinder moulds and other necessary equipment must be maintained on Site.

Concrete must not be discharged into formwork whilst slump or other tests are being performed which could result in its rejection.

20.6.9 Concrete Placing

Conditions for Placement

Concrete placement must be carried out under the direct supervision of a capable foreman, employed by the Contractor and approved by Superintendent, experienced in reinforced concrete construction and familiar with the relevant Standard Codes and Specifications.

Concrete must not be placed when the following conditions occur:

- The temperature of the concrete is less than 10 ^{o}C or exceeds 35 ^{o}C.
- The outdoor shade temperature is likely to be greater than 35 ^{o}C during placement, or within 2 hours subsequent to placement, unless special precautions, to the approval of the Superintendent, are undertaken. Notwithstanding that such special precautions are taken, concrete must not be placed when the outdoor shade temperature exceeds 38 ^{o}C.
- Where the concrete temperature is less than 32 ^{o}C, concrete must reach its final position in the forms within 30 minutes after the introduction of water to the cement and aggregate, or the cement to the aggregate, except in the case of concrete which is continuously agitated in a truck mixer, when 1.5 hours may elapse between introduction of water and final placing. In hot weather where the concrete temperature is greater than 32 ^{o}C the above times must be reduced to 15 minutes and 45 minutes respectively.

Notwithstanding the above, the Superintendent may direct other times.

The concrete slump must be 80 $\pm$ 15 mm at the construction Site unless noted otherwise.

The Contractor must not cover up formwork and reinforcement by placing concrete without the prior approval of the Superintendent.

Concrete must not be placed except in the presence of the Superintendent.

Concrete must not be placed unless materials for curing unformed surfaces are at the Site and ready for use.

Before concrete is placed, the formwork and the space into which the concrete is to be placed must be free of contaminants and free of water.

Concrete is to be brought to the forms and placed in such a manner that there is to be no segregation of the concrete mix. Internal vibrators must not be used to move concrete within the forms.

Concrete must not be exposed to rain during mixing, transport or placing, until it has set.

Equipment

Hoppers, skips, barrows and the like must be of such design that concrete does not segregate in them. Sufficient numbers of such equipment must be available to ensure a satisfactory rate of placing concrete.

Chutes must be so designed that concrete flows readily and does not segregate.

Barrow runs and pump lines must be supported off the formwork, not the reinforcement and must be agreed to by the Superintendent. The Contractor is responsible for the design and installation of high-rise pump lines. All fixings must be removed and the structure made good after detachment of the pump lines.

Except for slabs on ground compaction must be achieved by the use of high frequency immersion type vibrators.

One spare vibrator which is in full operating condition must be on hand during concrete placement.

Vibrators mounted on screed boards must be used for the compaction of slabs on ground when the width of pour permits. Vibrating screeds must be supplemented by immersion vibrators.

Cleaning

All items of equipment used for carrying, holding and working with concrete must have dry mortar, mud and other deleterious matter removed from them.

Water puddles which may form by whatever means must be removed before pouring concrete all to the agreement of the Superintendent. All slab, beams and column forms must be cleaned of foreign material. The cleanliness of formwork must be inspected and accepted by the Superintendent prior to placement of concrete. The Contractor must ensure that the release agent does not puddle due to excessive application and so cause staining or retardation of the concrete surface. No part of the reinforcement or construction joints shall be coated with the release agent.

Reinforcement, including starter bars, which have become contaminated by oil, mud, mortar or other coatings other than a firm rust layer must be cleaned to the acceptance of the Superintendent prior to placing concrete.

Transport of Concrete

Concrete must be transported in such a manner that it is not caused to segregate or spill, or be contaminated.

Concrete Placement

Immediately prior to placement of concrete the forms must be wetted. Excess water from this process must be removed before commencing concrete placement to the agreement of the Superintendent.

The concrete must not be placed if the specified slump as measured in accordance with this Specification is not within the required limits.

The specified slumps refer to on-site delivery slumps. For pumping and placement purposes the specified slump is to be a maximum of 80 mm ± 15 mm using a super plasticiser which conforms and is added in accordance with AS1478. At no stage from the time of mixing must water or admixture be added to the concrete to increase workability.

Where concrete is to be placed by pumping all excess slurry used to prime equipment and all material surplus must be discharged to waste, not into forms, and must be removed from the Site by the Contractor.

Pumping equipment must be arranged so that no vibrations that may damage freshly placed concrete shall result.

Concrete must be deposited as near as practicable to its final position. It must not be dumped away from its final position and worked along the forms.

Where concrete is to be pumped, line stools must be used. Provide bases to stools to prevent damage to formwork, post-tensioning ducts, reinforcement, cast-ins and other associated items.

Concrete must be placed at a rate that will permit proper compaction and must not be placed to a depth greater than 300 mm before compaction of the concrete below. Carry out placing in such a manner as will ensure that concrete which is partially set is not subsequently disturbed.

The concrete shall be placed in such a manner as to avoid segregation or loss of materials. To achieve this in the placing of concrete in thin walls and columns in excess of 1.5 m in height it may be necessary to pour the concrete through enclosed chutes or access hatches. These chutes must be kept as vertical as possible during the placing operation.

Where it is proposed that concrete be placed from a height in excess of 3.5 m, the Contractor must submit for acceptance details of the proposed placing procedure by the Superintendent. Such procedures may only be proposed for use where forms have been designed to be adequate to resist all consequent forces.

The concrete placing must be carried out continuously between the construction joints and in such a manner that a plastic edge is maintained, at all times.

Columns and walls must be poured first and allowed to cure for a minimum of 8 hours prior to pouring of the suspended structure.

Compaction

All concrete must be fully compacted by mechanical vibration using internal vibrators and/or vibrating screeds and/or vibrators fixed to the formwork. The vibration method used by the Contractor must minimise segregation of the concrete.

The Contractor must have available for immediate use at least one standby vibrator.

Joints

In general, concrete must be placed and compacted against unset previously-placed concrete such that the finished work is monolithic and uniform in strength and appearance.

Construction joints may be made only where indicated on the Drawings and otherwise in such locations and in such a manner as may be accepted by the Superintendent, who may direct the Contractor to scabble or otherwise remove laitance and provide for bond and to provide keys, steps and other means of load transfer. Any such provision, whether indicated on the Drawings or directed by the Superintendent, is at the Contractor's expense.

Concrete poured on Natural Ground

All slabs cast on ground require a minimum 50 mm thick N20 concrete blinding.

Concrete Poured on Rock

Surfaces of rock that will be in contact with concrete must be free of loose materials. Except where concrete is placed on a vapour barrier, the rock must be thoroughly wetted prior to pouring of concrete. Water used for cleaning such excavations must not lie in puddles at the time of placing concrete.

Concrete Poured on Fill or Other Porous Material

Except where concrete is placed on a vapour barrier, formed surfaces of earth, fill, roadbase or hardcore must be thoroughly wetted to a depth of at least 75 mm prior to pouring concrete. Water must not lie in puddles on the surface at the time of pouring concrete.

Where shown, a vapour barrier consisting of a 0.3 mm thick layer of polythene sheeting must be supplied and laid on the sub-grade or fill by the Contractor. Adjoining sheets must be lapped 250 mm at the sides and ends and taped for the full length of the lap. The sheeting must be taped to pipes and other embedments. The vapour barrier must be turned up the full thickness of the slab at free edges, walls, columns and the like. Further treatment of the vapour barrier must be as detailed.

Finish at Edges of Slabs on Ground

Finishes at edges of slabs on ground include:

At edges of slabs - unless specifically shown otherwise on the Drawings, concrete must be finished flush with the top of the formwork with square corners.

Where slabs are poured against existing slabs - concrete must be poured and screeded flush with existing concrete and the corners left square.

Joints - generally the treatment of joints for slabs on ground must be as specified on the Drawings.

20.6.10 Unformed Surface Finishes

Unformed surfaces must be constructed to a smooth even surface and finished with a wooden float.

Finish unformed surfaces, unless otherwise specified, by hand or power driven equipment.

Commence finishing operations as soon as the screeded surface has stiffened sufficiently and produce a surface that is free from screed marks and uniform texture.

20.6.11 Curing

All concrete work must be cured.

For unformed surfaces curing must be commenced immediately finishing is complete.

The curing period from the time of placing concrete is to be continuous and must be not less than the following:

- Portland cement concrete - 7 days
- Cements with fly ash or pozzolanic materials - 10 days

The curing method must include one or a combination of the following methods:

- Ponding or continuous sprinkling with water
- Use of a curing compound that is in accordance with the recommendations of AS3799
- Use of an absorptive cover kept continuously wet
- Use of an impermeable membrane

The Superintendent may direct that any curing method not be used.

The concrete shall be protected from damage during the curing period.

Protection

Load application on newly poured surfaces shall comply with AS3610.

The concrete must be protected from damage due to overload, heavy shocks and excessive vibration particularly during the curing period.

All finished concrete surfaces must be protected from damage caused by construction equipment, materials, or methods and by rain or running water.

Self-supporting structures must not be loaded in such a way as to overstress the concrete.

Rejection of Concrete

Plastic and hardened concrete that does not meet the requirements of this Specification and of AS3600, AS3610 or AS1379 is not in accordance with the Contract.

Repairs of Concrete

Where repair of concrete is necessary and permitted, such repairs must be performed by skilled workers and must be completed within 24 hours after removal of formwork or, in the case of unformed concrete, within 24 hours after placing of concrete. All repair of concrete work must be in accordance with AS3600.

The materials and techniques of repair that the Contractor proposes to use must be notified to the Superintendent prior to commencement and are subject to agreement of the Superintendent.

The repairs will be at no cost to the Superintendent.

21. Granular pavements

21.1 General

All granular pavements shall be constructed in accordance with Cessnock Council construction specification requirements unless stated otherwise in this specification or drawings. This section provides for the granular pavement works.

21.2 Standards

- *Standard*: To AS 1348
- RMS QA Specification R71
- Austroads Guide to Pavement Technology Part 6: Unsealed Pavements, 2009

21.3 Pavement base and sub-base

21.3.1 Aims

Provide base and sub-base courses that are as follows:

- In conformance with the level tolerances specified
- Tested by a NATA registered geotechnical testing authority
- In conformance with the compaction requirements supplied

21.3.2 Definitions

For the purposes of this section the definitions given below apply.

- Absolute level tolerance means maximum deviation from design levels
- Relative level tolerance means maximum deviation from a 3 m straight edge laid on the surface

21.3.3 Tests

All testing shall be carried out in accordance with Cessnock Councils Construction specification and AS 1289.5.4.1 and AS 1289.5.4.2.

21.3.4 Submissions

General: Not less than the following (whichever requires the most tests):

- Two tests per road
- One test per 50 metres of road

Standard: To Table 8.1 in AS 3798.

Source of material: State the supplier name, nature of material (for example, crushed rock, natural gravel, recycled) and source quarry or recycling site.

Compliance of material: Provide certification and test results from a NATA registered laboratory confirming that the material complies with the requirements of the Specification.

Execution

General: Submit proposals for the methods and equipment to be used for the roadworks, including the following:

- Staging of the work, access and traffic control methods
- Disposal of surface water, control of erosion, contamination and sedimentation of the site, surrounding areas and drainage systems
- Methods and equipment for each operation
- Sources of materials
- Material stockpiles

Compaction: If it is proposed that a layer is to exceed 150 mm in thickness, submit evidence demonstrating that the proposed compaction equipment can achieve the required density throughout the layer.

21.4 Products

21.4.1 Base and sub-base material

Base and sub-base materials shall comply with Table 3.5 Austroads Guide to Pavement Technology, Part 6 (2009) and Table 21-1.

Table 21-1 Particle size and soaked CBR

Item	Maximum particle size (mm)	Soaked CBR (%)
Sub-base	55	30
Wearing course	20	40

21.5 Execution

21.5.1 Subgrade preparation

Subgrade preparation to be undertaken in accordance with Section 4.3.3.

21.5.2 Tolerances

Provide a finished surface that is free draining and evenly graded between level points.

Edges abutting gutters/drains shall be within -0 + 10 mm of the level of the actual gutter/drain edge.

The tolerances apply to the finished level of each layer, unless overridden by the requirements (including tolerances) for the finished level and thickness of the wearing course.

Table 21-2 Surface Level Tolerances

Item	Level tolerance	
	Absolute	Relative
Sub-base surface	- 15 to +25 mm	12 mm
Base surface	- 15 to +25 mm	6 mm

21.5.3 Sub base and base compaction

Compact each layer of fill to the required depth and density, as a systematic construction operation and to conform to.

Table 21-3 Minimum Relative Compaction

Item description	Minimum dry density ratio (standard compaction) to AS 1289.5.2.1
Sub-base	98%
Base	98%

Any unstable areas that develop during rolling or are identified by proof rolling shall be removed for the full depth of the layer and disposed of and replaced with fresh material. Material used as replacement material shall comply with the requirements of the Specification. The placing and compaction of the replacement materials shall also comply with the requirements of the Specification.

Compaction requirements

General: Apply uniform and sufficient compactive effort over the whole area to be compacted. Use rollers appropriate to the materials and compaction requirements.

Moisture content

During spreading and compaction, maintain materials at the moisture content (modified compaction) not exceeding the optimum moisture content or less than –3% of OMC.

Maintain moisture content. Use water-spraying equipment capable of distributing water uniformly in controlled quantities over uniform lane widths.

Rectification

If a section of pavement material fails to meet the required density or moisture content after compaction remove the non-complying material, replace with fresh material, and recompact.

Level corrections

General: Rectify incorrect levels as follows:

- *High areas*: Grade off
- *Low areas*: Remove layers to a minimum depth of 75 mm, replace with new material and recompact

21.5.4 Placing base and sub base

General

Weak surfaces: Do not place material on a surface that has been so weakened by moisture that it will not support, without damage, the constructional plant required to perform the work.

Spreading: Spread material in uniform layers without segregation.

Moisture content: Maintain wet mixed materials at the required moisture content before and during spreading. Add water to dry mixed materials through fine sprays to the entire surface of the layer after spreading, to bring the material to the required moisture content.

Layer thickness: 150 mm maximum and 75 mm minimum (after compaction). Provide equal layers in multilayer courses.

Joints

General: Plan spreading and delivery to minimise the number of joints. Offset joints in successive layers by at least 300 mm.

Final trimming

General: Trim and grade the base course to produce a tight even surface without loose stones or a slurry of fines.

22. Gabions and gabion mattresses

22.1 General

This section contains the technical requirements for the gabions and gabion mattresses.

The Superintendent may reject any component of the gabions and gabion mattresses that do not meet or exceed the requirements of this section.

Any component of the gabions and gabion mattresses rejected by the Superintendent shall be remediated at the expense of the Contractor.

22.2 Standards

22.2.1 Australian standards

Relevant Australian standards are as follows but not limited to:

- 1141.3.1 Methods for Sampling and Testing Aggregates – Sampling of aggregates/rock
- RTA R63 – Geotextiles (Separation and Filtration)
- AUSTROADS – Guide to Geotextiles
- AS 1141.22 – Wet / dry strength variation
- AS 1289.5.4.1 – Compaction control test – Dry density ratio, moisture variation and moisture ratio
- AS 1289.5.7.1 – Compaction control test (Rapid method)
- AS 1650 – Hot-dipped galvanised coatings on ferrous articles

22.3 Definitions

Gabions: Galvanised-steel, wire-mesh box-shaped baskets of various sizes, filled on site.

Diaphragms: Internal wire-mesh partitions that divide the gabion into cells.

Lacing or Binding Wire: The wire used to assemble and join the gabion unit.

Heavily galvanised: To the coating mass requirements of type A wire per AS 1650.

22.4 Products

The Contractor shall provide documentation that the materials specified below conform to this specification for approval by the Superintendent.

22.4.1 Wire mattresses

The wire mattresses shall be flexible woven wire mesh boxes with dimensions of 6m x 2m in plan or as specified in the Drawings. The mattresses shall be divided by diaphragms into cells at not more than 1.0 m centres or as specified in the Drawings. Unless otherwise specified, they shall be fabricated of woven heavily galvanised wire and PVC coated.

Mattresses shall have a mesh size of 60 mm x 80 mm and body wire shall be a minimum diameter of 2.0 mm heavily galvanised with an additional minimum thickness of 0.4 mm PVC coating. The minimum core diameters of heavily galvanised selvedge wire and lacing wire shall be 2.7 mm and 2.2 mm respectively.

22.4.2 Gabions

The gabions shall be of the sizes shown on the Drawings and fabricated of woven heavily galvanised wire mesh and PVC coated. Each gabion shall be divided by diaphragms into cells whose length shall not be greater than the width of the gabions plus 100 mm.

Gabions shall have a nominal mesh size of 80 mm x 100 mm and body wire shall be a minimum diameter of 2.7 mm heavily galvanised with an additional thickness of 0.4 mm PVC coating. The minimum core diameters of heavily galvanised selvedge wire and lacing wire shall be 3.4 mm and 2.2 mm respectively.

22.4.3 Geotextiles

Before laying out gabions and mattresses, a non-woven filter fabric as shown on the Drawings shall be placed between the wire cages and the material being protected or retained. Filter fabric shall be supplied and installed in accordance with RTA R63.

A chemically and biologically stable geotextile with a minimum strength rating (G) of 1350 and minimum mass of 180 grams per square metre, in accordance with AUSTROADS Guide to Geotextiles, shall be used.

Samples, manufacturer’s specification and instructions on installation shall be submitted to the Superintendent for review and approval seven days before the intended use of geotextile.

22.4.4 Rock fill material

The rock fill shall consist of clean hard rock with a minimum wet strength of 100 kilonewtons and a maximum wet/dry strength variation not greater than 35 percent as determined by AS 1141.22.

Rock fill for wire mattresses shall have particle sizes between 80 mm and 0.66 dmm where d is the mattress depth. The maximum rock size should not exceed 200 mm. Not more than 5% shall pass through a 75 mm aperture sieve opening.

Rock fill for gabions shall have particle sizes between 100 mm and 250 mm with not more than 5% passing a 75 mm aperture sieve opening. Rock fill material may be placed by hand or suitable mechanical device to ensure fill is tightly packed with a minimum of voids. Fill material shall be levelled off 25 mm to 50 mm above the top of the mesh to allow for settlement.

Details regarding the properties and source of rock fill shall be submitted to the Superintendent for approval. When the mattress is on a slope, rock fill material shall be placed into the units starting from the low end. Units shall be filled slightly overfull to allow for settlement and to provide an even, tight and smooth surface of the required contour.

22.4.5 Select backfill

Select Granular Fill material shall be placed behind the gabions as indicated on the Drawings.

Compaction adjacent to the gabions should be done using hand operated rollers, plate compactors or rammers.

Before installation of rock filled wire mattresses, the foundation material shall be excavated such that the final surface levels of the Drawings are achieved. The foundation material supporting mattresses and gabions shall be shaped free of humps, hollow and defined channels (unless shown on the Drawings) and compacted, and in accordance with AS 1289.5.4.1 the dry density ratio shall not be less than 95 per cent for standard compactive effort.

22.5 Execution

22.5.1 Gabion installation

Unless directed otherwise by the Superintendent, multi-layered gabion baskets shall be placed in a horizontal plane, rather than following the grade of the ground surface. Where necessary, individual boxes shall be cut down to the required shape to allow horizontal placement, or to otherwise fit in with the overall shape of the gabion structure.

Assembly

Prior to assembly, the gabions material shall be opened out flat on the ground and stretched to remove all kinks and bends.

The gabion boxes shall be assembled individually, by raising the sides, ends and diaphragms, ensuring that all creases are in the correct position and that the tops of all four sides and the diaphragms are even.

The four corner edges of the Gabion boxes shall be laced first, followed by the edges of internal diaphragms to the sides.

In all cases, lacing shall commence by twisting the end of the lacing wire tightly around the selvedge/s. It shall then pass round the two edges being joined using alternate single and double loops at 100 mm intervals and be securely tied off at the bottom. The ends of all lacing wires shall be turned to the inside of the box on completion of each lacing operation. Each loop shall be pulled tight to prevent the joint opening during filling. Tightness of the lacing is essential.

As an alternative to the continuous lacing wire system for securing gabions, an approved mechanical system using heavily galvanised clips (or Stainless Steel for plastic specification units) may be used. Spacing of clips shall be to the gabion manufacturer's recommendations.

Erection

Only assembled boxes, or groups of boxes, shall be positioned in the structure. The side, or end, from which work is to proceed, shall be secured either to the completed work or by rods or stakes driven into the ground at the corner. These stakes must be secure and reach at least to the top of the gabion box.

Further gabion boxes shall be positioned in the structure as required, each being securely laced to the preceding one along all common corners and diaphragms using the lacing technique described above.

The constructed gabion boxes shall be inspected for approval by the Superintendent.

Stretching

Final stretching of the gabion boxes shall be carried out using a pull-lift of at least one tonne capacity, firmly secured to the free end of the assembled gabion boxes.

Whilst under tension, the gabion boxes shall be securely laced along the edges (top, bottom and sides) and at diaphragm points, to all adjacent boxes.

Filling

Filling shall be carried out whilst gabion boxes are under tension.

The front face and all other faces which will be exposed in the completed structure shall be “hand packed” with the stones placed so as to produce a neat face free from excessive bulges, depressions and voids.

Internal bracing wires shall be provided on the exposed faces at the rate of 4/ cm.m at 330 mm centres to prevent distortion of the gabion units during filling and in the completed structure. Additional bracing wires shall be provided on exposed ends at a rate of 4/ sq.m of face.

Tension on the gabion boxes shall be released only when fully laced and sufficiently full to prevent the mesh from slackening.

All gabions shall be overfilled by 25 mm using flat stone to allow for minor settlement and to provide a level surface for subsequent layers.

The filled gabions shall be inspected for approval by the Superintendent.

Final Lacing

Closing and lacing down of lids shall proceed as soon as practicable after filling operations especially if exposed to the likelihood of a storm or flood during construction.

Lids shall be stretched tight over the filling with suitably designed closing tools and laced down securely through each mesh along all edges, ends and diaphragms before commencing work on the next layer of gabion. The ends of all tying and bracing wires shall be turned into the gabion box on completion of each lacing operation.

The filled gabions shall be inspected for approval by the Superintendent.

22.5.2 Mattress installation

Assembly

To assemble, the mattress base shall be opened out on the ground and all unnecessary creases removed. The lid is opened separately and all folds and creases should be removed.

Mattresses shall be assembled individually by raising the sides and stamping the mesh to create the diaphragm folds. Care must be taken to ensure that the folded diaphragms and sides are vertical and of the correct height (as identified in the Drawings).

The edges of the folded diaphragms shall be laced to the side panels using the lacing technique described in above.

Shortening of the double diaphragm standard units to create smaller mattress lengths may be affected by cutting along the apex of any diaphragm fold ensuring a neat and integral end remains.

In all cases, lacing shall commence by twisting the end of the lacing wire around the selvedge/s. It shall then pass round the two edges being joined using alternative single and double loops at 100 mm centres and be securely tied off at the bottom. Tightness of the mesh and wiring is essential.

As an alternative to the continuous lacing wire system for securing gabions, an approved mechanical system using heavily galvanised clips (or Stainless Steel for plastic specification units) may be used. Spacing of clips shall be to the gabion manufacturer’s recommendations.

Erection

Only assembled mattress or groups of mattresses shall be positioned in the structure, with each mattress being securely laced to the surrounding ones along the perimeter. When the mattress is laid on a slope steeper than 1 in 1.5, it should be secured by hardwood stakes or star pickets driven into the ground just below the upper end panel, at 2 m centres or as approved. It is essential that the mattress remain free to flex and accommodate any settlement or scour.

The constructed mattresses shall be inspected for approval by the Superintendent.

Filling

Mechanical filling equipment shall be used with the approval of the Superintendent and providing adequate precautions are taken to protect the plastic coating from abrasion during filling operations.

Filling materials shall be hand packed to ensure all diaphragm compartments are fully filled and to produce a neat and level top surface. Mattress units shall be overfilled by 25-50 mm above to allow for subsequent settlement to prevent excessive stone movement under hydraulic conditions.

Where suitably sized filling materials cannot be obtained, the Superintendent may approve insertion of a second mesh panel consisting of the same specifications as the mattress below the top and front face of the mattress to contain the smaller sized rock filling within the mattress. The second woven wire mesh panel can be laced to the structure and offset by one half mesh.

The filled mattresses shall be inspected for approval by the Superintendent.

Final Lacing

Closing and lacing down of lids shall proceed as soon as practicable after filling operations especially if exposed to the likelihood of a storm or flood during construction.

Lids shall be stretched tight over the filling with suitably designed closing tools and laced down securely through each mesh along all edges, ends and diaphragms using the lacing method described above. The ends of all tying and bracing wires shall be turned into the mattress box on completion of each lacing operation.

The filled mattresses shall be inspected for approval by the Superintendent.

23. Rip rap

This section contains the technical requirements for the rip rap. The relevant requirements for the rip rap in Section 3 shall be considered alongside guidance provided in this section.

The Superintendent may reject any component of the rip rap that do not meet or exceed the requirements of this section.

Any component of the rip rap rejected by the Superintendent shall be remediated at the expense of the Contractor.

23.1 Standards

23.1.1 Australian standards

Relevant Australian standards are as follows but not limited to:

- 1141.3.1 Methods for Sampling and Testing Aggregates – Sampling of aggregates and rock
- 1141.11 Methods for Sampling and Testing Aggregates – Particle size distribution/dry sieve
- 2758 Aggregates and rock for engineering purposes.

23.2 Submittals

23.2.1 Prior to delivery of rip rap to site

The Contractor shall submit the following to the Superintendent for review and approval prior to delivery of the rip rap to site (per material source):

- Material source
- Certification that the material is VENM or ENM or NSW EPA Resource Recovery Exemption appropriate for use a rip rap
- Pre-qualification test results/reports demonstrating that the proposed material complies with the material property requirements of this section of the Specification (refer Section 23.3)
- Estimated quantity of material which is represented by the pre-qualification test results/reports
- Information on the parent geology of the material.

23.2.2 Prior to placement of rip rap

The Contractor shall submit the following to the Superintendent for review and approval prior to placement of the rip rap:

- Survey of the underlying surface in accordance with Section 1.11
- Work method statement for placement of the rip rap, including repair procedures (refer Appendix A).

23.2.3 Following placement of rip rap

The Contractor shall submit the following to the Superintendent for review and approval following placement of rip rap:

- As-built survey of the completed surface showing conforming layer thickness within the allowable tolerances
- Defect and repairs log, showing details of all defects identified and any repairs completed.

23.3 Material

Rip rap shall:

- Be selectively sourced material from on-site or imported from an approved source. Imported material shall be classed as VENM or ENM or NSW EPA Resource Recovery Exemption.
- Not contain any unsuitable materials identified in Section 3.4.1 unless approved by the Superintendent.
- Be clean, hard, sound and durable material that will maintain the required performance under the maximum loads likely to be imposed on it in service.
- Shall not be single sized, but shall be a well graded mixture designed to ensure that all interstices between larger rocks are filled with rock of progressively smaller size. Rock gradation shall be as per the Contract Drawings.

The Contractor shall supply pre-qualification testing results showing that the proposed material meets the requirements of this Specification and the Contract Drawings. Samples taken shall be representative of the whole material source and shall be evenly distributed across the material source.

23.4 Installation

The Contractor shall prepare a work method statement for placement of the rip rap outlining the placement methodology and proposed construction plant to be used (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and approval prior to placement.

The work method statement and construction methodology for the rip rap shall be developed in accordance with the guidance provided below:

- Rip-rap shall be placed in a uniform manner which ensures that larger rocks are uniformly distributed, and smaller rocks effectively fill the spaces between the larger rocks without leaving any large voids.
- All rip rap is to be underlain by a geotextile. Rip rap shall be placed in a manner to prevent damage to the underlying geotextile. Hand placement shall be required to the extent necessary to prevent any punching, cutting, or tearing of the separation geotextile.
- Laying shall commence at the toe of the slope and shall progress upwards, with each rock being firmly embedded into the slope and against the adjoining rocks. The rip rap shall be thoroughly packed as construction progresses, so that the finished surface is tight and uniform and conforms to the design slope. Larger rocks shall be placed at the bottom of the slope.
- Rip rap shall be placed in a manner which does not result in excessive particle breakdown or crushing.

- Rip rap shall be placed carefully around any pipework to ensure the pipework is sufficiently protected.

23.5 Tolerances

The Contractor shall place the rip rap within the tolerances provided in Section 3.14.

23.6 Defects and repairs

The Superintendent may direct the Contractor to remove a section of the rip rap to inspect underlying materials for damage. The Contractor shall repair any damage that occurs to the underlying materials as a consequence of the placement of rip rap in accordance with this Specification.

Any areas of placed rip rap that do not conform to the Specification shall be repaired by the Contractor to the satisfaction of the Superintendent.

The Contractor shall submit to the Superintendent for review details of any defects identified and repairs carried out.

23.7 Acceptance

The Contractor shall retain ownership and responsibility for the riprap until Practical Completion.

The rip rap shall be accepted by the Superintendent when all of the following conditions are met:

- Required submittals are provided by the Contractor to the Superintendent and approved
- The Contractor has submitted the required as-built surveys of the completed rip rap showing conformance with the Contract Drawings within the allowable tolerances, and this has been approved by the Superintendent
- Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
- The Superintendent has inspected and approved the finished surface/s

24. Landfill gas system

24.1 General

This section contains the technical requirements for the landfill gas system. The relevant requirements for sequencing and scheduling in Section 1.5 and Earthworks in Section 3 shall be considered alongside guidance provided in this section.

The Superintendent may reject any component of the landfill gas system that does not meet or exceed the requirements of this section.

Any component of the landfill gas system rejected by the Superintendent shall be remediated at the expense of the Contractor.

24.2 Submittals

24.2.1 Prior to installation of landfill gas system

The Contractor shall submit the following to the Superintendent for review and approval prior to installation of the landfill gas system:

- Work method statement for installation of the landfill gas system, including sequencing and with other works and repair procedures (Appendix A).

24.2.2 Following installation of landfill gas system

The Contractor shall submit the following to the Superintendent for review and approval following placement of seal bearing layer:

- As-built survey of trenches, bore locations and vent location
- As-built survey of perimeter landfill gas monitoring bore network, borehole drilling and installation logs for each of the landfill gas monitoring bores

24.3 Installation

The Contractor shall install the landfill gas system in accordance with the Contract Drawings.

The Contractor shall prepare a work method statement for installation of the landfill gas system outlining installation methodology and proposed construction plant to be used (refer Appendix A). The work method statement shall be submitted to the Superintendent for review and comment prior to placement.

The landfill gas system trench and bore locations are approximate only and shall be confirmed with the Superintendent prior to drilling. The landfill gas system is installed directly into landfilled waste materials. Bores shall be installed using suitable drilling rigs and equipment.

The landfill gas system includes a single penetration without pipe boot through the cap for the ventilation shaft as part of the central landfill gas vent.

All drilling cuttings and other waste generated by the works are the responsibility of the Contractor. They shall be considered waste materials to be incorporated into the containment cell as directed by the Superintendent and in accordance with the requirements of these works (e.g., waste placement Section 14).

24.4 Acceptance

The Contractor shall retain ownership and responsibility for the landfill gas system until Practical Completion.

The landfill gas system shall be accepted by the Superintendent only when all of the following conditions are met:

- Required submittals are provided by the Contractor to the Superintendent and approved
- The Contractor has submitted the required as-built surveys of the completed landfill gas system, and this has been approved by the Superintendent
- The Contractor has submitted the required borehole logs of the completed landfill gas bores and landfill gas monitoring bores , and these have been approved by the Superintendent
- Details of all defects identified and repairs performed have been provided by the Contractor to the Superintendent and approved
- The CQA Engineer has provided the Superintendent with a recommendation that the conditions of final acceptance have been met
- The Superintendent has inspected and approved the finished landfill gas system.
- Three rounds of landfill gas monitoring have been completed of the system and perimeter landfill gas monitoring bores by the Contractor in accordance with an agreed standard, submitted to the superintendent and approved

25. Appurtenances

25.1 Sandbags

Unless otherwise instructed by the Superintendent, sand bags or approved equivalent shall have a minimum weight of 10 kilograms. Sandbags are to be placed at 2 m centres. The material used for the bags shall be non-degradable, UV stabilised material with a 5 year exposure rating.

25.2 Bentonite fill

Bentonite fill shall consist of nominal 6 mm bentonite pellets. Pellets shall be adequately hydrated during installation to provide a suitable seal around the installed pipe.

The Contractor shall provide manufacturer documentation for the bentonite fill shall be submitted to the Superintendent for approval prior to installation.

25.3 Recycled aggregate

The recycled aggregate will consist of clean, sound, rock or crushed/broken brick and tile of nominally 20-40 mm in size. It is to be free from metals, organic material and other contaminants. This material should be free flowing and achieve a hydraulic conductivity of greater than 1×10^{-4} m/s.

Where possible, the material supplier should provide a copy of the grading and hydraulic conductivity results for this material. At commencement of the works, one load of recycled aggregate will be delivered to site for a visual inspection by the Superintendent. The Contractor will be required to source an alternative recycled aggregate if approval is not granted by the Superintendent (the Superintendent will be required to provide details of the non-conformance in writing). Once the material has been approved, the Superintendent will continue to carry out visual inspections and reject any future loads, which are not considered to conform.

25.4 Gabions and gabion mattresses

The following standards should be adhered to:

Standard	Title
RMS R55	Rock filled gabions and mattresses Include PVC coating for all reno mattresses

25.5 Leachate transfer system

The contractor is to provide a leachate transfer system that has the following key components:

- Two leachate transfer pipelines, nominally one for each side of the containment cell that conveys flows to the leachate pond
- Portable pump set that can be relocated around site by the operators to utilise at the other cells in the facility

Provide details of the nominate pumps and any other associated equipment to the Superintendent for approval prior to procurement. The Superintendent shall review the information and provide feedback as required. The contractor shall provide details of the nominated pump, maintenance requirements and items with a long lead-time.

25.5.1 Pump requirements

The contractor is to nominate a pump that can access the leachate sump as shown in the drawings. A surface operated pump is preferred. The pump shall be diesel-powered and should be able to be operated by a single operator safely utilising a small truck or ute for transport. The pump shall be readily serviceable with spares and consumables available from Australian suppliers.

The pump is to be compatible with the nominated Leachate Collection System The Contractor may modify the Leachate Collection System to accommodate the nominate pump subject to approval from the Superintendent.

The pump is to operate over a range of duties to accommodate the flows at various cells:

Note that the operating heads may vary considerably based on pipeline temperature.

The pump is to be suitable to handle leachate from the landfill, and it is likely that there may be small fines and solids in the leachate up to say 10 mm size.

25.5.2 Transfer pipeline

The transfer pipelines shall be constructed of a nominal 90 mm diameter HDPE PE 100 SDR 21

The transfer pipeline shall be located above ground, except as noted below:

- Provide a mass concrete surround to the pipeline adjacent to the Leachate Pond nominally 1 m long and 250 mm thick on all sides. Location is to be confirmed by the Superintendent. Extend the pipeline down the bank and nominally 1 m beyond the lined crest.
- At the start of the pipeline, provide a mass concrete surround nominally 1 m long and 250 mm thick on all sides. Provide a short vertical section within the concrete and provide a camlock fitting and cap as approved by the Superintendent.

The alignment of the transfer pipelines is generally as shown on the drawings. The final alignment shall be confirmed onsite by the Superintendent. Ensure that the pipe is founded on even ground free of any deleterious material that may damage the pipeline.

Provide warning signage at nominally 50 m intervals along the pipelines. The signs shall have the following wording:

- WARNING LEACHATE PIPELINE.
- If damaged, urgently contact XXXXXXXX on XXXXXXXXX. Details to be confirmed by Superintendent.

Where the pipeline is likely to be trafficked (even intermittently) bury the pipeline for nominally 3 m length to prevent damage. Details to be agreed with the superintendent. During construction protect the pipeline from damage. Any temporary crossing shall be removed prior to Practical Completion as directed by the Superintendent.

25.5.3 Commissioning

Advise the Superintendent at least 10 working days prior to commissioning to allow for their attendance. At this time submit a Commissioning Plan outlining procedures and checklists and details of precommissioning activities (pipeline welding details, etc.). Commissioning shall be conducted in a logical sequence.

All materials, equipment, installation and workmanship shall be tested and/or inspected to prove compliance with the Specification requirements. Tests and inspections shall comply with current relevant Australian Standards.

Throughout commissioning the Contractor shall be responsible for the test program.

Provide continuous supervision by personnel experienced in the operation of the equipment and have qualified personnel in attendance to carry out all necessary adjustments and/or remedial work during the commissioning tests.

25.5.4 Operation and maintenance information

Provide Operation and Maintenance Information in digital PDF format following commissioning. The package shall include:

- Contents page
- Description of the work under the contract
- Operational requirements, settings and constraints for the work (refer below)
- Listing of installed components, including pumps, motors, valves, flowmeters
- Draft Maintenance Schedules for all components of the work
- Copies of test certificates for components of the work
- Copies of performance curves or capability statements for components (particularly pump curves)
- Proposed Spare Parts list
- Work-As-Constructed drawings
- Supplier documentation and warranties

Appendices

Appendix A – Schedule of work method statements

Component	Work method statement requirements
General	The Contractor shall prepare the following general work method statements for review approval by the Superintendent: • Scheduling • Site access and traffic control • Survey control • Surface water management • Erosion and sediment control
Earthworks	The Contractor shall prepare an earthworks work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Removal of vegetation • Excavation of earthwork materials • Filling of earthwork materials • Supply and quality control • Stockpile management and control measures • Method of moisture conditioning, material placement and compaction for earthworks materials • Earthworks material layer thickness control and survey • Trimming and final surface preparation • Anchor trench excavation and backfilling • Defects and repairs • Quality control testing
Subgrade	The Contractor shall prepare a subgrade work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply and quality control • Method of moisture conditioning, material placement and compaction • Surface preparation • Material layer thickness control and survey • Trimming and final surface preparation • Defects and repairs • Quality control testing
Clay rich fill layer	The Contractor shall prepare a clay rich fill layer work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply and quality control • Method of moisture conditioning, material placement and compaction • Surface preparation • Material layer thickness control and survey • Trimming and final surface preparation • Defects and repairs • Quality control testing

Component	Work method statement requirements
Geonet drainage composite	The Contractor shall prepare a geonet drainage composite work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply and quality control • Method of material placement • Surface preparation • Defects and repairs • Quality control testing
Sand drainage layer	The Contractor shall prepare a sand drainage work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply and quality control • Method of material placement and compaction • Surface preparation • Material layer thickness control and survey • Trimming and final surface preparation • Defects and repairs • Quality control testing
Geosynthetic clay liner	The Contractor shall prepare a geosynthetic clay liner work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply and quality control • Method of material placement • Surface preparation • Defects and repairs • Quality control testing
PE geomembrane	The Contractor shall prepare a PE geomembrane work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply and quality control • Method of material placement • Surface preparation • Defects and repairs • Quality control testing
Geotextile	The Contractor shall prepare a geotextile work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply and quality control • Method of material placement • Surface preparation • Defects and repairs • Quality control testing

Component	Work method statement requirements
Drainage aggregate	The Contractor shall prepare a drainage aggregate work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply and quality control • Method of material placement and compaction • Surface preparation • Material layer thickness control and survey • Trimming and final surface preparation • Defects and repairs • Quality control testing
PE pipework	The Contractor shall prepare a PE pipework method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply and quality control • Method of material placement • Defects and repairs • Quality control testing
Soil confining layer	The Contractor shall prepare a soil confining layer work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply and quality control • Method of moisture conditioning, material placement and compaction • Surface preparation • Material layer thickness control and survey • Trimming and final surface preparation • Defects and repairs • Quality control testing
Waste placement	The Contractor shall prepare a waste placement work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply • Numbers, types, and sizes of equipment proposed to perform hauling and placement • Anticipated challenges and mitigation measures • Methods for maintaining adequate survey control during placement operations • Method of material placement and compaction • Trimming and final surface preparation • Contaminated water management procedures detailing: methods and equipment to handle contaminated water during placement operations as specified herein and washing/decontamination methods, disposal methods, all with reference to relevant regulations.

Component	Work method statement requirements
Seal bearing layer	The Contractor shall prepare a seal bearing layer work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply and quality control • Method of moisture conditioning, material placement and compaction • Surface preparation • Material layer thickness control and survey • Trimming and final surface preparation • Defects and repairs • Quality control testing
Revegetation layer	The Contractor shall prepare a revegetation layer work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply and quality control • Method of moisture conditioning, material placement and compaction • Surface preparation • Material layer thickness control and survey • Trimming and final surface preparation • Planting and sowing • Vegetation maintenance • Defects and repairs • Quality control testing
Field trials	The Contractor shall prepare a field trials work method statement for review approval by the Superintendent with consideration to the following: • Method of transportation of fill material to placement location • Method of moisture conditioning of material prior to placement • Method of mixing and processing of material for clod removal prior to placement • Method of spreading fill material • Method of lift thickness control • Method of compaction and moisture conditioning of material during placement • Details of plant and equipment to be used during placement • Approximate number of passes for each item of plant on the clay rich fill layer
Drainage and Stormwater infrastructure	The Contractor shall prepare a waste placement work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply and quality control • Method of installation • Defects and repairs • Quality control testing
Concrete	The Contractor shall prepare a concrete method statement for review and approval by the Superintendent with consideration of the following: • Scheduling • Supply and quality control • Method of installation • Defects and repairs • Quality control testing

Component	Work method statement requirements
Granular Pavements	The Contractor shall prepare a pavement method statement for review approval by the Superintendent with consideration of the following: • Scheduling • Supply and quality control • Method of installation • Defects and repairs • Quality control testing
Rip rap	The Contractor shall prepare a rip rap work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply and quality control • Method of installation • Defects and repairs • Quality control testing
Landfill gas system	The Contractor shall prepare a landfill gas monitoring bore work method statement for review approval by the Superintendent with consideration to the following: • Scheduling • Supply and quality control • Method of drilling, material placement and pipework installation • Defects and repairs.

Appendix B – Example submittal forms

Delivery submittal form – earthworks materials

Submission data	
Project name and location:	
Submittal number:	
Material designation (as per the Specification):	
Reference section of Specification:	
Material source (including certificates):	
Proposed placement location:	
Estimated quantity:	
Material sample provided:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Material inspected by CQA Engineer:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Material certificates/documentation for VENM, ENM and/or Resource Recovery Exemption:	
Additional comments (including other information provided as required):	

Attachments	
VENM/ENM certification:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Pre-qualification test results/reports:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Additional comments (including other information provided as required):	

Submitted by: (include title and signature)	Date:

Installation submittal form – earthworks materials

Submission data	
Project name and location:	
Submittal number:	
Material designation (as per the Specification):	
Reference section of Specification:	
Material source (including certificate:	
Proposed placement location:	
Estimated quantity:	
Material sample provided:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Material inspected by CQA Engineer:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Additional comments (including other information provided as required):	

Attachments	
Work method statement for material use:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Survey of underlying surface:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Additional comments (including other information provided as required):	
Submitted by: (include title and signature)	Date:

Pre-selection submittal form – geosynthetics

Submission data	
Project name and location:	
Submittal number:	
Material designation (as per the Specification):	
Reference section of Specification:	
Product manufacturer:	
Product name:	
Proposed placement location:	
Estimated quantity:	
Material sample provided:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Additional comments (including other information provided as required):	

Attachments	
Material data sheet:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Manufacturer’s quality control and assurance procedures:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Additional comments (including other information provided as required):	

Submitted by: (include title and signature)	Date:

Delivery submittal form – geosynthetics

Submission data	
Project name and location:	
Submittal number:	
Material designation (as per the Specification):	
Reference section of Specification:	
Product manufacturer:	
Product name:	
Proposed placement location:	
Estimated quantity:	
Material sample provided:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Additional comments (including other information provided as required):	

Attachments	
Manufacturer’s certificate of compliance:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Manufacturer’s quality control and assurance test results/reports:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Manufacturer’s shipping, handling and storage procedures:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Manufacturer’s installation procedures and requirements:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Work method statement for material delivery, storage, handling and installation:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Additional comments (including other information provided as required):	
Submitted by: (include title and signature)	Date:

Installation submittal form – geosynthetics

Submission data	
Project name and location:	
Submittal number:	
Material designation (as per the Specification):	
Reference section of Specification:	
Product manufacturer:	
Product name:	
Proposed placement location:	
Estimated quantity:	
Material sample provided:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Material inspected by CQA Engineer:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Additional comments (including other information provided as required):	

Attachments	
Delivery, storage and handling log (including roll numbers):	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Proposed panel placement drawing:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Survey of underlying surface:	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Independent conformance test results/reports (provided by CQA Engineer)	☐ Yes ☐ No (provide reason below) ☐ N/A (provide reason below)
Additional comments (including other information provided as required):	
Submitted by: (include title and signature)	Date:

GHD

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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	A Roberts, D Morrison	D Barrett		David Barrett		20/10/2017
1	A Roberts, D Morrison	D Barrett		David Barrett		10/07/2018

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Appendix I Construction Quality Assurance

Hydro Aluminium Kurri Kurri Pty Ltd

Containment Cell Design

Construction Quality Assurance (CQA) Plan

October 2017

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Figure index

1. Introduction

This plan presents the Construction Quality Assurance (CQA) requirements for the construction of the Works (refer section 1.3) at the former Hydro Aluminium Kurri Kurri Aluminium Smelter (the site), and must be read in conjunction with the Works Documents.

1.1 Overview

Careful quality assurance (QA) and quality control (QC) testing of the materials and services used in the construction of waste facilities is an important aspect of the construction process. The CQA program is intended to provide a level of confidence to the Owner, engineer, regulator and the public that the completed project is constructed in accordance with the approved specifications and permit conditions. The programs proposed in this CQA Plan meet and exceed the requirements of EPA guidelines, including additional test methods, increased testing frequencies and increased levels of experience, which provide added control over the quality of the completed project and greater confidence in the long-term performance of the facility.

In general, CQA and construction quality control (CQC) are described as follows.

CQA consists of a planned and systematic pattern of all means and actions designed to provide adequate confidence that items or services meet contractual requirements and will perform as designed. QA includes the review of work performed in the field and the testing of installed materials to verify compliance with the drawings and specifications. Overall QA means and actions also include QC.

CQC consists of those actions which provide a means to measure and regulate the characteristics of an item or service to contractual and regulatory requirements. These actions comprise the specification of testing methods and frequencies as well as specifying minimum levels of experience and training for the individuals and organisations performing the work. In general, QC is performed prior to allowing individuals and organisations to perform the work and prior to accepting materials for delivery to the work site as a means for prequalification of services and materials and continues throughout construction to evaluate the consistency of products and services.

1.2 Purpose

The purpose of this CQA Plan is to define, for the landfill barrier system and leachate collection and conveyance system, construction quality assurance procedures and requirements necessary to demonstrate compliance with the requirements of the Works Documents.

1.3 Scope of Works

The Works to be undertaken are detailed in the Works Documents, however, in general the Works include:

- Protect the Works Area to prevent unauthorised pedestrian and vehicular access and damage to existing infrastructure and works proposed under this contract. This shall include, but not be limited to, locate and protect existing environmental monitoring wells, gas infrastructure and services to the satisfaction of the Superintendent and other authorities, providing site and traffic management such as temporary signage, fencing, gates, lighting (if necessary) and protection barriers.
- Set out the Works including all associated survey work.

- Install and maintain during construction all necessary erosion and sedimentation control measures.
- Supply and construct all necessary temporary works to facilitate the construction of the works.
- Excavate, fill, compact and grade as necessary to develop the finished surfaces.
- Supply and install the leachate barrier system (including sidewall liner system)
- Supply and install leachate collection and conveyance system.
- Supply and construction all necessary access roads and infrastructure.
- Supply and install the surface water drainage works.
- Supply and install the gas extraction system
- Supply and install the final cap
- Supply record drawings in both digital and hardcopy format.

2. General Requirements

2.1 General

The CQA Engineer will consist of personnel with specific experience in the inspection and CQA monitoring of activities related to the construction of the Works.

2.2 Definitions

As per Specification and Contract Documents

2.3 Responsible parties

The responsible parties for implementation of this CQA Plan, as set forth herein, are as follows:

<u>Superintendent</u>

…………………………………………………………………………………………………..

Contact: ……………………………………………………………………………………..

Phone: ....…………………………………………………………………………………….

<u>Superintendents Representative</u>

…………………………………………………………………………………………………..

Contact: ……………………………………………………………………………………..

Phone: ....…………………………………………………………………………………….

<u>Contractor</u>

…………………………………………………………………………………………………..

Contact: ……………………………………………………………………………………..

Phone: ....…………………………………………………………………………………….

<u>CQA Engineer</u>

…………………………………………………………………………………………………..

Contact: ……………………………………………………………………………………..

Phone: ....…………………………………………………………………………………….

<u>Regulatory Authority</u>

…………………………………………………………………………………………………..

Contact: ……………………………………………………………………………………..

Phone: ....…………………………………………………………………………………….

2.4 Lines of communication

Each individual and organisation associated with the design, construction and testing of the proposed project have defined roles and responsibilities during the progress of the work. Timely communication among the parties can reduce problems and changes encountered in the field, increase the efficiency of the work and improve the quality of the finished project.

By delineating lines of communication, questions, concerns and problems can be more effectively and efficiently addressed and resolved. All items which arise in the field should be directed to the Contractor, who in turn can resolve the situation or bringing it to the attention of the Principal or its representative (including the Superintendent and the CQA Engineer).

By developing efficient and direct lines of communication, the reporting and resolution of problems and changes should be efficiently handled, thereby reducing work stoppages and delays.

The lines of communication that are proposed for this project are illustrated in Figure 1.

The Superintendent shall be the main point of liaison between the Contractor and the CQA Engineer, as well as the Client.

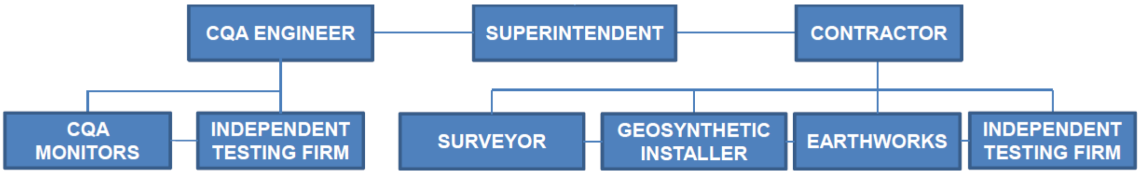

Figure 1 Lines of communication

2.5 Responsibilities

2.5.1 Principal

The general roles and responsibilities of the Principal are as follows:

- Communicate with the CQA Engineer regarding proposed modifications and changes.
- Engage the Leak Location Contractor
- Promptly submit required any requested information to the Regulatory Authority
- Submit a CQA report including Record Drawings to the Regulatory Authority at the completion of the Works.

2.5.2 Superintendent

The Superintendent shall be the liaison between the Contractor and the CQA Engineer while keeping the Principal advised regarding work in progress. The Superintendent shall be responsible for review of schedules, attendance at meetings with the Contractor, recording and receiving samples and shop drawings, reviewing work and interpreting the Contract Documents. Daily construction activities shall be recorded in a daily field report and colour photos of major construction activities shall be taken and labelled.

All CQA functions shall be under the Principal’s authority. All coordination, reporting and issues related to non-compliance shall be directed through the Superintendent. Any requests for information, design modifications or proposed changes in the Technical Specification shall be directed through the Superintendent who shall then liaise with the relevant parties to address these.

2.5.3 Contractor

The Contractor shall select products and suppliers that meet the Technical Specification, obtain supplier proposals, execute purchase agreements, process shop drawings, arrange for product delivery, inspect products on delivery, obtain/collect and forward product certifications and warranties, attend progress meetings, and update schedules. The Contractor shall be responsible for ensuring all CQC activities are undertaken in accordance with the Technical Specification.

2.5.4 CQA Engineer

The CQA Engineer shall be responsible for assessing the compliance of the completed Works with the Works Documents. This shall involve a range of activities that are described in this CQA Plan. Generally, the tasks will include:

- Review the Works Documents;
- Review the CQA Plan;
- Review approved changes to the Works Documents;
- Reviewing and recommend rejection or approval of site-specific documentation including Contractor submittals, Manufacturer's information, Geosynthetic Installer's information and referenced standards. The Superintendent shall make the final decision on approval or disapproval of submittals;
- Verify construction is performed in accordance with the Works Documents. CQA Monitors (refer Section 3.4) shall be assigned to every major construction activity related to the construction of the landfill barrier system and leachate collection and conveyance system. A minimum of one CQA Monitor shall be on-site during the relevant Works;
- Attend required meetings;
- Coordinate CQA Monitors to observe all CQA activities requiring monitoring;
- Educate CQA Monitors on site specific CQA requirements and procedures;
- Verify calibrations of CQC and CQA conformance testing equipment are correctly performed and recorded;
- Verify that CQC and CQA conformance tests are properly performed, recorded, and the results meet specified requirements;
- Review Contractor qualifications to verify conformance with the Works Documents;
- Review warranty submittals to verify they comply with the specified warranty requirements;
- Verify that the Contractor is following the approved work method statements, including relevant CQC requirements identified in the Technical Specification;
- Review required submittals and recommend rejection or approval;
- Report any unapproved deviations from the CQA Plan to the Superintendent as soon as practicable;
- Report any activities that could result in damage to installed Works to the Superintendent as soon as practicable;
- Prepare and maintain required CQA documentation;
- Prepare Daily Reports for submission to the Superintendent
- Oversee the collection, marking, packaging, and shipping of CQA conformance samples for testing; and
- Review 'as-built' surveys and Works as Executed Drawings.

The CQA Engineer is to work with the Superintendent to determine whether sufficient evidence has been provided to adequately document that the Works comply with the requirements of the Works Documents.

The CQA Engineer (and assigned CQA monitors) shall provide full-time monitoring and inspection of the Works until completion.

2.5.5 CQA Monitors

The CQA Engineer may appoint CQA Monitors as necessary, typically permanent site staff (such as the Superintendent) or specialist personnel (such as Geotechnical Engineers), who will observe the Works on behalf of the CQA Engineer to provide a basis for concluding that the Works conform with the Works Documents.

2.5.6 Construction Quality Assurance Engineer's Independent Testing Firm

The CQA Engineer's Independent Testing Firm shall be an independent testing firm(s) engaged by the CQA Engineer to conduct quality assurance testing. The CQA Engineer's Independent Testing Firms(s) shall be National Association Testing Authorities (NATA) accredited.

2.6 Meetings

In order to facilitate CQA, close coordination between the CQA Engineer, the Superintendent and other concerned parties is essential and communication shall be ongoing during the construction. The Superintendent shall document all meetings and minutes shall be distributed to all parties. Construction and design issues shall be reviewed on an as-needed basis and shall be resolved and documented by the Superintendent.

2.6.1 Pre-construction meeting

Prior to initiating construction, the following items will be considered by the CQA Engineer:

- Any appropriate modifications to the CQA requirements;
- Review of the responsibilities of each party;
- Review of the lines of authority and communication;
- Review of the Works Documents;
- Review of the procedures for Works documentation and reporting, and distribution of documents and reports;
- Review of the procedures for field and laboratory CQA conformance testing;
- Establishment of procedures for correcting and documenting construction deficiencies;
- Conducting a Site tour; and
- Review of the Construction Program.

2.6.2 Weekly progress meetings

Weekly progress meetings shall be held between the Superintendent, CQA Engineer (including appropriate CQA Monitors) and other concerned parties. The purpose of these meetings is to discuss current progress, planned activities for the next week, issues requiring resolution, and any revisions to the Works. The CQA Engineer shall report any deficiencies noted during the previous week.

2.6.3 Special meetings

Special meetings will be conducted as required to discuss problems or deficiencies and to formulate comprehensive solutions.

2.7 Hold Points

The Works Documents include a number of Hold Points that require the Contractor to obtain the approval of the Superintendent prior to proceeding with the Works. The CQA Engineer shall advise the Superintendent on the release of Hold Points as required. The Superintendent shall make the final decision on the release of Hold Points.

2.8 Regulatory Authority requirements

The Regulatory Authority should be provided with the opportunity to observe key elements of the Works such as:

- Landfill barrier system construction;
- Leachate collection and conveyance system construction;
- Field trials; and
- Completed Works.

2.9 Independent conformance testing

2.9.1 General

General independent conformance sampling and testing requirements are provided below. Further guidance for each material is provided in the individual sections of this CQA Plan.

2.9.2 Independent conformance sampling

The CQA Engineer shall arrange for independent conformance testing of the materials used in the Works, in accordance with this CQA Plan, to assure conformance with the Technical Specification. Samples shall be collected at locations designated by the CQA Engineer and all independent conformance sampling shall be witnessed by the CQA Engineer. The CQA Engineer shall confirm that all samples are collected, cut, labelled, and packaged in accordance with the Technical Specification and this CQA Plan. Samples shall be labelled with the following:

- Sample number
- Date sampled
- Project name
- Material and source
- Location of test
- Intended use of material.

The location, sample number and purpose of the samples shall be noted on the daily report.

2.9.3 Independent conformance testing

All independent conformance testing shall be undertaken by authorities accredited by the National Association of Testing Authorities (NATA) to test in the relevant field, or an organisation outside Australia recognised by NATA through a mutual recognition agreement. Field tests shall be conducted by suitably qualified personnel.

Subsequent sections of this CQA Plan describe the conformance testing to be performed.

2.9.4 Independent conformance results

The CQA Engineer shall verify the following when reviewing independent conformance test results:

- The correct conformance tests have been performed and specified test procedures have been used
- Test results meet the requirements of the Technical Specification.

The CQA Engineer shall immediately notify the Superintendent of problems with CQA conformance testing procedures or non-compliance of conformance test results, including recommendations for rejection of materials.

The CQA Engineer shall maintain a log of all CQA test results, including date and location of specific tests. This log shall be provided to the Superintendent on a weekly basis. The log may be provided to the Contractor at the discretion of the Superintendent.

2.10 Non-conformance and corrective action procedures

All non-conformances that arise from non-compliance with the Works Documents will be duly noted and appropriately recorded by the CQA Engineer, in the form of a non-conformance report, and made available to the Superintendent within 24 hours of becoming aware of the non-conformance.

Where a non-conformance occurs, the non-conformance report is to include the following information:

- The location of the non-conformance;
- The time of the non-conformance;
- The time that the CQA Engineer was made aware of non-conformance;
- The suspected cause of the non-conformance; and
- A description of the resulting impacts of the non-conformance.

The Superintendent, in consultation with the CQA Engineer, shall prepare a corrective action plan to address the non-conformance. The corrective action plan will at least address the following:

- The nature of the non-conformance and its level of effect on the project;
- Determination if the non-conformance is an isolated incident or a recurring problem;
- How amendments to procedures to prevent future occurrences of the non-conformance will be implemented;
- The nature of corrective action to be applied to rectify that specific non-conformance (eg re-compaction and testing); and
- The need to report the non-conformance to the Regulatory Authority (eg. major exceptions / variations to the approved Works Documents).

3. Earthworks

3.1 General

The CQA Engineer shall verify the CQA requirements described in this section for earthworks specific to the landfill barrier system and leachate collection and conveyance system. Additional requirements for specific material types are discussed in subsequent Sections.

3.2 Qualifications

The CQA Engineer assigned CQA responsibilities for earthworks shall have provided CQA inspection during installation of soil layers for at least three major earthworks projects totalling a minimum of 50,000 m^3 of earthwork activities.

The CQA Engineer may assign CQA Monitors in accordance with Section 2.5.5 as appropriate.

3.3 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor.

3.4 Materials

The CQA Engineer shall:

- Review all test results/reports provided by the Contractor for the proposed fill material to verify that the relevant fill material is uniform and matches the required properties given in the Technical Specification
- Advise the Superintendent about the need to do additional borrow source assessment testing if visual inspections identify that the properties of the relevant fill material appear to have changed significantly
- Inspect fill material stockpiles prior to use and advise the Superintendent of the presence of any unsuitable material.

3.5 Equipment

The CQA Engineer shall visually inspect and verify soil processing, placement, and compaction equipment meet the requirements of the Specification and the approved work method statement(s).

3.6 Quantities

If requested by the Superintendent, the CQA Engineer shall review and comment on any quantity re-measurements submitted by the Contractor.

3.7 Extent of Disturbed Areas

The CQA Engineer shall notify the Superintendent if the Contractor is witnessed working outside the Works Area shown on the Contract Drawings.

3.8 Lines and Levels

The CQA Engineer shall review as-built survey data of the completed surfaces to verify conforming lines, levels and layer thickness within the allowable tolerance.

3.9 Clearing and Grubbing

If requested by the Superintendent, the CQA Engineer shall inspect and comment on any clearing and grubbing works undertaken by the Contractor.

3.10 Excavation

The CQA Engineer shall verify the following during excavation:

- Material that is unsuitable for use shall be excavated and disposed by the Contractor
- Excavation slopes shall be finished in conformance with the required lines and grades
- All debris and loose material is removed from the finished surfaces
- The Contractor has implemented protective measures to ensure that the excavation areas are not damaged during periods of inclement weather.

3.11 Subgrade preparation

During subgrade preparations verify the following:

- The subgrade is smooth, free of voids, and composed of satisfactory materials;
- The subgrade is compacted as specified;
- The lines and levels of the top surface of the subgrade is correct; and
- The subgrade surface is scarified as specified prior to placement of the first lift of fill.

3.12 Filling

During filling, verify the following:

- Sudden braking or sharp turns are not made;
- Slippage of filling and compaction equipment is not occurring on side slopes. This is especially important when the fill layer is underlain by geosynthetics;
- There are no thin areas of fill which could allow underlying geosynthetics to be punctured or torn;
- Loose lifts are no greater than the specified maximum allowable thickness;
- Fill contains no large clods or other material prohibited by the Works Documents; and
- Fill is placed to the lines and levels shown in the Works Documents.

3.13 Compaction

- Verify the specified minimum number of passes are being made over all areas of each lift of fill (if applicable);
- Visually observe fill placement around all penetrations and verify that fill placed around penetrations does not contain voids and is adequately compacted;
- Inspect pipes which penetrate fill layers for damage due to placement and compaction equipment;
- Verify the surface of each lift is adequately scarified prior to placement of the next lift of fill;
- Verify low ground pressure equipment is used when compaction is required over piping, geosynthetics, or other appurtenances.

3.14 Conformance testing

3.14.1 Borrow tests

- Check CQC borrow test results to verify that the borrow material is uniform and matches the required properties given in the Works Documents; and
- Advise the Superintendent about the need to do additional borrow source assessment testing if the properties of a borrow source appear to have changed significantly.

3.14.2 In-place moisture content and density tests

Verify the following during testing of the in-place fill:

- CQC moisture content and density tests are performed at the specified frequency;
- Additional CQC tests are taken where test results are not in compliance with the Works Documents or the fill is visibly suspect;
- The Contractor performs corrective action as a result of failed tests in compliance with the Works Documents and submits documentation describing the corrective measures taken; and
- The Contractor uses nuclear gauges in the direct transmission mode to measure density.

3.15 Tolerances

The CQA Engineer shall review as-built survey data of the completed surfaces to verify conforming layer thickness within the allowable tolerance.

3.16 Anchoring of Geosynthetics

The CQA Engineer shall verify the following when inspecting anchor trenches:

- The anchor trench is constructed to the correct dimensions
- Termination points of geosynthetic layers within the anchor trench are correct
- Corners of the anchor trench are slightly rounded to avoid sharp bends in the geosynthetics
- Loose fill or objectionable materials such as geosynthetic scraps and food containers are removed from the bottom of the anchor trench prior to placement of geosynthetics
- The anchor trench is dewatered (pumped out) if standing water is present in the bottom of the trench
- The anchor trench is backfilled with approved fill placed at the specified moisture content and density
- Compaction work within the anchor trench does not damage the geosynthetics.

3.17 Stockpiles

The CQA Engineer shall inform the Superintendent if the Contractor is witnessed to not be managing stockpiles in accordance with the requirements of the Technical Specification and the approved work method statement.

3.18 Protection

- Verify the Contractor removes puddles and excess moisture from the fill surface prior to placement of additional fill;

- Look for areas of erosion after each rainfall event;
- Inspect for damage due to freezing and/or desiccation; and
- Ensure the Contractor repairs damaged areas and re-establishes grades.

3.19 Weather conditions

Verify that earthworks do not occur during periods of excessive rain, freezing temperatures, or if other detrimental weather conditions exist.

3.20 Defects and Repairs

If a fill layer does not conform to the Works Documents, assist the Superintendent in defining the extent of the area requiring repair. This shall be done through the use of additional testing and visual inspection.

After repairs have been made, ensure CQC retests are performed to check the repaired areas. In general, CQC retests shall be performed at the same frequency as the rest of the project. Additional CQC testing shall be performed in suspect areas.

3.21 Acceptance

Prior to the final acceptance of all earthwork activities by the Superintendent, the CQA Engineer shall provide a recommendation to the Superintendent on whether the conditions of final acceptance have been met as per the Technical Specification. This recommendation shall be based on, but not limited to, the following:

- Review of all submittals, including CQC test results
- Review of CQA test results
- Relevant monitoring and inspections undertaken.

4. Subgrade

4.1 General

The CQA Engineer shall verify the following during subgrade preparation.

The relevant requirements for subgrade preparation in Section 3.11 shall be considered alongside guidance provided in this section.

All individuals assigned CQA responsibilities for subgrade inspection shall have provided CQA inspection during preparation of subgrade for at least three major earthworks projects totalling a minimum of 50,000 m^3 of earthwork activities.

The subgrade shall be constructed and prepared under Level 1 Inspection and Testing by the CQA Engineer in accordance with AS3798.

4.2 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor.

4.3 Preparation of subgrade

The CQA Engineer shall inspect the subgrade and verify the following during subgrade preparation:

- Suitable protection measures are installed to protect the subgrade from erosion and damage
- The subgrade is kept free of all trash and debris
- The subgrade is smooth, free of voids and composed of satisfactory materials
- The subgrade is compacted as specified
- The elevation of the top surface of the subgrade is correct
- The subgrade surface is scarified as specified prior to placement of the first lift of soil
- The subgrade is smooth, free of voids, and composed of satisfactory materials
- The subgrade provides a stable surface for the overlying liner system.

4.4 Quality control testing

The subgrade shall be constructed and prepared under Level 1 Inspection and Testing by the CQA Engineer in accordance with AS3798. The CQA Engineer shall agree on all sampling locations for testing with the Contractor and Superintendent. The CQA Engineer shall review the test results to confirm they meet the requirements of the Specification.

4.5 Proof rolling

The CQA Engineer shall witness proof rolling to assess the soundness and suitability of the subgrade based on the requirements of the Specification.

4.6 Acceptance

Prior to the final acceptance of the subgrade by the Superintendent/Principal, the CQA Engineer shall provide a recommendation to the Superintendent on whether the conditions of final acceptance have been met as per the Specification. This recommendation shall be based on, but not limited to, the following:

- Review of all submittals
- Review of CQA test results
- Relevant monitoring and inspections undertaken.

5. Clay rich fill

5.1 General

The CQA Engineer shall verify the following during placement of the clay rich fill.

All individuals assigned CQA responsibilities for the Clay rich fillshall have provided CQA inspection during installation soil layers for at least three major earthworks projects totalling a minimum of 50,000 m^3 of protective soil layer material.

5.2 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor, including any updates made based on the results of the field trial.

5.3 Materials

The CQA Engineer shall:

- Review all test results/reports provided by the Contractor for the proposed clay rich fill material to verify that the material is uniform and matches the required properties given in the Specification
- Advise the Superintendent about the need to do additional borrow source assessment testing if the properties of the clay rich fill material appear to have changed significantly
- Inspect material stockpiles prior to use and advise the Superintendent of the presence of any unsuitable material.

5.4 Delivery, storage and handling

The CQA Engineer shall inspect stockpiles prior to use and advise the Superintendent of the presence of any unsuitable material or contamination as per the Specification.

5.5 Preparation of surface to receive clay rich fill

The receiving surface shall be inspected and approved by the CQA Engineer each day that clay rich fill is installed. Additional inspections shall be performed if weather, vehicular traffic or other factors may have damaged the receiving surface after approval. The CQA Engineer shall verify the following during inspections of the receiving surface:

- The receiving surface is complete and accepted by the Superintendent
- The receiving surface is cleared of any debris and/or foreign material
- The receiving surface has not been damaged by inclement weather.

5.6 Installation

The CQA Engineer shall verify the following during installation:

- Installation is undertaken in accordance with the approved work method statement, which includes any adjustments made as a result of the field trial.
- Equipment used for installation and cover are in accordance with the approved work method statement
- Weather conditions are acceptable for installation

- Oversize and angular material which could damage underlying geosynthetics has been removed from the clay rich fill material
- Clay rich fill material is not dumped directly onto underlying geosynthetics from a height greater than specified
- Underlying geosynthetics are not being damaged by placement equipment. Placement equipment should be observed from the front side as clay rich fill material is being spread over the underlying geosynthetics
- Wrinkles in underlying geosynthetics are not folding over onto themselves during clay rich fill material placement
- Low ground pressure equipment is being used where specified
- Placement of clay rich fill material proceeds from a stable working area adjacent to the deployed geosynthetic materials and gradually progresses outward. For slopes, clay rich fill material must be placed by starting at the toe and working up the slope
- Access routes are adequately built up to protect underlying geosynthetics. Access routes generally must be a minimum of 900 mm in thickness
- Tracks and wheels of full scale construction equipment remain on the access routes at all times
- Repairs are made to the access routes as needed. Inspect access routes daily to see if thinning of the clay rich fill material is occurring
- Large stockpiles of clay rich fill material are not placed on top of in-place geosynthetics
- Thin areas of clay rich fill material which could allow underlying geosynthetics to be punctured or torn by construction equipment are repaired immediately.

5.7 Defects and repairs

The CQA Engineer shall visually inspect the clay rich fill for damage or defects after placement. If an area of the clay rich fill does not conform to the Specification, the CQA Engineer shall assist the Superintendent in defining the extent of the area requiring repair. This shall be done through the use of additional testing and visual inspection.

After repairs have been made, the CQA Engineer shall confirm quality control retests are performed to check the repaired areas. In general, CQC retests shall be performed at the same frequency as the rest of the project. Additional CQC testing shall be performed in suspect areas.

5.8 Acceptance

Prior to the final acceptance of the clay rich fill by the Contract Manager, the CQA Engineer shall provide a recommendation to the Superintendent on whether the conditions of final acceptance have been met as per the Specification. This recommendation shall be based on, but not limited to, the following:

- Review of all submittals
- Review of CQA test results
- Relevant monitoring and inspections undertaken.

6. Geonet drainage composite

6.1 General

All individuals' assigned CQA responsibilities for the geonet and geonet drainage composite shall have be accredited by the Geosynthetic Certification Institute-Inspectors Certification Program for installation of geosynthetic materials or have provided CQA inspection during installation of geosynthetics for at least three projects totalling a minimum of 100,000 m^2 of geosynthetics.

6.2 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor.

6.3 Manufacturers quality control

The CQA Engineer shall review the manufacturer's quality control procedures and test results prior to delivery of geonet and geonet drainage composite to site to confirm the material conforms to the requirements of the Specification.

6.4 Manufacturers quality assurance

The CQA Engineer shall review the manufacturer's quality assurance procedures and test results prior to delivery of geonet and geonet drainage composite to site to confirm the material conforms to the requirements of the Specification.

6.5 Material

The CQA Engineer shall review all test results/reports provided by the Contractor to confirm the material conforms to the requirements of the Specification.

6.6 Independent conformance testing

The CQA Engineer shall supervise collection of CQA samples by the Geosynthetic Installer for geonet and geonet drainage composite at the rate specified in Table 1 and forward the samples to the CQA Engineers Independent Testing Firm for testing. The samples shall be taken from the rolls delivered to site prior to use. All samples test results shall be received, accepted and reported by the CQA Engineer prior to installation.

The required testing frequencies may be revised by the CQA Engineer to conform with improvements in testing methods and/or in the state of the art practice and/or to account for the criticality of the application. Revisions must be approved by the relevant parties before application.

Unless otherwise specified or approved, the CQA Engineer shall verify CQA samples are not taken from the outer wrap of the roll and samples are a minimum of 1 m in length by the roll width.

Table 1 Geonet and geonet drainage composite CQA testing

Test Type	Test Method	Frequency	Comments
Mass per unit area	D5261	1 test per 5 rolls	Laboratory measurement
Thickness	D5199	1 test per 5 rolls	
Tensile strength (machine direction)	D1682	1 test per 10 rolls	Laboratory measurement
Transmissivity (1)	D4716	1 test per 10 rolls	Laboratory measurement
Compressive strength	D1621	1 test per 10 rolls	Laboratory measurement
Apparent opening size of geotextile		1 test per 5 rolls	
Ply adhesion (MARV)	D7005	1 test per 5 rolls	Laboratory measurement

6.7 Roll and sample identification

The CQA Engineer shall verify rolls and samples are identified in accordance with the Specification.

6.8 Delivery, storage and handling

The CQA Engineer shall fill out a receiving inspection report for each delivery of geonet and geonet drainage composite. The CQA Engineer shall be present during delivery and unloading to verify the following:

- Rolls are shipped, handled and stored in such a manner that no damage occurs to the geonet and geonet drainage composite
- Rolls are shipped, handled and stored in accordance with the approved work method statement and the manufacturer's instructions
- Geonet and geonet drainage composite rolls are packaged in opaque, waterproof, protective coverings
- Each roll is labelled in accordance with the Specification
- Rolls which are damaged beyond use are removed from the site.

6.9 Preparation of surface to receive geonet and geonet drainage composite

The receiving surface shall be inspected and approved each day that geonet and geonet drainage composite is installed by the CQA Engineer. Additional inspections shall be performed if weather, vehicular traffic or other factors may have damaged the receiving surface after approval. The CQA Engineer shall verify the following during inspections of the receiving surface:

- The receiving surface is complete and accepted by the Superintendent
- The receiving surface is free of defects or imperfections that may result in damage to the geonet and geonet drainage composite
- The receiving surface is free from abrupt breaks, sharp objects, or other foreign material

[1] Hydraulic gradient (1 m/m), Confining stress (>230 kPa), Seating time (100 hours)

- The receiving surface has not been damaged by inclement weather
- If the receiving surface is subgrade or fill materials, verify the surface is compacted in accordance with the Specification and not pebbly, or tracked and rutted by equipment.

6.10 Installation

The CQA Engineer shall verify the following during installation:

- Installation is undertaken in accordance with the approved work method statement and manufacturer's instructions
- Any damaged or defective rolls are identified, inspected and approved or rejected
- Weather conditions are acceptable for installation (with consideration to manufacturer's instructions)
- Winds are not so high as to cause damage during installation
- Any rolls or panels which have been displaced by wind are inspected for damage and approved or rejected
- Equipment used for installation and cover are in accordance with the approved work method statement
- The Contractor has adequate ballasts (e.g. sandbags) on hand and they are properly deployed to prevent uplift of the panels by wind
- Field panels are installed at the locations and positions indicated on the Contractor's approved panel placement drawing. The CQA Engineer shall verify that the identification code, location, and date of installation of each field panel are recorded
- Rolls are laid reasonably flat with a minimum of wrinkles so that they contain no areas that can fold over during covering
- Rolls are placed with the correct side facing up (where relevant)
- There are no broken needles present in the geotextiles
- The Contractor cuts out and repairs waves that are so large as to cause folding of the geonet and geonet drainage composite when they are covered
- There are no tensile stresses in the deployed geonet and geonet drainage composite
- Construction personnel are not smoking or wearing shoes that could damage the geonet and geonet drainage composite
- Seams are constructed as specified and in accordance with manufacturer's instructions, and lapped in the correct direction (where relevant). Also verify seams are not placed in locations prohibited by the Specification
- Rolls are not dragged across the receiving surface or other deployed geonet and geonet drainage composite. This can result in damage to the geonet and geonet drainage composite. A sacrificial rub sheet may be used to alleviate this problem
- Rolls are not being damaged during placement or covering
- The ribs of the composite are continuous and are securely attached to each other
- Plastic fasteners are used to join adjacent rolls and they are placed at the specified spacing
- Fasteners are of contrasting colour with the composite to facilitate visual inspection
- Rolls are not being damaged during the fabrication of heat bonded geotextile seams

- Rolls are inspected for evidence of clogging from eroded or windblown soil.

6.11 Defects and repairs

The CQA Engineer shall visually inspect geonet and geonet drainage composite for damage after placement. Damaged areas shall be marked. The CQA Engineer shall document the location of the damaged panels, repairs which were performed and panels which were rejected in the daily report (Section 24.2).

The CQA Engineer shall visually inspect and verify that all deficiencies have been repaired in accordance with the Specification prior to final acceptance.

6.12 Acceptance

Prior to the final acceptance of the geonet and geonet drainage composite by the Superintendent/Principal, the CQA Engineer shall provide a recommendation to the Superintendent on whether the conditions of final acceptance have been met as per the Specification. This recommendation shall be based on, but not limited to, the following:

- Review of all submittals
- Review of CQA test results
- Relevant monitoring and inspections undertaken.

7. Sand Drainage Layer

7.1 General

The CQA Engineer shall verify the following during placement of the sand drainage layer.

All individuals assigned CQA responsibilities for the sand drainage layer shall have provided CQA inspection during installation soil layers for at least three major earthworks projects totalling a minimum of 50,000 m^3 of protective soil layer material.

7.2 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor, including any updates made based on the results of the field trial.

7.3 Materials

The CQA Engineer shall:

- Review all test results/reports provided by the Contractor for the proposed sand drainage material to verify that the material is uniform and matches the required properties given in the Specification
- Advise the Superintendent about the need to do additional borrow source assessment testing if the properties of the sand drainage material appear to have changed significantly
- Inspect sand drainage material stockpiles prior to use and advise the Superintendent of the presence of any unsuitable material.

7.4 Delivery, storage and handling

The CQA Engineer shall inspect sand fill stockpiles prior to use and advise the Superintendent of the presence of any unsuitable material or contamination as per the Specification.

7.5 Preparation of surface to receive sand drainage layer

The receiving surface shall be inspected and approved by the CQA Engineer each day that sand drainage layer is installed. Additional inspections shall be performed if weather, vehicular traffic or other factors may have damaged the receiving surface after approval. The CQA Engineer shall verify the following during inspections of the receiving surface:

- The receiving surface is complete and accepted by the Superintendent
- The receiving surface is cleared of any debris and/or foreign material
- The receiving surface has not been damaged by inclement weather.

7.6 Installation

The CQA Engineer shall verify the following during installation:

- Installation is undertaken in accordance with the approved work method statement, which includes any adjustments made as a result of the field trial.
- Equipment used for installation and cover are in accordance with the approved work method statement
- Weather conditions are acceptable for installation

- Oversize and angular material which could damage underlying geosynthetics has been removed from the sand drainage material
- Sand drainage material is not dumped directly onto underlying geosynthetics from a height greater than specified
- Underlying geosynthetics are not being damaged by placement equipment. Placement equipment should be observed from the front side as sand drainage material is being spread over the underlying geosynthetics
- Wrinkles in underlying geosynthetics are not folding over onto themselves during sand drainage material placement
- Low ground pressure equipment is being used where specified
- Placement of sand drainage material proceeds from a stable working area adjacent to the deployed geosynthetic materials and gradually progresses outward. For slopes, sand drainage material must be placed by starting at the toe and working up the slope
- Access routes are adequately built up to protect underlying geosynthetics. Access routes generally must be a minimum of 900 mm in thickness
- Tracks and wheels of full scale construction equipment remain on the access routes at all times
- Repairs are made to the access routes as needed. Inspect access routes daily to see if thinning of the sand drainage material is occurring
- Large stockpiles of sand drainage material are not placed on top of in-place geosynthetics
- Thin areas of sand drainage material which could allow underlying geosynthetics to be punctured or torn by construction equipment are repaired immediately.

7.7 Defects and repairs

The CQA Engineer shall visually inspect the sand drainage layer for damage or defects after placement. If an area of the sand drainage layer does not conform to the Specification, the CQA Engineer shall assist the Superintendent in defining the extent of the area requiring repair. This shall be done through the use of additional testing and visual inspection.

After repairs have been made, the CQA Engineer shall confirm quality control retests are performed to check the repaired areas. In general, CQC retests shall be performed at the same frequency as the rest of the project. Additional CQC testing shall be performed in suspect areas.

7.8 Acceptance

Prior to the final acceptance of the sand drainage layer by the Contract Manager, the CQA Engineer shall provide a recommendation to the Superintendent on whether the conditions of final acceptance have been met as per the Specification. This recommendation shall be based on, but not limited to, the following:

- Review of all submittals
- Review of CQA test results
- Relevant monitoring and inspections undertaken.

8. Geosynthetic Clay Liner

8.1 General

The CQA Engineer shall verify the following during geosynthetic clay liner (GCL) installation.

8.2 Qualifications

The CQA Engineer assigned CQA responsibilities for the GCL shall have be accredited by the Geosynthetic Certification Institute-Inspectors Certification Program for installation of geosynthetic materials or have provided CQA inspection during installation of GCL for at least three projects totalling a minimum of 100,000 m^2.

The CQA Engineer may assign CQA Monitors in accordance with Section 2.5.5 as appropriate.

8.3 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor.

8.4 Manufacturers Quality Control

The CQA Engineer shall review the manufacturer’s quality control procedures and test results prior to delivery of GCL to site to confirm the material conforms to the requirements of the Specification. This shall include verification that the measurements of properties by the manufacturer are properly documented, test methods are acceptable, sampling procedure detailed and that the proposed geosynthetic clay liner, the geotextile and the bentonite meet the Specification.

8.5 Manufacturers Quality Assurance

The CQA Engineer shall review the manufacturer’s quality assurance procedures and test results prior to delivery of GCL to site to confirm the material conforms to the requirements of the Specification. This may include liaison with the manufacturer on the frequency of MQA testing.

8.6 Material

The CQA Engineer shall review all test results/reports provided by the Contractor to confirm the material conforms to the requirements of the Specification.

8.7 Independent Conformance Testing

The CQA Engineer shall supervise collection of CQA samples by the Geosynthetic Installer for GCL at the rate specified in Table 2 and forward the samples to the CQA Engineers Independent Testing Firm for testing. The testing frequencies shall apply to all GCL products provided as part of the Works.

Each product supplied shall be treated as a separate GCL material with the testing frequencies applied per product and not additively. The samples shall be taken from the rolls delivered to site prior to use. All samples test results shall be received, accepted and reported by the CQA Engineer prior to installation.

The required testing frequencies may be revised by the CQA Engineer to conform with improvements in testing methods and/or in the state of the art practice and/or to account for the criticality of the application. Revisions must be approved by the relevant parties before application.

Unless otherwise specified or approved, the CQA Engineer shall verify CQA samples are not taken from the outer wrap of the roll and samples are a minimum of 1 m in length by the roll width.

Samples shall be cut on a flat surface and the edges taped closed to limit loss of bentonite.

Table 2 lists the independent conformance testing that shall be performed on the GCL prior to installation.

Table 2 GCL independent conformance testing

Test Type	Test Method	Frequency	Comments
Bentonite Clay – Mass @ 0% moisture	ASTM D5993	1 test per 2,500 m^2	Laboratory
Bentonite Clay – Fluid Loss	ASTM D5891	1 test per roll or per 1,250 m^2 (whichever is greater)	Laboratory
Bentonite Clay – Free Swell Index	ASTM D5890	1 test per roll or per 2,500 m^2 (whichever is greater)	Laboratory
Bentonite Clay – Montmorrillonite Content	CSIRO method	1 test per 10,000 m^2	Laboratory
Bentonite Clay – Moisture Content	ASTM D5993	1 test per roll or per 2,500 m^2 (whichever is greater)	Laboratory
Bentonite Clay – Cation exchange capacity	Methylene blue method	1 test per roll or per 2,500 m^2 (whichever is greater)	Laboratory
Strip tensile strength – machine direction	ASTM D6768	1 test per 5,000 m^2	Laboratory
Peel strength	ASTM D6496	1 test per roll or per 1,250 m^2 (whichever is greater)	Laboratory
Hydraulic conductivity	ASTM D5887	1 test per 10,000 m^2	Laboratory

In addition to this testing, GCL thickness and apparent variations in the as placed moisture distribution shall be assessed on-site for each roll during placement. If thickness appears to be variable a check of the variability of the mass per unit area shall be conducted.

8.8 Roll and Sample Identification

The CQA Engineer shall verify rolls and samples are identified in accordance with the Specification.

8.9 Delivery, Storage and Handling

The CQA Engineer shall fill out a receiving inspection report (Section 23.3 and Appendix A) for each delivery of GCL. The CQA Engineer shall be present during delivery and unloading to verify the following:

- Rolls are shipped, handled and stored in such a manner that no damage occurs to the GCL
- Rolls are shipped, handled and stored in accordance with the approved work method statement and the manufacturer’s instructions

- GCL rolls are packaged in opaque, waterproof, protective coverings. GCL rolls delivered without complete packaging, labelling and documentation shall be either rejected or quarantined based on inspections by the CQA Engineer
- Each roll is labelled in accordance with the Specification
- Rolls which are damaged beyond use are removed from the site.

If the CQA Engineer determines any damaged GCL rolls or partial rolls are suitable for use, written justification for doing so shall be provided.

8.10 Preparation of Surface to Receive Geosynthetic Clay Liner

The receiving surface shall be inspected and approved each day that GCL is installed by the CQA Engineer. Additional inspections shall be performed if weather, vehicular traffic or other factors may have damaged the receiving surface after approval. The CQA Engineer shall verify the following during inspections of the receiving surface:

- The receiving surface is complete and accepted by the Superintendent
- The receiving surface is free of defects or imperfections that may result in damage to the GCL
- Excessive moisture is not present which may inhibit GCL installation
- The receiving surface is free from abrupt breaks, sharp objects, or other foreign material
- The receiving surface has not been damaged by inclement weather
- If the receiving surface is subgrade or fill materials, verify the surface is compacted in accordance with the Specification and not pebbly, or tracked and rutted by equipment.

The CQA Engineer shall sign a certificate of subgrade acceptance shall be signed each day GCL materials are placed.

8.11 Installation

The CQA Engineer shall verify the following during installation:

- Installation and movement of GCL is undertaken in accordance with the approved work method statement and manufacturer’s instructions
- Each roll is visually inspected for damage and deficiencies with consideration to colour, thickness, needle punching, presence of needles or broken needles, and sewing density or other faults in the material
- Any damaged or defective rolls are identified, inspected and approved or rejected based on criteria within the Specification
- Any visible or suspected damage is recorded and reported, and relevant rolls are tagged and segregated for further investigation
- Weather conditions are acceptable for installation (with consideration to manufacturer’s instructions)
- Winds are not so high as to cause damage during installation
- Any rolls or panels which have been displaced by wind are inspected for damage and approved or rejected
- Equipment used for installation and cover are in accordance with the approved work method statement

- The Contractor has adequate ballasts (e.g. sandbags) on hand and they are properly deployed to prevent uplift of the panels by wind
- Field panels are installed at the locations and positions indicated on the Contractor's approved panel placement drawing. The CQA Engineer shall verify that the identification code, location, and date of installation of each field panel are recorded
- Rolls are laid reasonably flat with a minimum of wrinkles so that they contain no areas that can fold over during covering
- Rolls are placed with the correct side facing up (where relevant)
- The Contractor cuts out and repairs waves that are so large as to cause folding of the GCL when they are covered
- There are no tensile stresses in the deployed GCL
- Construction personnel are not smoking or wearing shoes that could damage the GCL
- GCL which has been hydrated prior to being covered is removed and replaced. Hydrated GCL is defined as material, which has become soft as determined by squeezing the material with finger pressure or material that has exhibited swelling.
- Seams are constructed as specified and in accordance with manufacturer’s instructions, and lapped in the correct direction (where relevant). Also verify seams are not placed in locations prohibited by the Specification
- Overlaps are constructed in accordance with the requirements of the Specification
- Bentonite paste is placed along the entire overlap width at the rate as per manufacturer’s instructions
- Adhesives or other approved seaming methods recommended by the manufacturer are used if horizontal seams are allowed on slopes
- Rolls are not dragged across the receiving surface or other deployed GCL. This can result in damage to the GCL. A sacrificial rub sheet may be used to alleviate this problem
- Rolls are not being damaged during placement or covering
- GCL is not hydrated prior to covering.

8.12 Protection

The CQA Engineer shall visually inspect and verify that only those GCL panels which can be anchored and covered before the end of the day are removed from the packaging. If exposed GCL cannot be covered before the end of the day, the CQA Engineer shall verify it is covered with a plastic cover material and ballasted until construction can resume.

8.13 Penetrations

The CQA Engineer shall verify the following:

- Penetrations are located as shown on the plans
- Penetrations are constructed and tested as per the Specification and the manufacturer’s instructions.

8.14 Defects and Repairs

The CQA Engineer shall visually inspect GCL for damage after placement. Damaged areas shall be marked. The CQA Engineer shall document the location of the damaged panels, repairs which were performed and panels which were rejected in the daily report.

The CQA Engineer shall visually inspect and verify that all deficiencies have been repaired in accordance with the Specification and the manufacturer's instructions prior to final acceptance.

8.15 Acceptance

Prior to the final acceptance of the GCL by the Superintendent, the CQA Engineer shall provide a recommendation to the Superintendent on whether the conditions of final acceptance have been met as per the Specification. This recommendation shall be based on, but not limited to, the following:

- Review of all submittals, including CQC test results GCL deployment
- Review of CQA test results
- Relevant monitoring and inspections undertaken.

9. PE Geomembrane

9.1 General

The CQA Engineer shall verify the following during PE geomembrane installation.

9.2 Qualifications

The CQA Engineer assigned CQA responsibilities for the PE geomembrane shall have be accredited by the Geosynthetic Certification Institute-Inspectors Certification Program for installation of geosynthetic materials or have provided CQA inspection during installation of PE geomembrane for at least three projects totalling a minimum of 100,000 m^2.

The CQA Engineer may assign CQA Monitors in accordance with Section 2.5.5 as appropriate.

9.3 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor.

The CQA Engineer shall review the finalised panel placement drawing to confirm it accurately depicts installation.

9.4 Manufacturers Quality Control

The CQA Engineer shall review the manufacturer's quality control procedures and test results prior to delivery of PE geomembrane to site to confirm the material conforms to the requirements of the Specification. This shall include verification that the measurements of properties by the manufacturer are properly documented, test methods are acceptable, sampling procedure detailed and that the proposed geomembrane meets the Specification.

9.5 Manufacturers Quality Assurance

The CQA Engineer shall review the manufacturer's quality assurance procedures and test results prior to delivery of PE geomembrane to site to confirm the material conforms to the requirements of the Specification. This may include liaison with the manufacturer on the frequency of MQA testing.

9.6 Material

The CQA Engineer shall review all test results/reports provided by the Contractor to confirm the material conforms to the requirements of the Specification.

Prior to installation of geomembrane, the CQA Engineer shall review quality control certificates issued by the resin supplier. The CQA Engineer shall compare resin source lot numbers from the manufacturer with the manufacturer's roll listing to verify the proposed resin was used to manufacture the rolls delivered to the site. This information shall be logged and included as part of the CQA Report.

9.7 Independent Conformance Testing

The CQA Engineer shall supervise collection of CQA samples by the Geosynthetic Installer for PE geomembrane at the rate specified in Table 3 and forward the samples to the CQA Engineers.

Independent Testing Firm for testing. The testing frequencies shall apply to all PE geomembrane products provided as part of the Works. Each product supplied shall be treated as a separate PE geomembrane material with the testing frequencies applied per product and not additively. The samples shall be taken from the rolls delivered to site prior to use. All samples test results shall be received, accepted and reported by the CQA Engineer prior to installation.

The required testing frequencies may be revised by the CQA Engineer to conform with improvements in testing methods and/or in the state of the art practice and/or to account for the criticality of the application. Revisions must be approved by the relevant parties before application.

Unless otherwise specified or approved, the CQA Engineer shall verify CQA samples are not taken from the outer wrap of the roll and samples are a minimum of 1 m in length by the roll width.

While sampling, the CQA Engineer shall ensure that the samples are not scratched as this may affect results. The samples shall be packaged with suitable protection to avoid damage during transport.

Table 3 lists the independent conformance testing that shall be performed on the PE geomembrane prior to installation.

Table 3 PE geomembrane independent conformance testing

Test Type	Test Method	Frequency	Comments
Thickness (average)	ASTM D5994	One test per 5 rolls or 5,000 m^2 (whichever is greater).	Laboratory measurement
Minimum thickness	ASTM D5994	One test per 5 rolls or 5,000 m^2 (whichever is greater).	Laboratory measurement
Asperity height (min)	ASTM D7466	One test per 5 rolls or 5,000 m^2 (whichever is greater).	Laboratory measurement
Density	ASTM D1505 or D792 (method B)	One test per 5 rolls or 5,000 m^2 (whichever is greater).	Laboratory measurement
Tensile properties (each direction) • Strength at break • Elongation at break • Strength at yield • Elongation at yield	ASTM D6693	One test per 5 rolls or 5,000 m^2 (whichever is greater).	Laboratory measurement
Tear resistance	ASTM D1004	One test per 5 rolls or 5,000 m^2 (whichever is greater).	Laboratory measurement
Puncture resistance	ASTM D4833	One test per 5 rolls or 5,000 m^2 (whichever is greater).	Laboratory measurement
Carbon black content	ASTM D4218	One test per 5 rolls or 5,000 m^2 (whichever is greater).	Laboratory measurement

Test Type	Test Method	Frequency	Comments
Carbon black dispersion	ASTM D5596	One test per 5 rolls or 5,000 m^2 (whichever is greater).	Laboratory measurement
Oxidative Induction Time (OIT) • Standard OIT (AND) • High pressure OIT	ASTM D 3895 ASTM D 5885	One test per resin type or manufacturing run or per 10,000 m^2 of geomembrane. (whichever is greater)	Laboratory measurement
Stress crack resistance	ASTM D5397	One test per resin type or manufacturing run or per 10,000 m^2 of geomembrane.	Laboratory measurement

9.8 Roll and Sample Identification

The CQA Engineer shall verify rolls and samples are identified in accordance with the Specification.

9.9 Delivery, Storage and Handling

The CQA Engineer shall fill out a receiving inspection report (Section 23.3 and Appendix A) for each delivery of PE geomembrane. The CQA Engineer shall be present during delivery and unloading to verify the following:

- Rolls are shipped, handled and stored in such a manner that no damage occurs to the PE geomembrane
- Rolls are shipped, handled and stored in accordance with the approved work method statement and the manufacturer's instructions
- PE geomembrane rolls are packaged in opaque, waterproof, protective coverings
- Each roll is labelled in accordance with the Specification
- Rolls which are damaged beyond use are removed from the site.

9.10 Preparation of Surface to Receive Geomembrane

The receiving surface shall be inspected and approved each day that PE geomembrane is installed by the CQA Engineer. Additional inspections shall be performed if weather, vehicular traffic or other factors may have damaged the subgrade after approval. The CQA Engineer shall verify the following during inspections of the receiving surface:

- The receiving surface is complete and accepted by the Superintendent
- The receiving surface is free of defects or imperfections that may result in damage to the PE geomembrane
- The receiving surface is free from abrupt breaks, sharp objects, or other foreign material
- The receiving surface has not been damaged by inclement weather
- If the receiving surface is subgrade or fill materials, verify the surface is compacted in accordance with the Specification, does not have areas of roughness that may prevent direct contact of the PE Geomembrane on the surface and is not pebbly, or tracked and rutted by equipment.

The Geosynthetic Installer, the Contractor and the CQA Engineer shall sign a certificate of subgrade acceptance for each day that geomembrane materials are placed.

9.11 Installation

The CQA Engineer shall verify the following during installation:

- Installation is undertaken in accordance with the approved work method statement and manufacturer's instructions
- Each roll is visually inspected for damage and deficiencies with consideration to tears, punctures, abrasions, cracks, indentations, thin spots, or other faults in the material
- Any damaged or defective rolls are identified, inspected and approved or rejected based on criteria within the Specification. This may include blemishes, holes, indentations, thin spots, tears and punctures
- Any repair works are conducted in accordance with the Specification
- Weather conditions are acceptable for installation (with consideration to manufacturer's instructions)
- Winds are not so high as to cause damage during installation
- Any rolls or panels which have been displaced by wind are inspected for damage and approved or rejected
- Equipment used for installation and cover are in accordance with the approved work method statement
- The Contractor has adequate ballasts (e.g. sandbags) on hand and they are properly deployed to prevent uplift of the panels by wind
- Field panels are installed at the locations and positions indicated on the Contractor's approved panel placement drawing. The CQA Engineer shall verify that the identification code, location, and date of installation of each field panel are recorded
- Rolls are laid reasonably flat with a minimum of wrinkles so that they contain no areas that can fold over during covering
- Rolls are placed with the correct side facing up (where relevant)
- The Contractor cuts out and repairs waves that are so large as to cause folding of the PE geomembrane when they are covered
- There are no tensile stresses in the deployed PE geomembrane
- Construction personnel are not smoking or wearing shoes that could damage the PE geomembrane
- Seams are constructed as specified and in accordance with manufacturer's instructions. Also verify seams are not placed in locations prohibited by the Specification
- Rolls are not dragged across the receiving surface or other deployed PE geomembrane. This can result in damage to the PE geomembrane. A sacrificial rub sheet may be used to alleviate this problem
- Rolls are not being damaged during placement or covering
- The Geosynthetic Installer provides sufficient slack in the deployed geomembrane to account for the temperature fluctuations anticipated
- After a significant drop in temperature, the PE geomembrane has not pulled away from the subgrade or anchor trench.

9.12 Trial Seams

The CQA Engineer shall be present when trial seams are performed to verify they are conducted in accordance with the Specification. Test results for each trial seam shall be recorded on the geomembrane trial seam data sheet.

9.13 Field Seams

The CQA Engineer shall verify the following during field seaming:

- Seaming equipment is in good condition and is functioning properly
- Field seams are laid out as shown on the approved panel layout drawing
- Seams are of high quality. Special attention shall be given to high stress points such as valleys, ridges and at penetrations
- Seam areas are clean and free of moisture, dust, dirt, and foreign material
- If grinding of the surfaces to be seamed is required, the grinding marks are oriented perpendicular to the seam direction and no marks extend beyond the extrudate after placement
- The depth of the grinding marks are no greater than 10% of the sheet thickness
- Where extrusion welds are terminated long enough to cool, they are ground prior to applying new extrudate over the existing seams.

Each seam constructed shall be recorded on a geomembrane seam log.

9.14 Field Sampling and Testing

9.14.1 Destructive Seam Testing

The CQA Engineer shall:

- Select locations where seam samples will be cut out for CQA testing. The Contractor shall not be informed in advance of the locations where the seam samples will be taken
- Verify seam strength testing is done as the seaming work progresses, not at the completion of field seaming
- Verify seams are labelled in accordance with the Specification
- Document CQA seam test results and repairs (refer Section 23.9 and Appendix A)
- Verify seams which fail CQA and/or CQC destructive seam testing are repaired in accordance with the Specification.

9.14.2 Non-destructive Seam Testing

The CQA Engineer shall verify:

- All seams are visually inspected to assess the quality of the workmanship and the appearance of the welded seam
- All seams are non-destructively tested as seaming work progresses and seams which fail are repaired
- The outcome of all non-destructive seam test results are documented.

9.15 Electrical Leak Location Survey

The CQA Engineer shall be responsible for engaging a Leak Location Contractor on behalf of the Principal to undertake electrical leak location surveys following the installation of all PE geomembranes layers. Electrical leak location surveys shall be undertaken in accordance with Section 14.

9.16 Defects and Repairs

The CQA Engineer shall visually inspect PE geomembrane for damage after placement. Damaged areas shall be marked. The CQA Engineer shall document the location of the damaged panels, repairs which were performed and panels which were rejected on a geomembrane repair log.

The CQA Engineer shall visually inspect and verify that all deficiencies have been repaired in accordance with the Specification and the manufacturer's instructions prior to final acceptance.

9.17 Acceptance

Prior to the final acceptance of the PE geomembrane by the Superintendent, the CQA Engineer shall provide a recommendation to the Superintendent on whether the conditions of final acceptance have been met as per the Specification. This recommendation shall be based on, but not limited to, the following:

- Review of all submittals, including CQC test results
- Review of CQA test results
- Relevant monitoring and inspections undertaken.

10. Electrical Leak Location Survey

10.1 General

This section contains the requirements for undertaking electrical leak location surveys. The Principal shall be responsible for engaging a Leak Location Contractor to undertake an electrical leak location surveys required for the Works.

The CQA Engineer may be the Leak Location Contractor.

Two types of leak location surveys shall be undertaken:

- Arc testing leak location survey (following installation of each PE geomembrane layer)
- Dipole leak location survey (following installation of the soil confining layer).

10.2 Standards

Relevant American Society for Testing and Material (ASTM) standards are as follows:

- D6747 – Standard Guide for Selection of Techniques for Electrical Detection of Potential Leak Paths in Geomembranes
- D7007 – Standard Practices for Locating Leak in Geomembranes Covered withWater or Earth Materials
- D7953 Standard Practice for Electrical Leak Location on Exposed Geomembranes Using the Arc Testing Method

Alternate test methods may be considered by the CQA Engineer in consultation with the Principal when requested in writing by the Contractor.

10.3 Submittals

10.3.1 Pre-qualification of Leak Location Contractor

The CQA Engineer shall submit to the Superintendent the following for review and approval prior to selection of a PE geomembrane manufacturer.

- Qualifications of the proposed Leak Location Contractor including the number of years the Leak Location Contractor has performed the proposed survey methods
- Certification that the Leak Location Contractor has previously tested a minimum of 90 ha of geomembrane liner and a minimum of 45 ha of the proposed survey method on at least five projects
- Certification that the leak location surveys shall be supervised by a professional or technician with a minimum of 18 ha of liner testing experience using the proposed method on at least three projects.

10.3.2 Prior to Conducting the Leak Location Surveys

The Contractor shall submit the following to the Superintendent for review and approval prior to conducting the leak location surveys:

- Work method statement for leak location surveys, including any information on any permanent electrodes and wires required during construction, and any installation instructions to be provide to the Contractor prior to the installation of the geomembrane and soil confining layer.

10.3.3 Following Completion of the Leak Location Surveys

The Contractor shall submit the following to the Superintendent for review and approval following completion of each of the leak location surveys:

- A report containing the methods, details and results of the leak location surveys, including a list of leak locations and rectification works undertaken by the Contractor.

10.4 Preparation and Support

Prior to the survey being conducted, the CQA Engineer, in consultation with the Leak Location Contractor, shall verify the Contractor has suitably prepared the PE geomembrane layer for the survey.

10.5 Execution

10.5.1 Arc Testing Leak Location Survey

The arc testing leak location survey shall be performed after the installation of each PE geomembrane layer in accordance with ASTM D7953.

The Leak Location Contractor shall be responsible for calibrating equipment utilised to achieve optimum data quality and sensitivity for the site conditions.

The survey works best when the geomembrane is in intimate contact with the subgrade. Wrinkles are an impediment to conducting a good survey and defects on wrinkles may not be detected.

Therefore, it is usually in the interest of the project to conduct the survey when the liner system is cool and flat, such as in the morning or during the night.

Working on slopes can create safety hazards with slippery surfaces, and may require additional harnessing and slower production rates. The Leak Location Contractor shall account for this in their work method statement.

Leak locations shall be logged, visibly marked, and reported to the CQA Engineer and Superintendent for repair.

10.6 Dipole Leak Location Survey

The dipole leak location survey shall be performed after the placement of the soil confining layer in accordance with ASTM D7007.

The Leak Location Contractor shall be responsible for calibrating equipment utilised to achieve optimum data quality and sensitivity for the site conditions.

Manual measurements shall be made to verify leak signals and to pinpoint the leak positions on top of the soil confining layer for excavation while the survey personnel are on site. Within 300 mm of the liner, the Contractor’s labourers shall hand excavate possible leak locations to expose the liner.

Additional manual measurements shall be made to guide the Contractor’s personnel while they excavate the leak, if required.

After the identification and excavation of a leak, the soil around the leak location shall be tested while the leak is uncovered and cleaned to check for adjacent leaks.

Leak locations shall be logged, visibly marked, and reported to the CQA Engineer and Superintendent for repair.

10.7 Reporting

The Leak Location Contractor shall report the general results of the survey to the CQA Engineer and Superintendent during the daily progress of the field work.

Prior to the demobilisation of the survey personnel from the site, the Leak Location Contractor shall submit a list of locations of the leaks detected to the CQA Engineer and Superintendent.

The Leak Location Contractor shall submit a report documenting the field work and results of the surveys to the CQA Engineer and Superintendent following completion of the field work. The report shall be certified by the CQA Engineer.

11. Geotextile

11.1 General

The CQA Engineer shall verify the following during geotextile installation.

11.2 Qualifications

The CQA Engineer assigned CQA responsibilities for the geotextile shall have be accredited by the Geosynthetic Certification Institute-Inspectors Certification Program for installation of geosynthetic materials or have provided CQA inspection during installation of geosynthetics for at least three projects totalling a minimum of 100,000 m^2 of geosynthetics.

The CQA Engineer may assign CQA Monitors in accordance with Section 2.5.5 as appropriate.

11.3 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor.

11.4 Manufacturers Quality Control

The CQA Engineer shall review the manufacturer's quality control procedures and test results prior to delivery of geotextile to site to confirm the material conforms to the requirements of the Specification.

This shall include verification that the measurements of properties by the manufacturer are properly documented, test methods are acceptable, sampling procedure detailed and that the proposed polymer, fibres and geotextile meet the Specification.

11.5 Manufacturers Quality Assurance

The CQA Engineer shall review the manufacturer's quality assurance procedures and test results prior to delivery of geotextile to site to confirm the material conforms to the requirements of the Technical Specification. This may include liaison with the manufacturer on the frequency of MQA testing.

11.6 Material

The CQA Engineer shall review all test results/reports provided by the Contractor to confirm the material conforms to the requirements of the Specification.

11.7 Independent Conformance Testing

The CQA shall supervise collection of CQA samples by the Geosynthetic Installer for geotextile at the rate specified in and forward the samples to the CQA Engineers Independent Testing Firm for testing. The testing frequencies shall apply to all geotextile products provided as part of the Works.

Each product supplied shall be treated as a separate geotextile material with the testing frequencies applied per product and not additively. The samples shall be taken from the rolls delivered to site prior to use. All samples test results shall be received, accepted and reported by the CQA Engineer prior to installation.

The required testing frequencies may be revised by the CQA Engineer to conform to improvements in testing methods and/or in the state of the art practice and/or to account for the criticality of the application. Revisions must be approved by the relevant parties before application.

Unless otherwise specified or approved, the CQA Engineer shall verify CQA samples are not taken from the outer wrap of the roll and samples are a minimum of 1 m metre in length by the roll width.

Table 4 lists the independent conformance testing that shall be performed on the geotextile prior to installation.

Table 4 Geotextile independent conformance testing

Test Type	Test Method	Frequency	Comments
Mass per unit area	ASTM D5261	1 test per 2,500 m^2	All geotextiles
Grab Tensile strength	ASTM D4632	1 test per 5,000 m^2	All geotextiles
CBR Puncture Strength	ASTM D6241	1 test per 5,000 m^2	All geotextiles
Trapezoidal Tear Strength	ASTM D4533	1 test per 5,000 m^2	All geotextiles
Apparent Opening Size	ASTM D4751	1 test per 5,000 m^2	Separation geotextiles only
Permittivity	ASTM D4491	1 test per 5,000 m^2	Separation geotextiles only

11.8 Roll and Sample Identification

The CQA Engineer shall verify rolls and samples are identified in accordance with the Specification.

11.9 Delivery, Storage and Handling

The CQA Engineer shall fill out a receiving inspection report for each delivery of geotextile. The CQA Engineer shall be present during delivery and unloading to verify the following:

- Rolls are shipped, handled and stored in such a manner that no damage occurs to the geotextile
- Rolls are shipped, handled and stored in accordance with the approved work method statement and the manufacturer’s instructions
- Geotextile rolls are packaged in opaque, waterproof, protective coverings
- Each roll is labelled in accordance with the Specification
- Rolls which are damaged beyond use are removed from the site.

11.10 Preparation of Surface to Receive Geotextile

The receiving surface shall be inspected and approved each day that geotextile is installed by the CQA Engineer. Additional inspections shall be performed if weather, vehicular traffic or other factors may have damaged the receiving surface after approval. The CQA Engineer shall verify the following during inspections of the receiving surface:

- The receiving surface is complete and accepted by the Superintendent
- The receiving surface is free of defects or imperfections that may result in damage to the geotextile
- The receiving surface is free from abrupt breaks, sharp objects, or other foreign material

- The receiving surface has not been damaged by inclement weather
- If the receiving surface is subgrade or fill materials, verify the surface is compacted in accordance with the Specification and not pebbly, or tracked and rutted by equipment.

11.11 Installation

The CQA Engineer shall verify the following during installation:

- Installation is undertaken in accordance with the approved work method statement and manufacturer's instructions
- Each roll is visually inspected for damage and deficiencies with consideration to colour, thickness, needle punching, presence of needles or broken needles, and sewing density or other faults in the material
- Any damaged or defective rolls are identified, inspected and approved or rejected based on criteria within the Specification
- Weather conditions are acceptable for installation (with consideration to manufacturer's instructions)
- Winds are not so high as to cause damage during installation
- Any rolls or panels which have been displaced by wind are inspected for damage and approved or rejected
- Equipment used for installation and cover are in accordance with the approved work method statement
- The Contractor has adequate ballasts (e.g. sandbags) on hand and they are properly deployed to prevent uplift of the panels by wind
- Field panels are installed at the locations and positions indicated on the Contractor's approved panel placement drawing. The CQA Engineer shall verify that the identification code, location, and date of installation of each field panel are recorded
- Rolls are laid reasonably flat with a minimum of wrinkles so that they contain no areas that can fold over during covering
- Rolls are placed with the correct side facing up (where relevant)
- There are no broken needles present in the geotextiles
- The Contractor cuts out and repairs waves that are so large as to cause folding of the geotextile when they are covered
- There are no tensile stresses in the deployed geotextile
- Construction personnel are not smoking or wearing shoes that could damage the geotextile
- Seams are constructed as specified and in accordance with manufacturer's instructions, and lapped in the correct direction (where relevant). Also verify seams are not placed in locations prohibited by the Specification
- Sewn, heat bonded and overlapped seams are constructed in the specified locations
- Sewn seams are constructed using the correct overlap, thread type and stitch type
- Stitch bonded seams are inspected for skipped stitches
- Heat bonded seams are inspected for discontinuities
- The geotextile is not being burned through during the fabrication of heat bonded seams

- Rolls are not dragged across the receiving surface or other deployed geotextile. This can result in damage to the geotextile. A sacrificial rub sheet may be used to alleviate this problem
- Rolls are not being damaged during placement or covering
- Check the Specification to determine the maximum allowable exposure time for the deployed geotextile. If the allowable exposure time has been exceeded, determine if the geotextile has been damaged. If needed, request the performance of additional CQA tests to verify the physical properties of the textile have not diminished due to exposure
- Staples or pins are not used to hold geotextiles in place if the geotextile will be placed immediately above other geosynthetics
- Rolls are inspected for evidence of clogging from eroded or windblown soil.

11.12 Defects and Repairs

The CQA Engineer shall visually inspect geotextile for damage after placement. Damaged areas shall be marked. The CQA Engineer shall document the location of the damaged panels, repairs which were performed and panels which were rejected in the daily report.

The CQA Engineer shall visually inspect and verify that all deficiencies have been repaired in accordance with the Specification and the manufacturer's instructions prior to final acceptance.

11.13 Acceptance

Prior to the final acceptance of the geotextile by the Superintendent, the CQA Engineer shall provide a recommendation to the Superintendent on whether the conditions of final acceptance have been met as per the Specification. This recommendation shall be based on, but not limited to, the following:

- Review of all submittals, including CQC test results
- Review of CQA test results
- Relevant monitoring and inspections undertaken.

12. Drainage aggregate

12.1 General

The CQA Engineer shall verify the following during placement of drainage aggregate.

12.2 Qualifications

The CQA Engineer assigned CQA responsibilities for the drainage aggregate installation shall have be accredited by the Geosynthetic Certification Institute-Inspectors Certification Program for installation of geosynthetic materials or have provided CQA inspection during installation of drainage aggregate for at least three projects totalling a minimum of 100,000 m^2.

The CQA Engineer may assign CQA Monitors in accordance with Section 2.5.5 as appropriate.

12.3 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor, including any updates made based on the results of the field trial.

12.4 Material

The CQA Engineer shall review all test results/reports provided by the Contractor to confirm the drainage aggregate conforms to the requirements of the Specification.

12.5 Independent Conformance Testing

The CQA Engineer shall supervise collection of CQA samples for drainage aggregate at a rate specified in Table 5 and forward the samples to the CQA Engineers Independent Testing Firm for testing.

Table 5 lists the independent conformance testing shall be performed on the plastic pipework prior to installation.

Table 5 Drainage aggregate independent conformance testing

Test Type	Test Method	Frequency	Comments
Particle size distribution	AS 1141.11	1 per 2,000 m^3	In-place sample (following placement)

12.6 Delivery, Storage and Handling

The CQA Engineer shall inspect drainage aggregate stockpiles prior to use and advise the Superintendent of the presence of any unsuitable material or contamination as per the Specification.

12.7 Preparation of Surface to Receive Drainage Aggregate

The receiving surface shall be inspected and approved each day that drainage aggregate is installed by the CQA Engineer. Additional inspections shall be performed if weather, vehicular traffic or other factors may have damaged the receiving surface after approval. The CQA Engineer shall verify the following during inspections of the receiving surface:

- The receiving surface is complete and accepted by the Superintendent
- The receiving surface is free from abrupt breaks, sharp objects, or other foreign material

- The receiving surface has not been damaged by inclement weather
- If the receiving surface is subgrade or fill materials, verify the surface is compacted in accordance with the Specification and not pebbly, or tracked and rutted by equipment.

12.8 Installation

The CQA Engineer shall verify the following during installation:

- Installation is undertaken in accordance with the approved work method statement, which includes any adjustments made as a result of the field trial
- Trafficking with heavy machinery is avoided after placement
- Oversize and angular material which could damage geosynthetics has been removed prior to placement
- Underlying geosynthetics are not being damaged by placement equipment. Placement equipment should be observed from the front side as drainage aggregate is being spread over the underlying geosynthetics
- Excessive fines have not been generated as a result of handling and placement of the drainage aggregate
- Wind-borne and water-borne fines do not contaminate the drainage aggregate after placement
- Erosion controls are placed such that the drainage aggregate is not contaminated by fines
- Watch for ponds of water on top of the drainage aggregate which may be an indication that it is contaminated by an excessive amount of fines
- Wrinkles in underlying geosynthetics are not folding over onto themselves during aggregate placement
- Low ground pressure equipment is being used where specified.

12.9 In Situ Conformance Testing

The CQA Engineer shall review and agree with the Superintendent where in situ conformance testing shall be undertaken as well as monitor the sampling. The CQA Engineer shall review the test results to confirm the material conforms to the requirements of the Specification.

12.10 Defects and Repairs

If an area of drainage aggregate does not conform to the Specification, the CQA Engineer shall assist the Superintendent in defining the extent of the area requiring repair. This shall be done through the use of additional testing and visual inspection.

12.11 Acceptance

After repairs have been made, the CQA Engineer shall confirm quality control retests are performed to check the repaired areas. In general, CQC retests shall be performed at the same frequency as the rest of the project. Additional CQC testing shall be performed in suspect areas.

Prior to the final acceptance of the drainage aggregate by the Superintendent, the CQA

Engineer shall provide a recommendation to the Superintendent on whether the conditions of final acceptance have been met as per the Specification. This recommendation shall be based on, but not limited to, the following:

- Review of all submittals, including CQC test results
- Review of CQA test results
- Relevant monitoring and inspections undertaken.

13. PE pipework

13.1 General

The CQA Engineer or appropriate CQA Monitor shall verify the following for plastic pipework, valves, fittings and other items associated with plastic pipework during construction of the landfill barrier system and leachate collection and conveyance system.

13.2 Equipment

Verify equipment used to place and cover pipe is in accordance with the Works Documents and the manufacturer's recommendations.

13.3 Delivery, storage and handling

Be present during delivery and unloading and verify the following:

- Pipe and appurtenances are not damaged during shipping, storage, and handling;
- Deliveries are properly recorded;
- The correct material type, strength, and pipe sizes have been delivered;
- The size, number and location of pipe perforations are as specified;
- Pipes with gouges deeper than 10% of the wall thickness are rejected or repaired before use; and
- Out-of-round pipe which cannot be properly joined together is rejected.

13.4 Manufacturer Quality Control testing

Verify that pipe is sampled and tested in accordance with the approved manufacturer's quality control manual and test results not meeting the requirements specified results in the rejection of applicable pipe.

13.5 Independent Conformance Testing

Table 6 lists the independent conformance testing shall be performed on the plastic pipework prior to installation.

Table 6 Plastic pipe independent conformance testing

Test Type	Test Method	Frequency	Comments
Standard pipe dimensions	-	Spot check each shipment of pipe	Field measurement
Pipe perforation dimensions	-	Spot check each shipment of pipe	Field measurement

13.6 Execution

Verify the following during pipe placement:

- Pipe is carried to the place of installation and not dragged;
- Defective or damaged pipe is not used;
- Pipe is not laid when trench conditions or weather is unsuitable;
- Pipe is not installed if standing water is present;

- Pipe and accessories are carefully lowered into the trench;
- Pipe is placed at the lines and grades indicated in the Works Documents. Verify the Contractor does not lay pipe on blocks to produce the specified grade;
- Specified bedding is used and the bedding is graded to provide a cradle for proper support of the pipe;
- The full length of each section of pipe rests solidly upon the pipe bedding layer with recesses excavated to accommodate couplings and joints;
- Compaction requirements are being met for bedding layers located around the pipe;
- Perforated pipe is installed in accordance with the Works Documents;
- Pipe and fittings are free of dirt, oil, or other contaminants;
- The interior of pipe and accessories are thoroughly cleaned of foreign matter before being lowered into the trench;
- Pinch bars and tongs for aligning or turning pipe are used only on the bare ends of pipe; and
- When work is not in progress, open ends of pipes, fittings, and valves are securely plugged or capped so that no trench water, earth or other substance enters the pipe and fittings.

14. Soil confining layer

14.1 General

The CQA Engineer shall verify the following during placement of the Soil confining layer.

All individuals assigned CQA responsibilities for the Soil confining layer shall have provided CQA inspection during installation soil layers for at least three major earthworks projects totalling a minimum of 50,000 m^3 of protective soil layer material.

14.2 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor, including any updates made based on the results of the field trial.

14.3 Materials

The CQA Engineer shall:

- Review all test results/reports provided by the Contractor for the proposed soil confining material to verify that the material is uniform and matches the required properties given in the Specification
- Advise the Superintendent about the need to do additional borrow source assessment testing if the properties of the soil confining material appear to have changed significantly
- Inspect material stockpiles prior to use and advise the Superintendent of the presence of any unsuitable material.

14.4 Delivery, storage and handling

The CQA Engineer shall inspect stockpiles prior to use and advise the Superintendent of the presence of any unsuitable material or contamination as per the Specification.

14.5 Preparation of surface to receive Soil confining layer

The receiving surface shall be inspected and approved by the CQA Engineer each day that Soil confining layer is installed. Additional inspections shall be performed if weather, vehicular traffic or other factors may have damaged the receiving surface after approval. The CQA Engineer shall verify the following during inspections of the receiving surface:

- The receiving surface is complete and accepted by the Superintendent
- The receiving surface is cleared of any debris and/or foreign material
- The receiving surface has not been damaged by inclement weather.

14.6 Installation

The CQA Engineer shall verify the following during installation:

- Installation is undertaken in accordance with the approved work method statement, which includes any adjustments made as a result of the field trial.
- Equipment used for installation and cover are in accordance with the approved work method statement
- Weather conditions are acceptable for installation

- Oversize and angular material which could damage underlying geosynthetics has been removed from the soil confining material
- Soil confining material is not dumped directly onto underlying geosynthetics from a height greater than specified
- Underlying geosynthetics are not being damaged by placement equipment. Placement equipment should be observed from the front side as soil confining material is being spread over the underlying geosynthetics
- Wrinkles in underlying geosynthetics are not folding over onto themselves during soil confining material placement
- Low ground pressure equipment is being used where specified
- Placement of soil confining material proceeds from a stable working area adjacent to the deployed geosynthetic materials and gradually progresses outward. For slopes, soil confining material must be placed by starting at the toe and working up the slope
- Access routes are adequately built up to protect underlying geosynthetics. Access routes generally must be a minimum of 900 mm in thickness
- Tracks and wheels of full scale construction equipment remain on the access routes at all times
- Repairs are made to the access routes as needed. Inspect access routes daily to see if thinning of the soil confining material is occurring
- Large stockpiles of soil confining material are not placed on top of in-place geosynthetics
- Thin areas of soil confining material which could allow underlying geosynthetics to be punctured or torn by construction equipment are repaired immediately.

14.7 Defects and repairs

The CQA Engineer shall visually inspect the Soil confining layer for damage or defects after placement. If an area of the sand drainage layer does not conform to the Specification, the CQA Engineer shall assist the Superintendent in defining the extent of the area requiring repair. This shall be done through the use of additional testing and visual inspection.

After repairs have been made, the CQA Engineer shall confirm quality control retests are performed to check the repaired areas. In general, CQC retests shall be performed at the same frequency as the rest of the project. Additional CQC testing shall be performed in suspect areas.

14.8 Acceptance

Prior to the final acceptance of the Soil confining layer by the Contract Manager, the CQA Engineer shall provide a recommendation to the Superintendent on whether the conditions of final acceptance have been met as per the Specification. This recommendation shall be based on, but not limited to, the following:

- Review of all submittals
- Review of CQA test results
- Relevant monitoring and inspections undertaken.

15. Waste placement

15.1 General

The CQA Engineer shall verify the following during placement of waste.

15.2 Qualifications

The CQA Engineer assigned CQA responsibilities for earthworks shall have provided CQA inspection during placement of waste for at least three major waste projects totalling a minimum of 50,000 m^3 of waste placement activities.

15.3 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor.

15.4 Equipment

The CQA Engineer shall visually inspect and verify waste placement and compaction equipment meet the requirements of the Specification and the approved work method statement(s).

15.5 Compaction

- Verify the specified minimum number of passes are being made over all areas of each lift of fill (if applicable);
- Visually observe fill placement around all penetrations and verify that fill placed around penetrations does not contain voids and is adequately compacted;
- Inspect pipes which penetrate fill layers for damage due to placement and compaction equipment;
- Verify the surface of each lift is adequately scarified prior to placement of the next lift of fill;
- Verify low ground pressure equipment is used when compaction is required over piping, geosynthetics, or other appurtenances.

15.6 Independent Conformance Testing

The CQA Engineer shall supervise CQA tests for waste placement at a rate specified in Table 7.

Table 7 Waste placement independent conformance testing

Test Type	Test Method	Frequency	Comments
Compaction	ASTM D 698	1 per 7,600 m^3	Prior to placement
Density	ASTM D 1556 ASTM D 2922	1 per 20 CQC tests	In-place soils

15.7 Weather conditions

Verify that earthworks do not occur during periods of excessive rain, freezing temperatures, or if other detrimental weather conditions exist.

15.8 Execution

The CQA Engineer shall verify the following during waste placement:

- Verify stockpiles containing contaminated material are bermed, lined, and covered. Also verify a means of managing leachate is provided.
- Verify waste material is placed so that large void spaces do not exist.
- Compaction of waste is usually specified by requiring several passes of a compactor over all areas of the waste instead of requiring that a specific density criteria be achieved. At least 3 times per 8-hour period, spot-check to make sure the contractor is making the minimum required number of passes for each lift of waste placed.
- For landfill liner systems, verify the contractor’s method of placement does not damage the liner.
- Immediately notify the superintendent if unexpected hazardous materials are discovered during waste regrading or placement.
- Verify the contractor minimizes the amount of waste exposed during regrading operations to reduce odour problems.
- Notify the superintendent if odour or volatilization of contaminants becomes a problem. Daily cover may need to be placed over areas of exposed waste.
- When waste is being regraded, look for leachate seeps that present unsuitable conditions for fill placement. Report such seeps to the superintendent
- For landfill liner systems, verify the contractor implements measures to remove runoff which collects in the landfill.
- Check for areas where additional fill needs to be placed due to settlement.
- For landfill liner systems, check interim surveys to verify adequate space is available within the landfill to store all contaminated material.
- Verify final lines and grades of the regraded and in-place waste are correct.

16. Seal bearing layer

16.1 General

The CQA Engineer shall verify the following during placement of the Seal bearing layer.

All individuals assigned CQA responsibilities for the Seal bearing layer shall have provided CQA inspection during installation soil layers for at least three major earthworks projects totalling a minimum of 50,000 m^3 of protective soil layer material.

16.2 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor, including any updates made based on the results of the field trial.

16.3 Materials

The CQA Engineer shall:

- Review all test results/reports provided by the Contractor for the proposed seal bearing material to verify that the material is uniform and matches the required properties given in the Specification
- Advise the Superintendent about the need to do additional borrow source assessment testing if the properties of the seal bearing material appear to have changed significantly
- Inspect material stockpiles prior to use and advise the Superintendent of the presence of any unsuitable material.

16.4 Delivery, storage and handling

The CQA Engineer shall inspect stockpiles prior to use and advise the Superintendent of the presence of any unsuitable material or contamination as per the Specification.

16.5 Preparation of surface to receive Seal bearing layer

The receiving surface shall be inspected and approved by the CQA Engineer each day that Seal bearing layer is installed. Additional inspections shall be performed if weather, vehicular traffic or other factors may have damaged the receiving surface after approval. The CQA Engineer shall verify the following during inspections of the receiving surface:

- The receiving surface is complete and accepted by the Superintendent
- The receiving surface is cleared of any debris and/or foreign material
- The receiving surface has not been damaged by inclement weather.

16.6 Installation

The CQA Engineer shall verify the following during installation:

- Installation is undertaken in accordance with the approved work method statement, which includes any adjustments made as a result of the field trial.
- Equipment used for installation and cover are in accordance with the approved work method statement
- Weather conditions are acceptable for installation

- Oversize and angular material which could damage underlying geosynthetics has been removed from the seal bearing material
- Seal bearing material is not dumped directly onto underlying geosynthetics from a height greater than specified
- Underlying geosynthetics are not being damaged by placement equipment. Placement equipment should be observed from the front side as seal bearing material is being spread over the underlying geosynthetics
- Wrinkles in underlying geosynthetics are not folding over onto themselves during seal bearing material placement
- Low ground pressure equipment is being used where specified
- Placement of seal bearing material proceeds from a stable working area adjacent to the deployed geosynthetic materials and gradually progresses outward. For slopes, seal bearing material must be placed by starting at the toe and working up the slope
- Access routes are adequately built up to protect underlying geosynthetics. Access routes generally must be a minimum of 900 mm in thickness
- Tracks and wheels of full scale construction equipment remain on the access routes at all times
- Repairs are made to the access routes as needed. Inspect access routes daily to see if thinning of the seal bearing material is occurring
- Large stockpiles of seal bearing material are not placed on top of in-place geosynthetics
- Thin areas of seal bearing material which could allow underlying geosynthetics to be punctured or torn by construction equipment are repaired immediately.

16.7 Defects and repairs

The CQA Engineer shall visually inspect the Seal bearing layer for damage or defects after placement. If an area of the sand drainage layer does not conform to the Specification, the CQA Engineer shall assist the Superintendent in defining the extent of the area requiring repair. This shall be done through the use of additional testing and visual inspection.

After repairs have been made, the CQA Engineer shall confirm quality control retests are performed to check the repaired areas. In general, CQC retests shall be performed at the same frequency as the rest of the project. Additional CQC testing shall be performed in suspect areas.

16.8 Acceptance

Prior to the final acceptance of the Seal bearing layer by the Contract Manager, the CQA Engineer shall provide a recommendation to the Superintendent on whether the conditions of final acceptance have been met as per the Specification. This recommendation shall be based on, but not limited to, the following:

- Review of all submittals
- Review of CQA test results
- Relevant monitoring and inspections undertaken.

17. Revegetation layer

17.1 General

The CQA Engineer shall verify the following during construction of the revegetation layer.

The relevant requirements for the revegetation layer in Section 3 shall be considered alongside guidance provided in this section.

17.2 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor.

17.3 Material

The CQA Engineer shall:

- Review all test results/reports provided by the Principal/Contractor for the proposed revegetation soil material and vegetation to verify that they conform to the required properties given in the Technical Specification
- Advise the Superintendent about the need to do additional borrow source assessment testing if the properties of the revegetation soil material appear to have changed significantly
- Inspect revegetation soil material stockpiles prior to use and advise the Superintendent of the presence of any unsuitable material
- Review the proposed seed mix.

17.4 Preparation of surface to receive revegetation layer

The receiving surface shall be inspected and approved by the CQA Engineer each day that seal bearing layer is installed. Additional inspections shall be performed if weather, vehicular traffic or other factors may have damaged the receiving surface after approval. The CQA Engineer shall verify the following during inspections of the receiving surface:

- The receiving surface is complete and accepted by the Superintendent
- The receiving surface is cleared of any debris and/or foreign material
- The receiving surface has not been damaged by inclement weather.

17.5 Installation

The CQA Engineer shall verify the following during installation:

- Installation is undertaken in accordance with the approved work method statement
- Equipment used for installation are in accordance with the approved work method statement
- Soil layers are not over compacted
- Weather conditions are acceptable for installation.

17.6 Seeding and sowing

The CQA Engineer shall verify the following:

- Seed and fertiliser are stored in a cool, dry location away from contaminants
- Pesticides, insecticides, herbicides and other materials are delivered in their original, unopened containers bearing legible labels indicating the registration number and the manufacturer's registered uses
- Vegetative operations are performed only during periods when weather conditions are acceptable
- Prior to seeding, areas which have been damaged by rain, traffic, or other causes are reworked to restore the specified ground condition
- Seeds are uniformly distributed. The CQA Engineer shall also verify seed are certified to contain no weed seed and meet specified requirements.

17.7 Compaction

As per Section 3.13.

17.8 Construction quality control testing

As per Section 2.9

17.9 Tolerances

As per Section 3.15.

17.10 Defects and repairs

The CQA Engineer shall visually inspect the revegetation layer for damage or defects after placement. The CQA Engineer shall assist the Superintendent in defining the extent of the area requiring repair, with reference to test frequencies and results. This shall be done through the use of additional testing and visual inspection.

After repairs have been made, the CQA Engineer shall confirm quality control retests are performed to check the repaired areas. In general, CQC retests shall be performed at the same frequency as the rest of the project. Additional CQC testing shall be performed in suspect areas.

17.11 Revegetation

The CQA Engineer shall regularly inspect revegetation works completed by the Contractor and recommend rejection or approval to the Superintendent.

17.12 Maintenance

The CQA Engineer shall review the proposed maintenance program provided by the Contractor and recommend rejection or approval to the Superintendent.

17.13 Acceptance

Prior to the final acceptance of the revegetation layer by the Superintendent/Principal, the CQA Engineer shall provide a recommendation to the Superintendent on whether the conditions of final acceptance have been met as per the Technical Specification. This recommendation shall be based on, but not limited to, the following:

- Review of all submittals
- Review of CQA test results
- Relevant monitoring and inspections undertaken.

18. Field Trials

18.1 General

The CQA Engineer shall verify the following during the field trials.

18.2 Qualifications

The CQA Engineer assigned CQA responsibilities for the field trials shall have be accredited by the Geosynthetic Certification Institute-Inspectors Certification Program for installation of geosynthetic materials or have provided CQA inspection during similar field trials for at least three projects.

18.3 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor, including any updates made based on the results of the field trial.

18.4 Field trial placement

During the field trials, the CQA Engineer shall:

- Verify that field trial preparation and completion is undertaken in accordance with the approved work method statement
- Verify underlying geosynthetics are placed in accordance with the approved work method statements and the manufacturer’s instructions
- Witness the field trial
- Inspect the underlying geosynthetics for damage and deficiencies following completion of the field trial
- Review any relevant test results/reports
- Review of field trial report prepared by the Contractor, including the updated placement method.

19. Drainage and stormwater infrastructure

19.1 General

The CQA Engineer shall verify the following during drainage and stormwater infrastructure construction.

19.2 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor.

19.3 Material

The CQA Engineer shall review all test results/reports provided by the Contractor to confirm the drainage and stormwater infrastructure materials conforms to the requirements of the Specification.

19.4 Equipment

The CQA Engineer shall visually inspect and verify excavation, placement, and compaction equipment meet the requirements of the Specification and the approved work method statement(s).

19.5 Extent of Disturbed Areas

The CQA Engineer shall notify the Superintendent if the Contractor is witnessed working outside the Works Area shown on the Contract Drawings.

19.6 Lines and Levels

The CQA Engineer shall review as-built survey data of the completed surfaces to verify conforming lines, levels and layer thickness within the allowable tolerance.

19.7 Excavation

The CQA Engineer shall verify the excavation for drainage and stormwater infrastructure subgrade is in accordance to Section 3.

19.8 Filling

The CQA Engineer shall verify the filling for drainage and stormwater infrastructure subgrade is in accordance to Section 3.

19.9 Compaction

The CQA Engineer shall verify the compaction for drainage and stormwater infrastructure subgrade is in accordance to Section 3.

19.10 Installation

The CQA Engineer shall verify the following during installation:

- Installation is undertaken in accordance with the approved work method statement, which includes any adjustments made
- Trafficking with heavy machinery is avoided after construction or placement
- Oversize and angular material which could damage geosynthetics (if any) has been removed prior to placement
- Underlying geosynthetics (if any) are not being damaged by placement equipment. Placement equipment should be observed from the front side as drainage aggregate is being spread over the underlying geosynthetics
- Excessive fines have not been generated as a result of handling and placement of the drainage aggregate
- Wind-borne and water-borne fines do not contaminate the drainage aggregate after placement
- Erosion controls are placed such that the drainage aggregate is not contaminated by fines
- Watch for ponds of water on top of the drainage aggregate which may be an indication that it is contaminated by an excessive amount of fines
- Wrinkles in underlying geosynthetics (if any) are not folding over onto themselves during aggregate placement
- Low ground pressure equipment is being used where specified.
- Visually inspect for dips and reverse grades along swales and channel bottoms.
- Verify inlets and outlets are not obstructed or damaged during construction.

19.11 Tolerances

The CQA Engineer shall review as-built survey data of the completed surfaces to verify conforming layer thickness within the allowable tolerance.

19.12 Stockpiles

The CQA Engineer shall inform the Superintendent if the Contractor is witnessed to not be managing stockpiles in accordance with the requirements of the Technical Specification and the approved work method statement.

19.13 Defects and Repairs

If a fill layer does not conform to the Works Documents, assist the Superintendent in defining the extent of the area requiring repair. This shall be done through the use of additional testing and visual inspection.

After repairs have been made, ensure CQC retests are performed to check the repaired areas. In general, CQC retests shall be performed at the same frequency as the rest of the project. Additional CQC testing shall be performed in suspect areas.

19.14 Acceptance

Prior to the final acceptance of construction and installation all drainage and stormwater infrastructure by the Superintendent, the CQA Engineer shall provide a recommendation to the Superintendent on whether the conditions of final acceptance have been met as per the Technical Specification. This recommendation shall be based on, but not limited to, the following:

- Review of all submittals, including CQC test results
- Review of CQA test results
- Relevant monitoring and inspections undertaken

20. Concrete structures

20.1 General

The CQA Engineer shall verify the following during concrete structures construction.

20.2 Qualifications

The CQA Engineer assigned CQA responsibilities for earthworks shall have provided CQA inspection during construction of concrete structures for at least three documented projects including concrete structure construction.

20.3 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor.

20.4 Materials

The CQA Engineer shall review all test results/reports provided by the Contractor to confirm the concreting materials conforms to the requirements of the Specification.

20.5 Equipment

Verify equipment used to handle, place, compact, finish and cure concrete is in accordance with the Works Documents and the manufacturer's recommendations.

20.6 Delivery, storage and handling

Be present during delivery and unloading and verify the following:

- Concrete materials are not damaged during shipping, storage, and handling;
- Deliveries are properly recorded;
- The correct material type, strength, and sizes have been delivered;

20.7 Manufacturer Quality Control testing

Verify that material is sampled and tested in accordance with the approved manufacturer's quality control manual and test results not meeting the requirements specified results in the rejection of applicable material.

20.8 Preparation of surface to receive concrete

The receiving surface shall be inspected and approved by the CQA Enginee on each occasion that concrete is constructed r. Additional inspections shall be performed if weather, vehicular traffic or other factors may have damaged the subgrade after approval. The CQA Engineer shall verify the following during inspections of the receiving surface:

- The receiving surface is complete and accepted by the Superintendent
- The receiving surface is free of defects or imperfections that may result in damage to the concrete once hardened
- The receiving surface is free from abrupt breaks, sharp objects, or other foreign material
- The receiving surface has not been damaged by inclement weather

20.9 Placing, compaction and finishing

Verify the following during concrete handling, placing and compaction:

- Segregation or loss of materials are minimised
- Premature stiffening is minimised
- Production of monolithic mass between planned joined or the extremities of structure
- Formwork is completely filled to intended level, expel entrap air and closely surround all reinforcement, tendons, ducts, anchorages, embedment and fixings
- Provide the specified finish to the formed surfaces of the structure
- Finish surface to achieve specified dimensions, falls, tolerances or similar details relating to the shape and uniformity of surfaces, cover from surface to reinforcement, tendons ducts and texture of the surface

21. Landfill gas system

21.1 General

The CQA Engineer shall verify the following during the installation of the landfill gas system.

21.2 Equipment

Verify equipment used to install landfill gas system is in accordance with the Works Documents and the manufacturer's recommendations.

21.3 Delivery, storage and handling

Be present during delivery and unloading and verify the following:

- Landfill gas system materials and components are not damaged during shipping, storage, and handling;
- Deliveries are properly recorded;
- The correct material type, strength, and sizes have been delivered;
- The size, number and location of pipe perforations are as specified;
- Pipes with gouges deeper than 10% of the wall thickness are rejected or repaired before use; and
- Out-of-round pipe which cannot be properly joined together is rejected.

21.4 Manufacturer Quality Control testing

Verify that components of the landfill gas system are sampled and tested in accordance with the approved manufacturer's quality control manual and test results not meeting the requirements specified results in the rejection of applicable landfill gas system components.

21.5 Independent Conformance Testing

Table 8 lists the independent conformance testing shall be performed on the components of the landfill gas system prior to installation.

Table 8 Landfill gas vent components independent conformance testing

Test Type	Test Method	Frequency	Comments
Standard pipe dimensions	-	Spot check each shipment of pipe	Field measurement
Pipe perforation dimensions	-	Spot check each shipment of pipe	Field measurement

21.6 Installation

The CQA Engineer shall verify the following during installation:

- Pipe is carried to the place of installation and not dragged;
- Defective or damaged pipe is not used;
- Pipe is not laid when trench conditions or weather is unsuitable;
- Pipe is not installed if standing water is present;

- Pipe and accessories are carefully lowered into the trench;
- Pipe is placed at the lines and grades indicated in the Works Documents. Verify the Contractor does not lay pipe on blocks to produce the specified grade;
- Specified bedding is used and the bedding is graded to provide a cradle for proper support of the pipe;
- The full length of each section of pipe rests solidly upon the bedding layer with recesses excavated to accommodate couplings and joints;
- Compaction requirements are being met for bedding layers located around the pipe;
- Perforated pipe is installed in accordance with the Works Documents;
- Pipe and fittings are free of dirt, oil, or other contaminants;
- The interior of pipe and accessories are thoroughly cleaned of foreign matter before being lowered into the trench;
- Pinch bars and tongs for aligning or turning pipe are used only on the bare ends of pipe;
- When work is not in progress, open ends of pipes, fittings, and valves are securely plugged or capped so that no trench water, earth or other substance enters the pipe and fittings.
- Ensure cover of perforated piping in gas collection layer is as per manufacturer’s recommendation
- Clamps are fitted tightly to riser pipe
- Riser pipes are secured properly following installation

21.7 Defects and Repairs

If a material or component does not conform to the Works Documents, assist the Superintendent in defining the extent of the area requiring repair. This shall be done through the use of additional testing and visual inspection.

21.8 Acceptance

Prior to the final acceptance of construction of the landfill gas system by the Superintendent, the CQA Engineer shall provide a recommendation to the Superintendent on whether the conditions of final acceptance have been met as per the Technical Specification. This recommendation shall be based on, but not limited to, the following:

- Review of all submittals, including CQC test results
- Review of CQA test results
- Relevant monitoring and inspections undertaken

22. Roads infrastructure

22.1 General

The CQA Engineer shall verify the following during construction of roads infrastructure.

22.2 Submittals

The CQA Engineer shall review all submittals provided by the Contractor and recommend rejection or approval to the Superintendent. This shall include relevant work method statements prepared by the Contractor.

22.3 Material

The CQA Engineer shall review all test results/reports provided by the Contractor to confirm the roads infrastructure construction materials conforms to the requirements of the Specification.

22.4 Equipment

The CQA Engineer shall visually inspect and verify excavation, placement, and compaction equipment meet the requirements of the Specification and the approved work method statement(s).

22.5 Extent of Disturbed Areas

The CQA Engineer shall notify the Superintendent if the Contractor is witnessed working outside the Works Area shown on the Contract Drawings.

22.6 Lines and Levels

The CQA Engineer shall review as-built survey data of the completed surfaces to verify conforming lines, levels and layer thickness within the allowable tolerance.

22.7 Excavation

The CQA Engineer shall verify the excavation for roads infrastructure subgrade is in accordance to Section 3.

22.8 Compaction

The CQA Engineer shall verify the compaction for roads infrastructure subgrade is in accordance to Section 3.

22.9 Installation

The CQA Engineer shall verify the following during installation:

- Installation is undertaken in accordance with the approved work method statement, which includes any adjustments made
- Trafficking with heavy machinery is avoided after construction or placement of bitumen (if any)
- Low ground pressure equipment is being used where specified.

22.10 Tolerances

The CQA Engineer shall review as-built survey data of the completed surfaces to verify conforming layer thickness within the allowable tolerance.

22.11 Weather conditions

Verify that roads infrastructure construction does not occur during periods of excessive rain, or if other detrimental weather conditions exist.

22.12 Defects and Repairs

If a road material does not conform to the Works Documents, assist the Superintendent in defining the extent of the area requiring repair. This shall be done through the use of additional testing and visual inspection.

After repairs have been made, ensure CQC retests are performed to check the repaired areas. In general, CQC retests shall be performed at the same frequency as the rest of the project. Additional CQC testing shall be performed in suspect areas.

22.13 Acceptance

Prior to the final acceptance of construction all road infrastructures by the Superintendent, the CQA Engineer shall provide a recommendation to the Superintendent on whether the conditions of final acceptance have been met as per the Technical Specification. This recommendation shall be based on, but not limited to, the following:

- Review of all submittals, including CQC test results
- Review of CQA test results
- Relevant monitoring and inspections undertaken

23. Appurtenances

23.1 Temporary access ramps

The CQA Engineer shall verify the following:

- That the construction Contractor complies with requirements concerning vehicle speeds and number of vehicles on the access ramp
- That construction equipment is not braking sharply while on the ramp
- Inspect the access ramp daily for cracks and slippage of the protective soil layer. Also verify the protective soil layer is not thinning due to traffic or erosion.

23.2 Sumps

Sumps are very labour intensive and difficult to construct. Continuous visual inspection during construction activities shall be performed in sump areas by the CQA Engineer. The CQA Engineer shall verify the following:

- Carefully inspect placement of sand and aggregate to confirm underlying geosynthetics are not being damaged
- Confirm pipe perforations meet specified requirements and are placed at the correct locations
- Pumps and other mechanical equipment are in accordance with the Specification and manufacturer's instructions
- That test operation of pumps, level alarms, valves, switches and controls have been performed in accordance with manufacturer's recommendations and all equipment is operational.

23.3 Trenches

The CQA Engineer shall verify the following:

- That trenches are constructed at the proper depth and alignment
- That any pipes in the trenches are placed at the proper lines and grades
- If geosynthetics are included in trenches, ensure that subgrade/sidewall protrusions or backfill placement does not damage the geosynthetics.

23.4 Swales and channels

- Visually inspect for dips and reverse grades along swales and channel bottoms.
- Verify inlets and outlets are not obstructed or damaged during construction.

24. CQA documentation

24.1 General

The CQA Engineer shall document all construction inspection and testing activities with logs, reports and photographs. The data sheets to be used for CQA documentation shall be as presented at the end of this section. With the approval of the Superintendent, data sheets presented in this CQA Plan may be revised as necessary by the CQA Engineer. Additional data sheets needed to record test results and observations shall be submitted to the Superintendent for approval.

The Superintendent shall maintain all CQA documentation onsite at all times.

Examples of the following reports are contained in Appendix A.

24.2 CQA Engineer's Daily Report

The CQA Engineer's Daily Report shall be prepared by the CQA Engineer and submitted weekly to the Superintendent. At a minimum, the Daily Report shall include the following information:

- Date, project name, location, and other identifying information
- Weather and site conditions
- A narrative describing construction activities underway
- Equipment used for each work task
- CQC and CQA activities performed
- Summary of CQA and CQC tests performed and test methods used
- Summary of CQA and CQC test results, including corrective actions taken for all construction materials not in compliance with project specifications
- A list of items requiring the Superintendent's attention
- Summary of geosynthetic materials placed including locations, panel numbers, seams completed, test results, repairs, methods of repairs and placement of cover material and temporary protection
- Documentation of borrow sources used and placement activities for all fill materials. Note any visual changes in borrow materials
- Corrective actions taken to repair damage
- Visual observations noted on all construction activities, including any concerns noted
- Summary of results for CQA lift thickness, density, and moisture content measurements
- Record of significant discussions or meetings with the Superintendent, Contractor, Geosynthetic Installer and others
- Signature of CQA Engineer

24.3 Receiving Inspection Report

Receiving inspection reports shall be completed for incoming geosynthetics and other materials.

24.4 Certificate of Subgrade Acceptance

A certificate of subgrade acceptance shall be signed each day geomembrane or GCL materials are placed. Each certificate shall be signed by the Geosynthetic Installer, the Contractor and CQA Engineer prior to installation of the geomembrane or GCL. The area being accepted must be described on the certificate.

24.5 Geomembrane Panel Deployment Log

This data sheet shall be used to record geomembrane panel numbers as they are placed in the field and to cross-reference assigned panel numbers with roll numbers. The weather conditions, time and temperature at placement shall be recorded on the log. Measured dimensions of the geomembrane shall also be recorded on the log.

24.6 Geomembrane Trial Seam Data Sheet

Test results for each trial seam shall be recorded on the geomembrane trial seam data sheet.

24.7 Geomembrane Seam Log

Each seam constructed shall be recorded on a geomembrane seam log.

24.8 Geomembrane Defects and Repairs

Each geomembrane defect and repair shall be recorded on a geomembrane repair log.

24.9 Non-destructive and Destructive Geomembrane Seam Testing Data Sheets

These data sheets shall be used to record test results for all non-destructive and destructive geomembrane seam tests.

24.10 Field Moisture and Density Test Result Data Sheet

All CQA moisture content and density tests shall be recorded on this data sheet.

24.11 Test Report

This data sheet shall be used to record all other CQA test results for which a specific data sheet does not exist.

24.12 Survey Records

Record drawings resulting from as-built survey data shall be reviewed by the CQA Engineer. Record drawings shall be included as part of the Final CQA Report issued by the CQA Engineer.

24.13 Photographic documentation

The CQA Engineer shall prepare a photographic record of each stage of the Works and this record will be readily available or kept onsite as part of the construction control activities.

Photographs shall include photographs of every phase of construction being performed, problem areas (including potential contractual or regulatory problems), corrective actions and final constructed features.

Photographs shall be identified with the site designation, the date taken, the location and a description of the activity covered by the photograph. The basic file shall contain colour prints and be stored in chronological order.

The photographs shall be available for review by the Principal, Superintendent, the CQA Engineer and other relevant parties as approved by the Principal.

Selected photographs shall be reproduced as part of the final report. The remaining photographs shall be transmitted to the Superintendent for archive as part of the permanent records.

24.14 Final Report

At the completion of work, the CQA Engineer shall be responsible for writing a final report on CQA activities performed at the site. The draft Final Report shall be completed and submitted to the Superintendent no more than 28 days after completion of construction and shall include, at a minimum, the following information:

- Brief description of the Works including type of facility, name of site, location, name of Principal, Superintendent, Contractor and Geosynthetic Installer
- A reviewed copy of all CQC reports undertaken, including earthworks, geosynthetics and other works aforementioned in this CQA Plan
- Detailed description of the lining and capping systems, including surface area, cross sections and a summary of all materials used
- Chronological summary of construction activities
- Photographic documentation, including photographs of the site at different phases of construction, photographs of construction details and photographs of all CQA operations
- General record of activities, such as dates of performance of CQA operations, number and names of CQA Monitors and number and names of Geosynthetic Installer's personnel
- Manufacturer's certification sheets and MQC/MQA documentation
- Sampling and testing locations
- Copies of all CQA data sheets and records completed during the Works
- All CQA field and laboratory test results as well as a summary of these results
- Discussion of special problems encountered and their solutions
- Discussion of significant changes from design and material specifications
- As built survey records and CQC reports
- Record Drawings which include the final geomembrane panel placement layout and all survey conformance data:
  - Plan view of the perimeter of the cell;
  - The installed alignments and grades of the groundwater drainage system within the cell;
  - Finished installed contours of the prepared subgrade within the cell (determined prior to placement of the geosynthetics);
  - The installed alignments and grades of the leachate collection pipework within the cell (all determined prior to placement of the leachate drainage layer);

- Finished installed contours of the leachate drainage layer and covering geotextile within the cell; and
- All test locations, showing as a minimum: approximate location, identification number, date sampled and type of testing completed.

- A summary statement sealed and signed by the CQA Engineer documenting that CQA was conducted in accordance with the CQA Plan and, based on visual observations and data generated in accordance with the CQA Plan, the Works shown in the Contract Drawings were constructed in accordance with Contract Documents except as properly authorised and documented in the CQA Final Report.

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