City of Greater Geraldton

Point Moore

Residential Onsite Effluent Treatment and Disposal Study

November 2016

Executive Summary

Point Moore accommodates approximately 200 residential dwellings that were built in the 1960s and 1970s on leasehold land within reserves vested with the City of Greater Geraldton. All dwellings use onsite systems (septic tanks with wastewater disposed of via leach drains or soak wells) for wastewater treatment and disposal. Whilst originally established as holiday cottages, many of the Point Moore lessees are now retirees and beach lifestyle enthusiasts that occupy the residences year-round.

The *Point Moore Inundation & Coastal Processes Study* completed in 2015 has highlighted that the area could be severely impacted by coastal inundation and erosion in the future. Given the small size of the residential properties (in the order of 300 m^2), the low elevation of the area (existing ground levels in the order of two metres above current sea levels) and predictions that sea levels will rise significantly in the future, the continued viability of onsite wastewater disposal systems in the area has also come into question.

The City of Greater Geraldton (CGG) commissioned GHD Pty Ltd (GHD) to complete a study to review available information and to conduct a series of investigations to assess the performance of the existing onsite systems, their potential impacts on the local environment, and the degree to which they comply with current legislation and guidelines. The fieldwork to locate and to assess the onsite systems at a selection of properties was completed by Sun City Plumbing (SCP).

The following conclusions have resulted from this study:

1. Observations made during the field investigation indicate that a significant number of the existing septic tanks and leach drains/soak wells are in a poor condition and require remedial works and in some cases replacement.
2. The properties in the study area are significantly smaller than the minimum lot size currently permitted for onsite wastewater disposal (typically 2,000 m^2), and many of the onsite systems do not comply with current standards in a number of respects (e.g. sizing, configuration, horizontal setbacks, vertical separation distance to groundwater). For many properties it would not be possible to upgrade the existing onsite systems to meet current standards, or install alternative onsite systems that comply with current standards.
3. Though local groundwater is not used for irrigation or any other purpose, it does discharge to the nearby ocean, and residents or others could come into contact with groundwater when undertaking a range of land-based activities. In relation to public health risks:
    - The potential for contact with groundwater when undertaking land based sub-surface activities such as excavation or trenching works is considered to represent a potential health risk to residents and others undertaking such activities in the study area. This risk will increase over time as local groundwater levels increase as a direct consequence of sea level rise.
    - It is considered unlikely that elevated levels of pathogens in groundwater flowing from the study area would pose a significant health risk to persons engaging in primary contact recreation in the ocean near Point Moore given natural purification processes in the aquifer and the high levels of dilution that would typically occur where the groundwater discharges into the ocean. However, under conditions of calm winds and low wave climate, rates of dilution may be greatly reduced, thereby increasing the potential health risk. These conditions typically occur late in the bathing season from March-May.

   - It is not possible to discount the possibility that onsite disposal of effluent from the Point Moore residential properties is at least partly responsible for the observed seasonal spikes in *Enterococci* levels at the CGG's local marine water quality monitoring sites.

4. In the long term local groundwater levels will rise as sea levels rise, and the magnitude of the rise will severely constrain the potential to dispose of wastewater generated in the study area with the existing conventional onsite septic tank and leach drain/soak well systems approach.
5. If residential properties are to remain at Point Moore for the long term then a reticulated wastewater collection system will need to be installed that routs wastewater to the Water Corporation's Geraldton wastewater scheme.
6. An indicative cost estimate to design and to construct a conventional reticulated gravity sewer type collection system to serve all properties in the study area is $6 to 10M. At a unit cost of approximately $35,000 to $55,000 per property, this is likely to be prohibitively expensive. Whilst alternative wastewater collection technologies exist that may be able to be implemented at a significantly lower capital cost, ongoing costs for these systems would be higher.
7. Whilst nutrient levels in sampled groundwater indicated elevated wastewater-induced contamination above the adopted assessment criteria for all monitoring rounds, given the high levels of dilution that typically occur where groundwater discharges into the ocean it is considered unlikely that elevated levels of nutrients in groundwater flowing from the study area are having any measurable impact on near shore marine ecosystems.

This report is subject to, and must be read in conjunction with, the limitations set out in Section 1.3 and the assumptions and qualifications contained throughout the Report.

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1. Introduction

Point Moore is located in the City of Greater Geraldton (CGG) and is a prominent sandy foreland protected by the Point Moore reefs. There are approximately 200 residential dwellings near the coast built in the 1960s and 1970s on leasehold land within reserves vested in CGG. All dwellings use onsite systems (septic tanks with effluent disposed of via leach drains or soak wells) for wastewater treatment and disposal. Whilst originally established as holiday cottages, many of the Point Moore lessees are now retirees and beach lifestyle enthusiasts that occupy the residences year-round.

Given their age, many of the original septic tanks and soak wells/leach drains may have reached or be approaching their serviceable life and some may have been replaced or upgraded. Due to the low ground levels in the area there is limited vertical separation distance between the soak wells/leach drains and the water table. This separation distance will likely reduce in the future due to rise in sea levels.

M P Rogers & Associates completed the *Point Moore Inundation & Coastal Processes Study*, hereafter termed the Coastal Inundation Study, in 2015 (m p rogers, 2015). The study identified areas of Point Moore which could be impacted by coastal inundation and erosion. Further discussion with regards to this study is provided in Section 3 and the summary report from this m p rogers study is provided in Appendix A.

The CGG commissioned GHD Pty Ltd (GHD) to complete a study to review available information and to conduct a series of investigations to assess the performance of the existing onsite systems and their potential impacts on the local environment and the degree to which they comply with current legislation and guidelines. The fieldwork completed to locate and assess the onsite systems at a selection of properties was completed by Sun City Plumbing (SCP).

1.1 Study Objective

The overall objective of the study is to provide the Point Moore stakeholders with data and documentation on the performance and compliance of the existing onsite wastewater treatment and disposal systems and to assist the CGG in their decision-making process relating to the future status of and potential obligation to Point Moore lessees beyond the current lease expiry dates of 2025 and 2028.

1.2 Scope of Work

The study was completed in two stages, with the key tasks in each stage listed in Table 1.

Table 1 Scope of Work

Phase/Task	Description
Stage 1	
Task 1	Desktop review of available information.
Task 2	Soil and groundwater investigations, including installation of three new monitoring wells.
Task 3	Groundwater level and quality monitoring program (three-month program).
Stage 2	

Phase/Task	Description
Task 4	Onsite wastewater system field inspections.
Task 5	Technical assessment and reporting.

This report documents the findings from all five tasks undertaken to complete this study.

1.3 Limitations and Assumptions

This report has been prepared by GHD for the City of Greater Geraldton and may only be used and relied on by the City of Greater Geraldton for the purpose agreed between GHD and the City of Greater Geraldton as set out in Section 1.1 of this report.

GHD otherwise disclaims responsibility to any person other than the City of Greater Geraldton 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 the City of Greater Geraldton 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. At the time of preparing this report, the nature of the proposed redevelopment (and as such the likely magnitude of disturbance across the site) remained unconfirmed.

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 indicative cost estimates using information reasonably available to GHD; and based on assumptions and judgments made by GHD.

The indicative cost estimates have been prepared to provide an order of magnitude indication of the costs to upgrade the existing onsite systems or install new reticulated wastewater infrastructure. They must not be used for any other purpose.

The cost estimates are indicative estimates only. Actual prices, costs and other variables may be different to those used to prepare the cost estimates 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 upgrade of the existing onsite systems or installation of new reticulated wastewater infrastructure could be completed at costs which are the same or less than the estimated indicative costs.

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.

2. Site Identification and Physical Characteristics

2.1 Site Description

Point Moore is located approximately two kilometres (km) south of the Geraldton business district, and forms the western extremity of the Geraldton tombolo (CGG, 2016). The study area is bounded by the Indian Ocean to the south, east and west, and John Willcock Link to the north. The subject land comprises several land parcels:

- Reserves vested in the City of Greater Geraldton:

– Reserve R29729	Public Recreation (Pages Beach Coastal Reserve);
– Reserve R2562	Esplanade and Recreation (Greys Beach, Point Moore and Explosives Coastal Reserve);
– Reserve R29173	Caravan Park and Tourist Accommodation;
– Reserve R25459	Recreation and Leasing of Cottages; and
– Reserve R31658	Parklands.

- Reserves vested in the Australian Maritime Safety Authority:

– Reserve R44687	Navigation, Communication, Meteorology and Survey (Point Moore Lighthouse).

- Other land:

– Private land holding	481 Marine Terrace (land and property around Point Moore lighthouse);
– Vacant Crown Land	Part of Point Moore and Greys Beach.

The focus of this study is the residential dwellings located within Reserve R25459. There are approximately 200 residential dwellings in this reserve, typically two to three bedroom dwellings, each on approximately 300 m^2 of land area. A locality plan is included as Figure 1.

2.2 Geology and Soil

2.2.1 Geology

Regional geological mapping indicates that the surface geology of the study area is dune and beach sand, which is comprised of white calcareous and quartzose sand (Geological Survey WA, 1995).

2.2.2 Soil Landscapes

DAFWA (2016) mapping of the South-West of Western Australia was used to characterise the soil-landscapes present within the study area. The study area is covered by the Quindalup Central 1 urban phase, which is described as follows:

- Urban development on Quindalup 1 coastal dune subsystem on Aeolian calcareous sands and minor limestone in the North Coastal Plain, adjacent to the coast from Jurien Bay to Bluff Point. Man-made, disturbed soils; originally Calcareous deep sand.

2.2.3 Preliminary Acid Sulphate Soil Assessment

A review of the WA Atlas for Department of Environment Regulation (DER) Acid Sulphate Soil risk mapping (Landgate, 2016), indicated that potential ASS has not been mapped within the study area. A search of the CSIRO (2016) database indicated that there was an extremely low probably of ASS occurring with very low confidence.

2.3 Hydrogeology

2.3.1 Aquifers and Groundwater Flow

The Perth Groundwater Atlas indicates that the Site is located above a Superficial (unconfined) Aquifer, Perth – Superficial Swan (DoW, 2016a).

The atlas indicates that groundwater beneath the study area is at approximately three metres below ground level. Groundwater was identified to flow towards the Indian Ocean.

2.3.2 Local Bores

General

Based on advice from CGG, groundwater from the Point Moore area is not used for irrigation or any other purposes in the study area, and the nearest production bores are the CGG bores located approximately 600 m east to north east of the study area near Ocean and Point Streets. These bores are up-gradient of the study area and supply irrigation water for open space areas near the Geraldton city business district.

Department of Water WIN Bore Search

A search of the Department of Water’s (DoW) water information reporting (WIN) bore database indicates that three bores are registered within a 2.5 km radius of the study area. The bores are located approximately 2 km north-east and 1.5 km south-east from the study area. No other registered bores occur down-gradient or up gradient of the study area within 1 km during the search.

Figure 1 Locality Plan

2.3.3 Local Groundwater Levels and Quality

Prior to this study there was one groundwater monitoring well (GMW – SHP8) located in the study area, more specifically within Coxswain Park as shown on Figure 11.

Groundwater Quality Data

No data was provided by CGG that could be used to characterise the quality of groundwater in the study area.

Groundwater Depth

The CGG is required under its groundwater licence to report to the DoW the standing water levels in GMW – SHP8 twice a year (Pers. comm. Michael DuFour, 28 July 2016). The standing water levels over the period February 2013 to August 2015 are depicted in Figure 2. There are some data gaps over this period, and no data was provided for the period beyond August 2015.

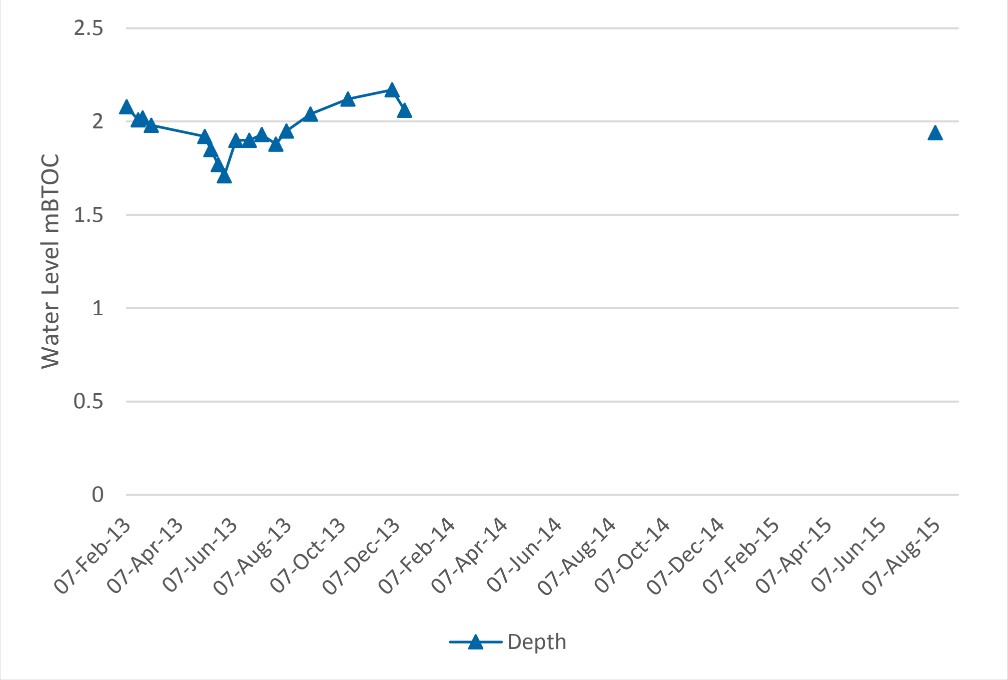


Figure 2 Standing Groundwater Levels at SHP8

2.4 Nearshore Marine Environment

2.4.1 General

The nearshore bathymetry ranges from 0 to 10 m in depth and comprises a complex system of exposed reefs and deeper channels. Beaches are sandy, and where sheltered they are wide and flat. In exposed areas the beaches are narrower and subject to erosion (CGG, 2016).

2.4.2 Water Quality

The CGG undertakes marine surface water monitoring at designated beach locations within Geraldton and Greenough at sampling locations depicted in Figure 3. GHD has reviewed the laboratory water quality data supplied by CGG for the period November 2012 to April 2016.

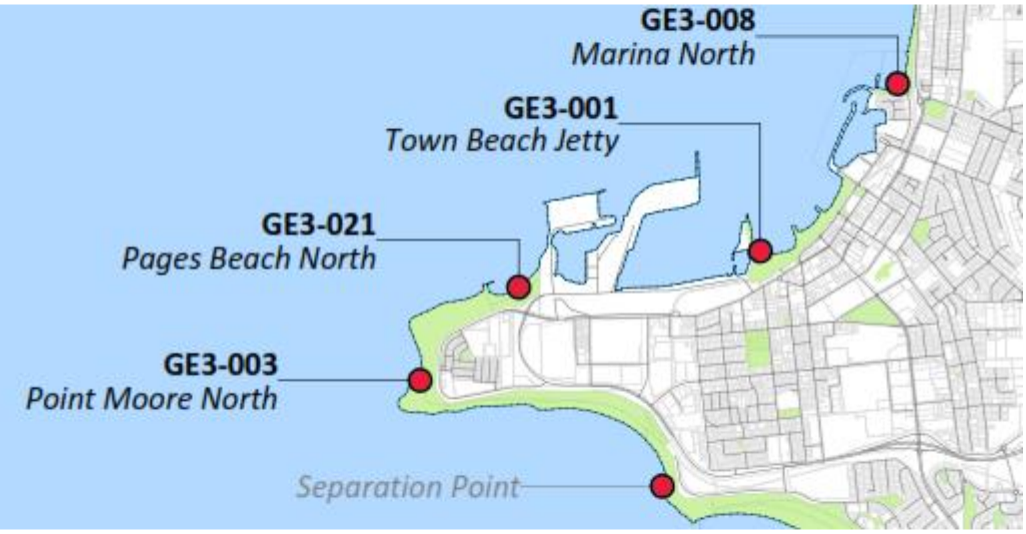


Figure 3 Near Shore Marine Sampling Points (CGG, 2016)

Two monitoring locations, Point Moore North (GE3-003) and Pages Beach North (GE3-021), are located close to the study area. The *Enterococci* data at these two locations, and at one location remote from Point Moore (Town Beach Jetty, GE3-001), was assessed in this study. As shown in Figure 4, the *Enterococci* data was compared against the ANZECC (2000) water quality guidelines for primary and secondary contact recreation which are:

- Primary contact: Median of 35 *Enterococci*/100 mL during bathing season with maximum in one sample being 60 to 100 *Enterococcoi*/100 mL;
- Secondary Contact: Median of 230 *Enterococcoi/*100 mL and maximum number in any one sample being 450 to 700 organisms/100 mL.

Based on these water quality guidelines, some reported *Enterococci* results were above the primary contact and in some instances above the secondary contact guideline values. The reported results thus indicate that persons engaging in both primary contact (e.g. swimming, skin diving) and secondary contact (e.g. boating and fishing) recreational activities in the area are exposing themselves to health risks. Of note, as shown Figure 4 there were no exceedances of the ANZECC (2000) guideline values at the Town Beach Jetty monitoring location over the same period.

The *Enterococci* data was also compared against the NHMRC (2008) percentile values for determining water-quality assessment categories for the protection of healthy adult bathers (refer to Appendix A) which are:

- Category A: <40 *Enterococci*/100 mL (no observed-adverse-effect-level (NOAEL);
- Category B: 41-200 *Enterococci*/100 mL (threshold of illness transmission in most epidemiological studies attempted to define a NOAEL);
- Category C: 200-500 *Enterococci*/100 mL (represents substantial elevation in the probability of all adverse health outcomes); and
- Category D: >500 *Enterococci*/100 mL (above this level may be a significant risk of high levels of illness transmission of *Enterococci*/).

As depicted in Figure 5, one reported *Enterococci* result was in Category C, and one result was in Category D, i.e. at levels that pose a significant risk of illness transmission of *Enterococci* and considered to warrant further investigation.

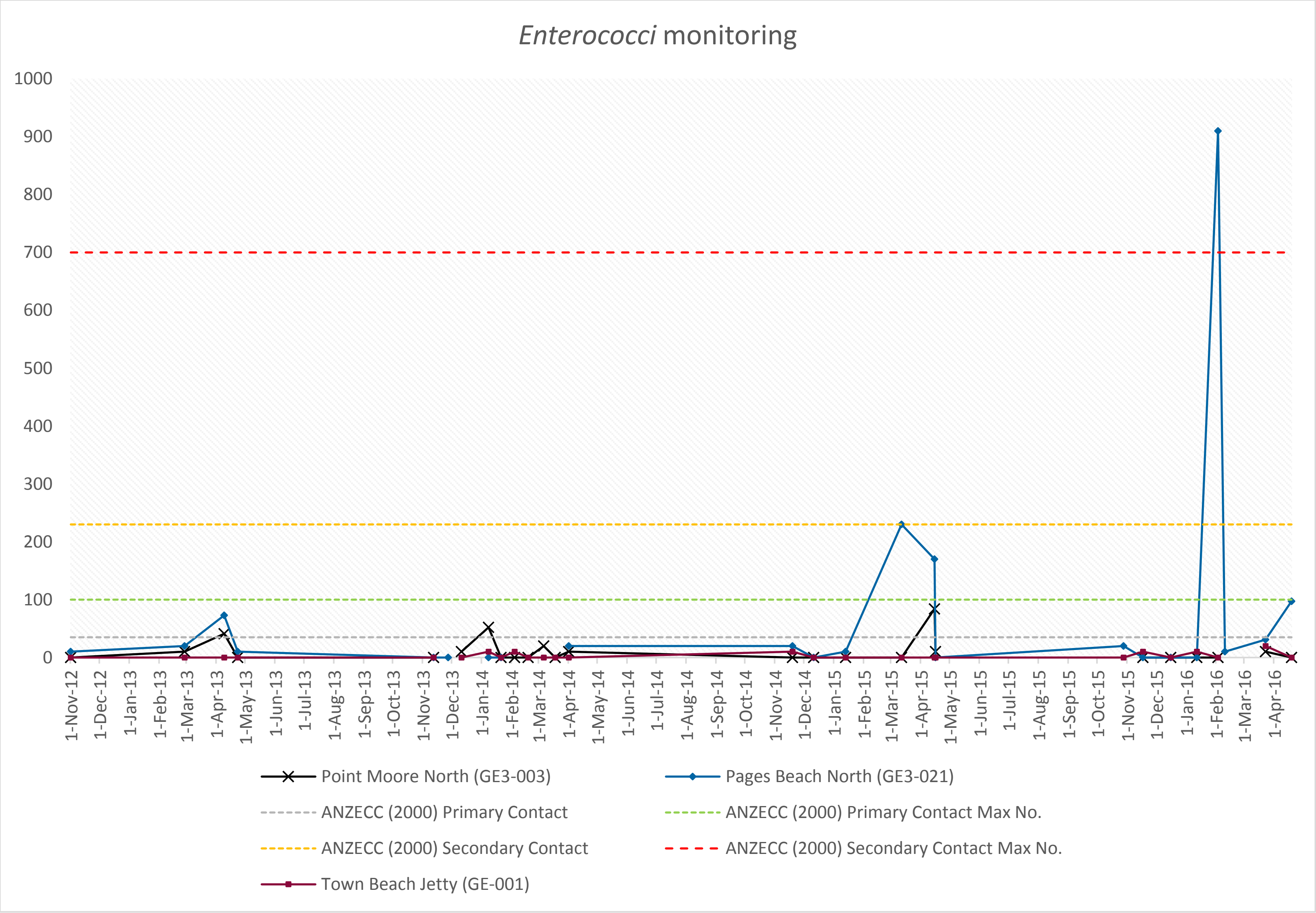


Figure 4 Comparison of Nearshore Marine *Enterococci* Levels with ANZECC (2000) Recreational Water Quality Guidelines

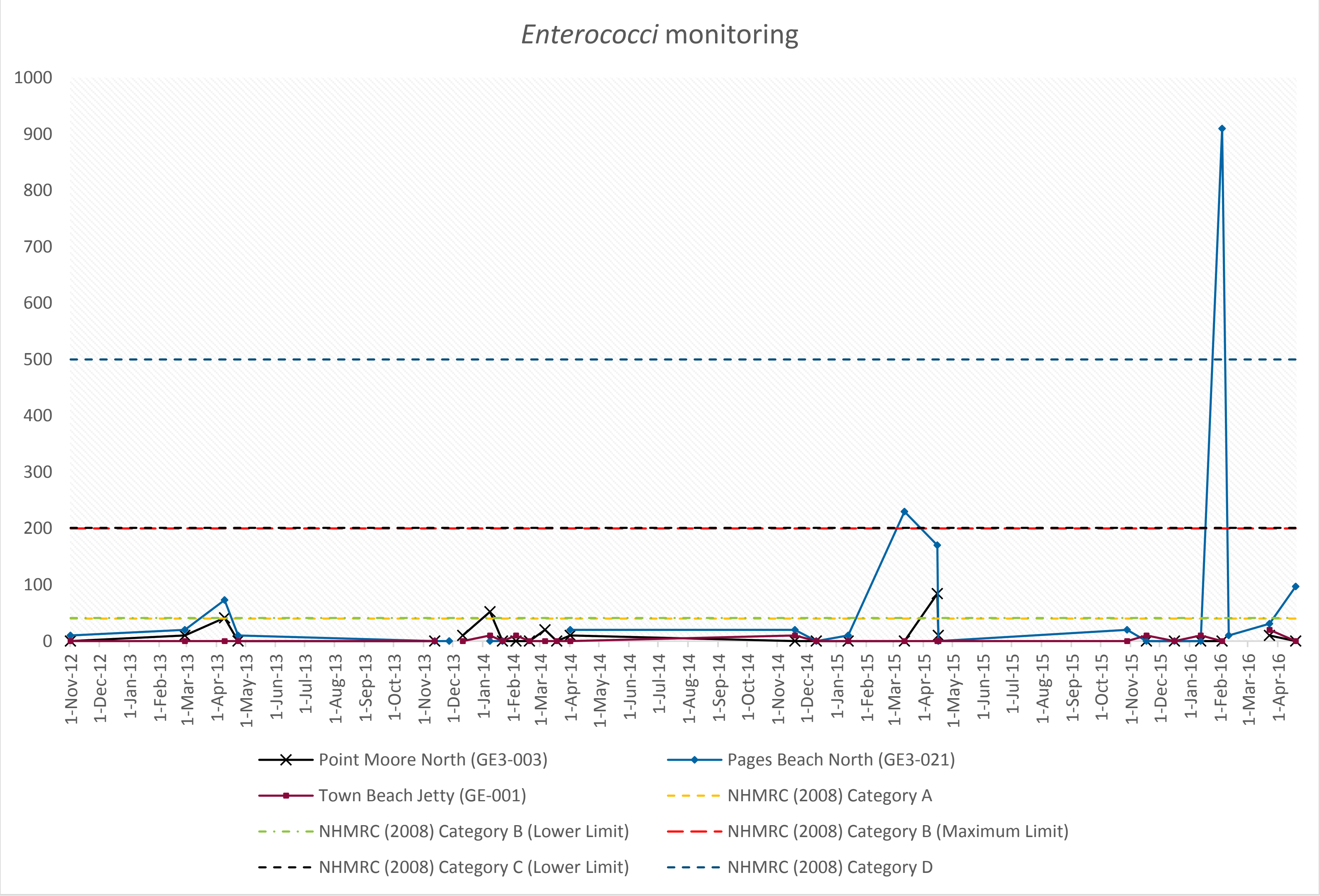


Figure 5 Comparison of Nearshore Marine *Enterococci* Levels with NHMRC (2008) Recreational Water Quality Categories

3. Coastal Inundation Study

3.1 Study Overview

The Coastal Inundation Study (m p rogers, 2015) identified areas of Point Moore which could be impacted by coastal inundation and erosion. As part of the study the following were completed:

- Cyclone storm surge modelling to determine the potential inundation of these extreme events;
- Analysis of available water level records to determine the potential inundation caused by non-cyclonic events;
- Modelling the potential beach and dune erosion caused by severe events;
- Assessment of historical and potential future shoreline movement caused by natural coastal processes; and
- Assessment of the effects of potential sea level rise (assuming 0.9 metres of sea level rise by year 2110 as required by State Planning Policy No. 2.6 (SPP 2.6)) on the coastal inundation and erosion.

The Coastal Inundation Study Summary Report is provided in Appendix B.

3.2 Maps Depicting Study Results

The Coastal Inundation Study (m p rogers, 2015) included a series of maps to depict the study results and recommendations. Some of the key maps are shown and briefly described next.

Coastal Processes Allowance Plan

The coastal processes allowance plan relates to the extent of coastal erosion over ‘planning horizons’ including present day, 2030, 2070 and 2110. The recommended present day, 2030, 2070 and 2110 coastal setbacks are shown in Figure 6.

Inundation Mapping Plans

The inundation map (Figure 7) depicts the areas of inundation that could occur in the present, with colours to represent different severity events. The purple shading represents those areas that are predicted to be inundated during a 20-year average recurrence interval (ARI) event, the blue shading demonstrates the additional area that would be inundated during a 100 year ARI event, and the green shading the additional area inundated during a 500 year ARI event. Inundation maps used to establish the 2030, 2070 and 2110 coastal setback are provided in Appendix B.

Inundation Depth Plans

The inundation depth plan provided in Figure 8 shows the potential depth of inundation that is predicted to occur in 2030 under a 20 year average recurrence interval (ARI) event. Other inundation depths maps produced by m p rogers (2015) are included in Appendix B.

Combined Coastal Vulnerability Mapping Plans

The combined coastal vulnerability map provided in Figure 9 depicts the area that would be impacted by inundation or coastal erosion (based on present day setbacks) in a 500 year ARI event. Similar plans generated for the recommended 2030, 2070 and 2110 setbacks (500 year ARI events) are provided in Appendix B.

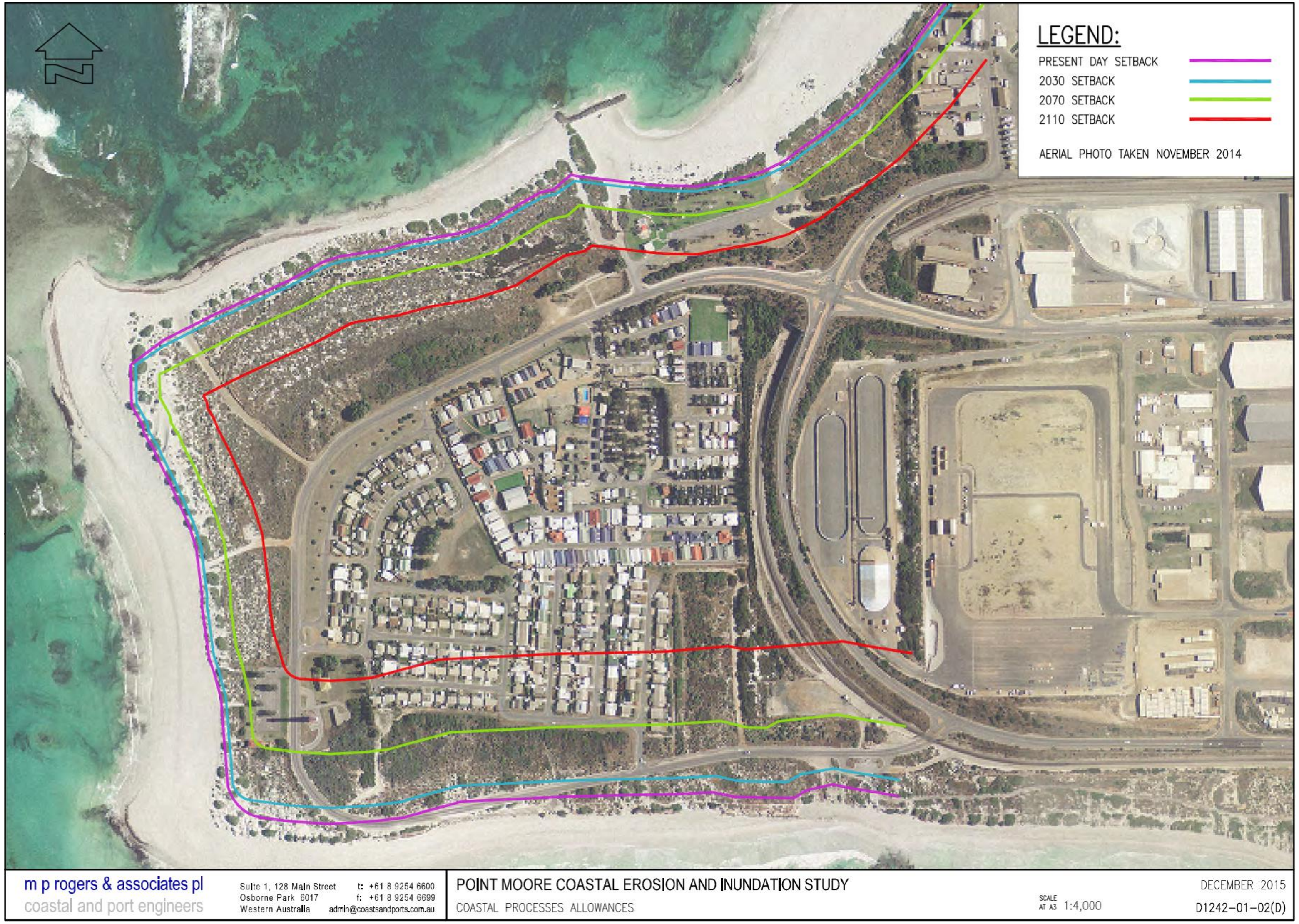
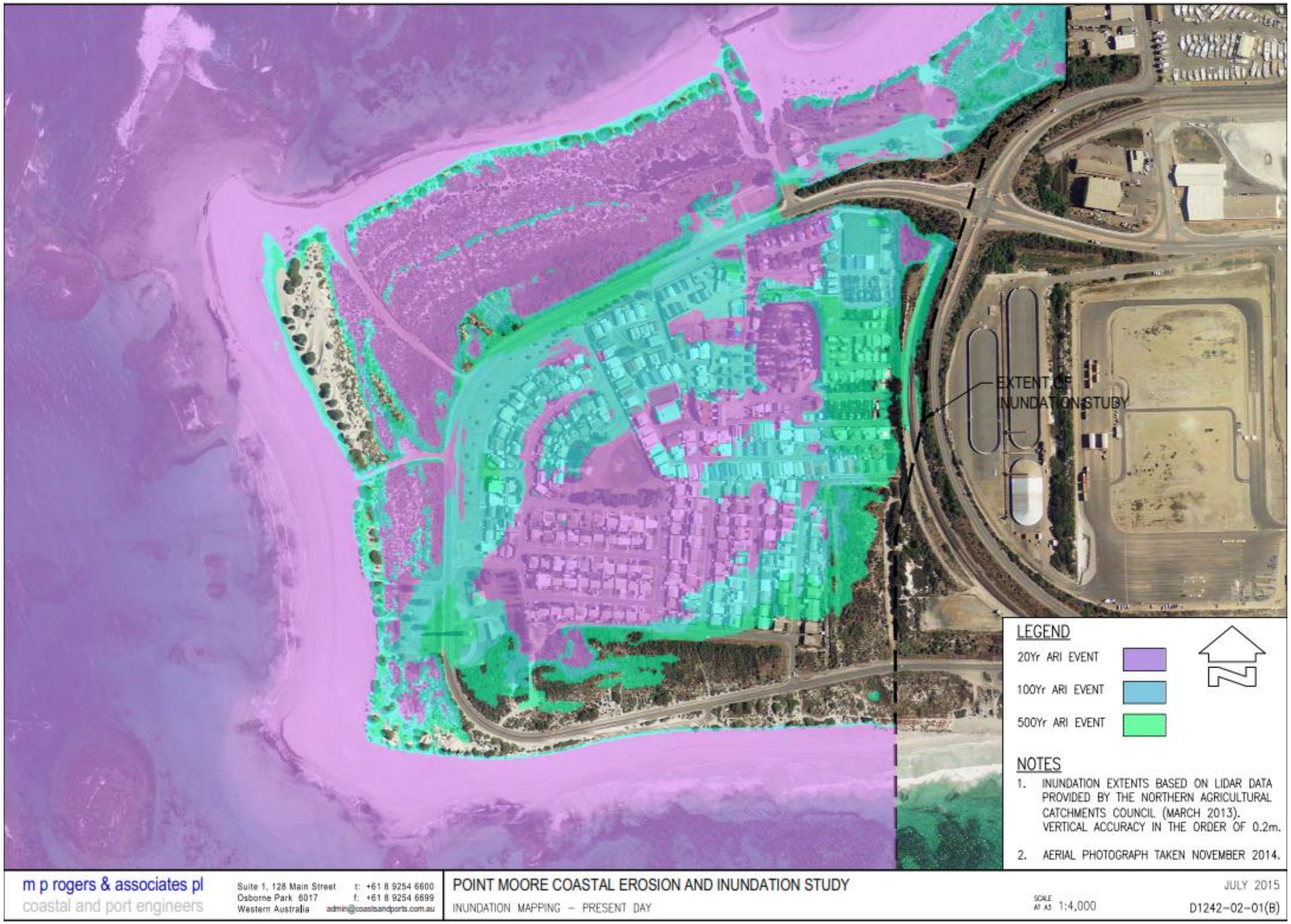


Figure 6 Coastal Processes Allowance Map (m p rogers, 2015)



NOTES

1. INUNDATION EXTENTS BASED ON LIDAR DATA PROVIDED BY THE NORTHERN AGRICULTURAL CATCHMENTS COUNCIL (MARCH 2013). VERTICAL ACCURACY IN THE ORDER OF 0.2m.
2. AERIAL PHOTOGRAPH TAKEN NOVEMBER 2014.

Figure 7 Inundation Mapping - Present Day Setback (m p rogers, 2015)

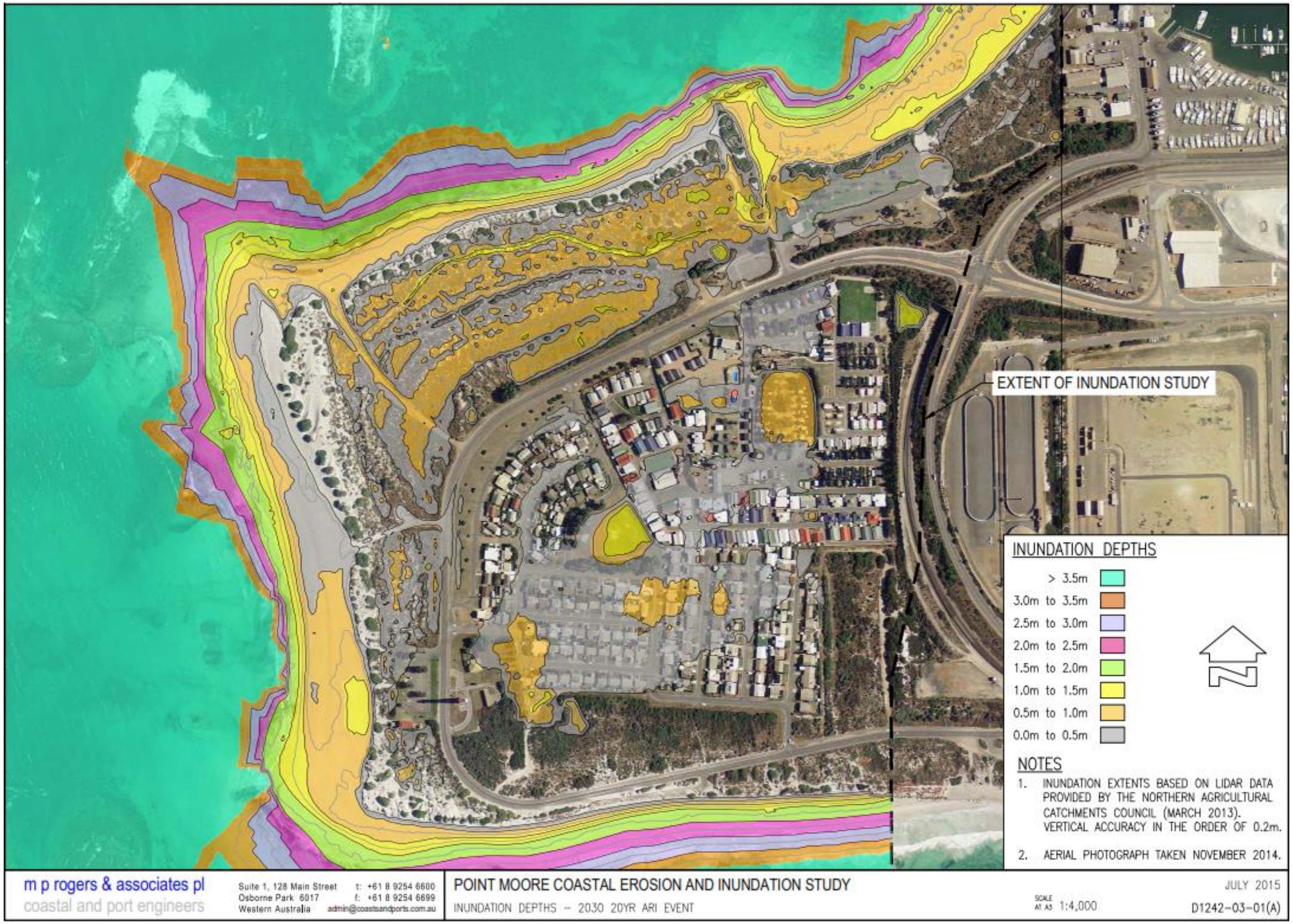


Figure 8 Inundation Depth – 2030 Setback (20 year ARI Event) (m p rogers, 2015)

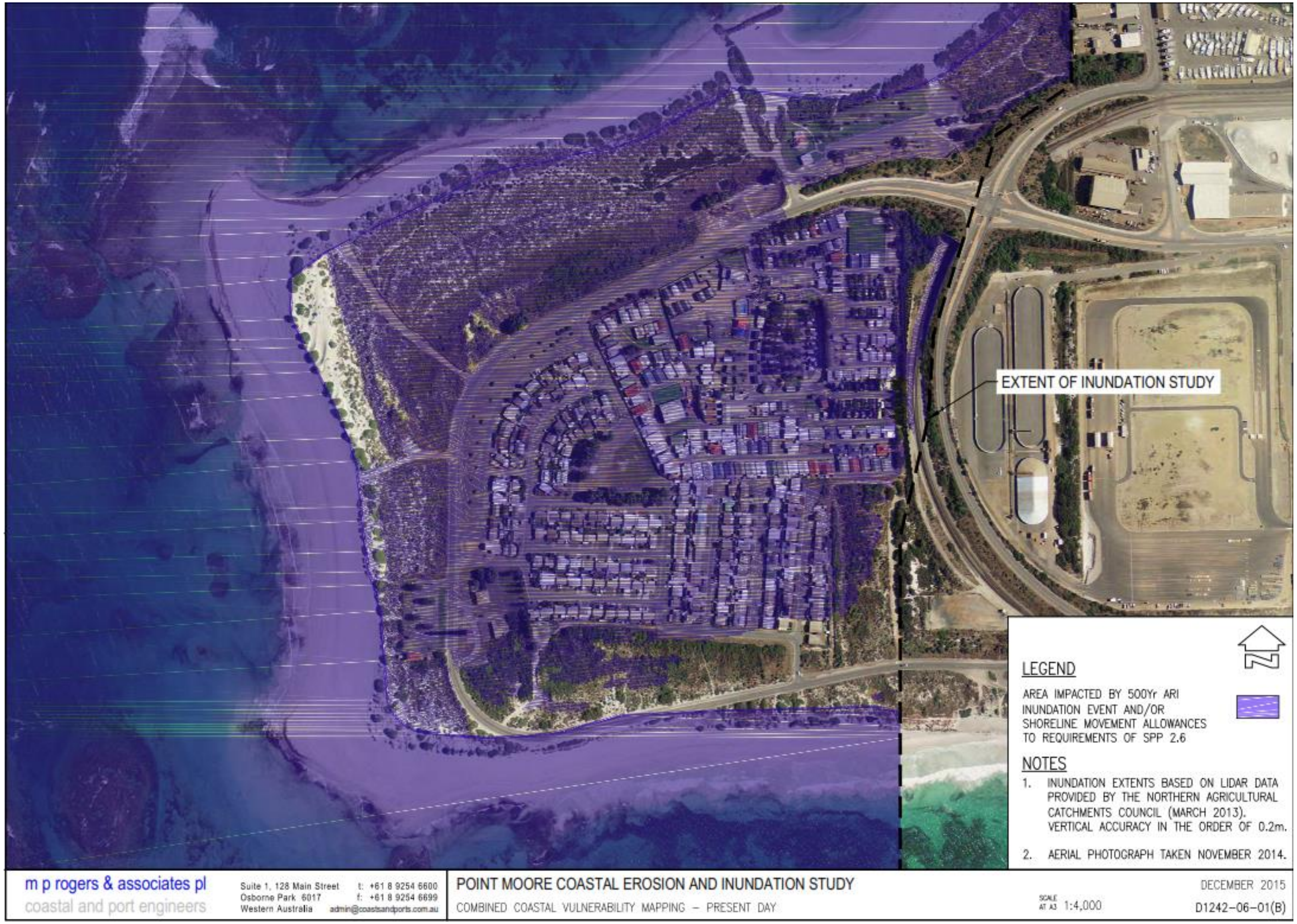


Figure 9 Combine Coastal Vulnerability Mapping - Present Day (Setback) (m p rogers, 2015)

3.3 Consultation with Regulatory and Planning Bodies

Advice and comments on the Coastal Inundation Study (m p rogers, 2015) provided to CGG by the Department of Health (DoH), Department of Lands (DoL) and Department of Planning (DoP) are summarised next. Note that CGG sought a response from the Department of Environment Regulation (DER), no comment was provided.

3.3.1 Department of Health

In a correspondence letter the DoH advised:

> *When developing strategies based upon the findings in the report you may consider a risk assessment of each of the respective areas. Such strategies should incorporate issues such as disaster preparedness, emergency shelters and recovery* (DoH, 2016a)*.*

3.3.2 Department of Lands

In a correspondence letter the DoL advised:

> *As indicated at that meeting, the findings of the report indicated that the reserve is at risk from coastal hazards and that the risk is increasing both in extent and depth. The report provides impetus for further discussion with the City on the long term land use planning for the area post the expiry of the current leases on Point Moore Reserve 25459* (DoL, 2016).

3.3.3 Department of Planning

In email correspondence the DoP advised:

> *The WAPC / DoP position on the West End is contained in the Greater Geraldton Structure Plan June 2011 which identifies it as an area of State Government owned land that provides facilities for tourism, visitor activity. It is severely constrained due to its proximity to the port, a lack of wastewater and vulnerability to storm surges, inundation and long term coastal recession (erosion). I believe the City has just updated its Local Planning Strategy and Scheme, this was the best place to include its intentions for the West End, you should discuss this with your colleague, Murray Connell, the City's Manager Urban and Regional Development. In the LPS on the Geraldton Area Strategy Plan the West End is identified as Strategic Tourism. The LPS also includes at section 4.11 page 27 an action to "ensure land use decision making is based on the best available science regarding coastal processes and the need for adequate setbacks"* (DoP, 2016a).

In a correspondence letter the DoP further advised:

> *DoP.... consider the study to be adequate in demonstrating that much of the current development footprint is already at risk from coastal hazards and that the risk is increasing both in extent and depth. Hence there is sufficient basis and detail in the study to conclude against extension of the current leases when they expire in 2028. It is unlikely that the City or the Department of Lands would wish to fund and maintain coastal protection works for this Crown Reserve and hence leaseholders should not be under any hope of such action (DoP, 2016b).*

4. Wastewater Management

4.1 General

Many of the residential properties established on the Point Moore leases were built in the 1960s and 1970s. Originally established as holiday cottages, they have been commonly acquired by retirees and beach lifestyle enthusiasts. Onsite wastewater treatment and disposal systems that were approved by DoH at that time consisted of either:

- combined systems, comprising two concrete septic tanks (1500 mm and 1200 mm diameter) and two standard size (1200 mm diameter) concrete soak wells or one 9 m leach drain; or
- separate systems comprising one tank and one soak well each for toilet waste and another tank and soak well receiving wastewater from separate sewer lines, with the tanks and soak wells typically located on opposite sides of the dwelling (CGG, 2016a).

Having land areas of approximately 300 m^2, the residential properties are significantly smaller than the minimum lot area currently recommended for houses reliant on onsite wastewater systems. For instance, in its discretionary provisions the Draft Country Sewerage Policy (DoH, 2003) states that lot sizes down to 1,000 m^2 can be considered under certain conditions (e.g. residential subdivisions in remote areas or towns without sewerage that do not create more than 25 lots). Given that the Point Moore area is within the Geraldton townsite, and that Geraldton is a sewered town, the discretionary provisions of this policy do not apply to Point Moore.

The City's internal health database established in 2003 has two reported cases of failing septic systems; one at Zodiac Lane and another at Bosons Crescent. This compares with 44 other enquiries received from various other locations across the City outside the Point Moore site in relation to poorly functioning septic systems (CGG, 2016).

In 2006 the City received advice from the DoH stating that it "*objects to the creation of any new lots and is unsupportive of the extension of the leases, without adequate provision being made for effluent disposal*". Accordingly, the City has since issued standard advice on settlement enquires regarding Point Moore properties because of the potential interest at the time from building owners to apply for building extensions; the advice stated;

> "*The future owner is advised that existing lease lot size may restrict / constrain the available area for future upgrade to onsite effluent disposal system as a result of functional failure or redevelopment in future*" (CGG, 2016).

4.2 Review of Available Information on Existing On-site Systems

CGG provided GHD with a copy of as-constructed records (stamped block plans) and correspondence that provides information on the existing onsite wastewater treatment and disposal systems for approximately 50% of the houses (dated from 1972 to 2001). GHD's review of this information found that:

- Of the nominal 80 houses for which information was available on the effluent disposal system, approximately 20% of the houses use soak wells (typically two soak wells per house), with the remainder using leach drains (typically 1 x 9 m leach drain).
- In July 1983 the Town of Geraldton's Senior Health Surveyor reported that approximately 59 beach cottage leases were due to expire in 1986, and that of these 30 have septic or disposal systems that do not conform to Health Act legislation. The majority of the non-conformances related to instances where wastewater from adjoining cottages was directed to a single septic tank/soak well installation. These landowners were advised to

effect plumbing amendments to achieve compliance with regulations, and that these amendments need to be completed prior to renewal of the lease agreements.

Since 1989, most household septic tank systems have been installed with either two leach drains or two sets of soak wells (DoH, 2011). These systems are known as alternating systems as they have a diverter box to enable flow to be switched from one leach drain or train of soak wells to the other, which allows the effluent disposal systems to be operated on a cyclic duty:resting regime. Such an operating regime is beneficial (if implemented), as periodic resting of leach drains and soak wells rejuvenates the soil's ability to receive effluent.

4.3 Current Regulatory Requirements

The current requirements for onsite treatment and disposal of wastewater in WA are set out in the Health (Treatment of Sewage and Disposal of Effluent and Liquid Waste) Regulations 1974. In addition to these regulations, the Draft Country Sewerage Policy (Draft from 22 September SOCWM Meeting Amended September 2003) and the Australian Standard AS1547:2012 (On-site domestic wastewater management) provide guidance that is relevant to the onsite wastewater systems at Point Moore. Some of the key requirements relevant to the performance of the existing onsite systems at Point Moore (sand conditions assumed) are summarised in Table 2.

Table 2 Key regulatory requirements

Item	Requirement/ Guideline	Regulation	Policy or Guideline	Reference (1)
Wastewater disposal area inundation/flooding risk	Probability of such to be less than once every 10 years.		✓	B
Soak Well Sizing				A
– 2 bedroom dwelling	3 x soak wells(2)	✓		
– 3 bedroom dwelling	4 x soak wells(2)	✓		
Leach Drain Sizing				A
– 2 bedroom dwelling	2 x 6 m leach drains(3)	✓		
– 3 bedroom dwelling	2 x 8 m leach drains(3)	✓		
Minimum Vertical Separation Distance to Groundwater (4)	1.2 m (5)		✓	B
	0.6 - >1.5 m (6)		✓	C

Table Notes:

1. References:
    - A. Health Regulations 1974
    - B. Draft Country Sewerage Policy
    - C. AS1547:2012
2. Each soak well shall have a minimum diameter of 1.2 m and a minimum effective depth of 1.5 m, unless otherwise approved by DoH.
3. Assuming standard dimensions of 0.6 m effective depth and 0.4 m internal width.
4. Minimum vertical distance between invert of septic tank receptacle (in this case soak well or leach drain) and the highest seasonal water table.
5. The policy states that "*for existing developed areas or infill areas a depth to highest known groundwater level may be a minimum of 1.2 m from ground level*".
6. The recommended separation distance is a function of the groundwater pollution hazard

Available as-constructed records (Section 4.2) indicate that existing effluent disposal systems are under-sized with respect to current requirements (Table 2).

In addition to the ‘performance requirements’ detailed in Table 2, current regulations and guidelines include minimum horizontal clearances that must (unless otherwise approved) be maintained between septic tanks/soak wells//leach drains and buildings, property boundaries etc. The purpose of these clearances is to ensure that septic tanks/leach drains/soak wells can be maintained or replaced without affecting the stability or structural integrity of nearby buildings and the like, and that loadings from buildings do not affect the structural integrity of the wastewater infrastructure. This is further discussed in Section 5.3.

4.4 Estimated Vertical Separation Distance to Groundwater

As shown in Figure 1, although there are some small areas of higher and lower land, the natural surface level across most of the study area is approximately RL 2.0 m. Adopting RL 2.0 m as the typical natural surface level on the residential lots and assuming that the upstream end of the drainage pipework is installed at a depth (to invert) of 0.5 m, and that the typical length and grade of the drain from this point to the septic tank is 10-20 m and 1 in 60, respectively, the typical invert level of the septic tank inlet pipes is estimated to be approximately 0.7-0.9 m below ground level, or RL 1.1 m to RL 1.3 m. Adopting this level, and assuming that soak wells and leach drains have effective depths of 1.5 m and 0.5 m, respectively, the typical invert level of the soak wells are estimated to be approximately RL -0.2 m to RL -0.4 m, and the typical invert level of the leach drains are estimated to be approximately RL 0.6 m to RL 0.8 m.

Noting that the groundwater level currently ranges from approximately RL 0.2-0.5 m (refer to Section 6.3.5), the vertical separation distance between the invert of the leach drains and the water table is estimated to be approximately 0.1 to 0.6 m, and the invert of the soak wells (assuming 1.5 m effective depth as above) is likely to be below water table.

With reference to the current guidelines summarised in Table 2, it is evident that most of the soak wells and many of the leach drains in the study area are unlikely to comply with current vertical separation distance guidelines.

5. Property Assessments

5.1 General

SCP completed field investigations over the week commencing 17 October 2016 to assess the existing wastewater treatment and disposal systems at seventeen properties at Point Moore selected by CGG. Of these fifteen properties had non-invasive investigations undertaken, and two properties had more detailed invasive investigations undertaken.

The scope for the investigations, and the main findings from the investigations, are summarised next. Further detail is provided in SCP's full report.

5.2 Scope of Investigations

The scope of the investigations was to:

- Review available as-constructed information on the existing wastewater systems;
- Liaise with owner/occupiers to gain access to works area, and obtain general advice relevant to this study (e.g. comment on system performance, recent upgrade/maintenance works etc.);
- Take photos of entire property, and measure exterior of house;
- Run a drain camera down the drain (where possible);
- Locate septic tanks by visual inspection or probing, determine if single or dual septic systems, and mark on plan;
- Locate soakwell/leach drains by visual inspection or probing, and mark on plan; and
- Excavate & take photos of the septic tanks and leach drains/soak wells, and then reinstate properties to similar condition to how they were found for the two properties selected for invasive investigations.

5.3 Assessment Findings and Conclusions

The key findings from the investigations were:

- All properties where septic tanks were located had two septic tanks (first tank 1.5 m diameter, second tank 1.2 m diameter). Whilst no markings or stamps were visible stating that the tanks are DoH approved products, they appeared to be proprietary products.
- None of the located septic tanks met all of the standard horizontal separation distance requirements detailed in current regulations. Specifically, the clearance between the tanks (required minimum clearance = 1.2 m), the separation distance between the tanks and buildings (1.8 m required) or property boundaries (1.8 m required) did not comply with current requirements. The same issue applies for the located leach drains.
- Without excavation, the leach drains were difficult to locate. Of those that were located, a number were in poor condition, with some having at least several collapsed segments.
- No twin (alternating) leach drain systems with diverter valves were located, the longest leach drain was 8 m in length, and it was not possible to determine if they are DoH approved products.
- Soil types encountered during the investigations were typically fine grained sands below a topsoil layer, and are expected to have good drainage properties.

Based on the above findings SCP concluded that:

1. For the sites where the septic tanks and leach drains were located, none of the homes inspected had onsite systems that comply with relevant Australian Standards or the current DoH regulations.
2. Because of the small block sizes at Point Moore, it is not possible to install septic tank and leach drain systems that are fully compliant with current DoH regulations on many of the properties.

6. Soil and Groundwater Investigations

6.1 Guideline Framework for Contamination Assessment

This section of the report summarises the assessment criteria adopted to evaluate the human health and ecological risks posed by the existing septic systems within the study area. Consideration has been given to potential off-site impacts.

The legislation and guidelines that outline the appropriate framework for the investigation include the:

- Contaminated Sites Act 2003 and Contaminated Sites Regulations 2006;
- DER Contaminated Sites Management Series guidelines;
- DER Assessment and management of contaminated sites guideline (DER 2014); and
- National Environmental Protection Council (1999), National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1).

The overarching reference in this assessment was the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended by the *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1)*, herein referred to as the NEPM. NEPM Schedule B1 “Guidelines on investigation levels for soil and groundwater” contains investigation and screening levels suitable for the assessment of the chemicals of potential concern in soil and groundwater at the site.

As defined in the NEPM, investigation levels are the concentrations of a contaminant above which further appropriate investigation and evaluation will be required.

6.1.1 Soil assessment criteria

Ecological Assessment Criteria

As defined in the NEPM (NEPC 1999), ecological investigation levels (EILs) have been developed for selected organic substances and are applicable for assessing risk to terrestrial ecosystems. EILs depend on specific soil physicochemical properties and land use scenarios and generally apply to the top 2 metres of soil. The NEPM advises that in arid regions, where the predominant species may have greater root penetration depth, specific consideration may result in their application to 3 m depth. Two metres depth is considered appropriate in this case for the site circumstances.

The following assessment criteria was adopted for a pragmatic consideration of risk to the environment:

- NEPC (2013) EIL for Public Open Space.

6.1.2 Groundwater Assessment Guidelines

The DER has provided criteria for use in the assessment of water (DEC, 2010), which are based upon the “*Australian and New Zealand Guidelines for Fresh and Marine Water Quality*” (ANZECC, 2000), the “*Australian Drinking Water Guidelines*” (NHMRC, 2004) and the “*Contaminated study areas Reporting Guideline for Chemicals in Groundwater*” (DoH, 2006).

Groundwater is likely to discharge into the Indian Ocean, which is located immediately adjacent to Point Moore. This part of the Indian Ocean is generally used for swimming, surfing, windsurfing, kite surfing, diving, fishing and boating.

No abstraction of groundwater takes place at Point Moore (refer to Section 2.3.2). The legislation and guidelines that outline the appropriate framework for the groundwater investigations is summarised next.

Ecological Assessment Criteria

A search was undertaken on the Bureau of Meteorology's (BoM) (2016) Atlas of Groundwater Dependent Ecosystems database. The BoM (2016) reported one groundwater dependent ecosystem reliant on surface expression of groundwater in the vicinity of the study area, which has a low potential for groundwater interaction. This GDE type is *Acacia ligulata*, an open scrub that is situated to north of the study area and is unlikely to interact with groundwater from the study area, and therefore is not considered further in the context of potential impacts from existing Point Moore wastewater practices.

The study area's groundwater is anticipated to flow towards the Indian Ocean. To assess the potential risk to the coastal marine environment and human health of coastal users, the ANZECC (2000) marine inshore default trigger values for South West Australia for physical and chemical stressors and primary recreational contact were adopted, respectively.

Health Assessment Criteria

As noted previously, the groundwater at Point Moore is not used for drinking water or irrigation in the study area, rather all such needs are met with scheme water. The groundwater beneath the study area flows towards the Indian Ocean, where a number of recreational activities are carried out. As a conservative measure the ANZECC (2000) guideline values for primary contact recreation (microbiological water quality limits only) were adopted.

6.2 Methodology

6.2.1 Field Work Preparation

Monitoring Bore Locations

Water Corporation and Telstra assets were identified in the vicinity of the original proposed location for MW1. Consequently, MW1 was relocated beyond these assets and to the western side of Marine Terrace. The rationale for the groundwater monitoring well locations is provided in Table 3, and the GMWs locations are depicted in Figure 11.

Table 3 Rationale of GMW Locations

Well ID	Location	Rationale
MW1	West side of Marine Terrace, south of Pages Beach carpark	Down-gradient of existing residential properties targeting groundwater flowing in a westerly direction towards the Indian Ocean.
MW2	South side of Captains Crescent, opposite of Helm Way	Down-gradient and south of all residential properties, intersecting groundwater flowing in a southerly direction towards the Indian Ocean.
MW3	Corner of Sextant and Astrolab Lane.	Down-gradient and east of all residential properties, intersecting groundwater flowing in a easterly direction towards the Indian Ocean
SHP8 (previously installed by CGG)	Coxswain Park, situated along Coxswain Crescent	Down-gradient and south of Belair Lifestyle Village, Belair Gardens Caravan Park and small number of residential properties. Up-gradient from older residential properties.

6.2.2 Soil Investigation

During the drilling program soils were logged and representative soil samples were collected during the installation of the new GMWs. The soil sampling activities were undertaken with reference to section 7, Schedule B2 of the *NEPM*, and Australian Standard AS 4482.1-2005 *Guide to the Sampling and Investigation of Potentially Contaminated Soil* (Standards, Australia, 2005).

Soil Sampling Methodology

To enable soil sample collection during the drilling program the drilling contractor utilised an air core drilling method for GMW installation. The following was undertaken at the GMW locations:

- Soil samples were collected at 0.5 metre intervals;
- Field observations, including olfactory and visual inspection of the soil, soil lithology, samples, QA samples were recorded on field sheets.

All soil samples were visually inspected and all field observations and subsurface conditions were recorded on field lithological logs. Soil from the borehole was obtained from a collection point on the drill rig and placed on clean sheeting, and samples were subsequently collected from this material.

Soil samples were placed into laboratory prepared containers provided by the primary laboratory and filled to the top to eliminate headspace. Each sample was identified by means of a label showing sample location, depth, date and job number. All soil samples were also identified by the depth at which they have been collected (MW1_0.5). The samples were then transferred to a chilled esky for sample preservation prior to and during shipment to the testing laboratory.

Sample details were entered onto a chain of custody form that accompanied the samples to the laboratory. All samples were transported and handled following chain of custody procedures. A chain of custody form was used for every batch of samples submitted to the laboratory. Delivery of the samples to the laboratory complied with analytical extraction holding times.

All field work was undertaken in the presence of an environmental scientist trained in sampling of contaminated sites. The environmental scientist was present during the services location, supervised the sub-contractors, sampled and completed lithological logs of the soil profile. Field activities were conducted in accordance with accepted industry protocols for environmental sampling.

The study area conditions were photographed during soil sampling and incorporated into the report.

6.2.3 Groundwater Investigation

Groundwater wells were sampled with reference to section 8, Schedule B2 of the *NEPM* and Australian Standard AS5667-11-1998 *Guidance on sampling of groundwaters* (Standards Australia, 1998).

Groundwater well locations were determined based on anticipated hydrogeological characteristics (from the desktop review) including reported depths to groundwater and apparent groundwater flow direction. The locations were confirmed following consultation with the CGG.

Three GMWs were installed in the study area on 16 August 2016 The locations of these GMWs were selected to complement the existing GMW SHP8 located in Coxswain Park (refer to Table 3 for rationale of GMW locations).

Groundwater Monitoring Well Installation

Monitoring wells were drilled to a minimum depth of three metres below the groundwater table and were installed with the following general characteristics:

- 50 mm polyvinyl chloride (PVC) class 18 blank and screened casings;
- Screened casing comprised of machine slotted apertures of approximately 0.5 mm;
- Screened casing extended the full length of the GMWs as the groundwater levels are influenced by tides and may significantly fluctuate. A screen sock extended the full length of the screen casing, to prevent the infiltration of gravel into the GMW;
- Blank and screened PVC casing was attached to each other using flush mounted factory-threaded joints;
- Primary filter pack material used was chemically inert, well rounded material with a high coefficient of uniformity and extend from the base of the borehole annulus to the ground surface;
- Bentonite/cement grout was placed at the ground surface to minimise surface water ingress; and
- Monitoring wells were equipped with flush mounted head-works to protect the wells.

The GMWs logs are provided in Appendix C.

Groundwater Monitoring Well Development

The groundwater monitoring wells were developed immediately following installation with air lifting techniques by the drilling contractor. Monitoring wells were developed until:

- No further noticeable sand or silt is recovered.
- The water was relatively clear when pumped from the well.
- A minimum of four well volumes removed.

Monitoring well development optimises the well efficiency, specific capacity, stabilisation of aquifer material and control of suspended solids.

The newly installed groundwater monitoring wells were allowed to stabilise for a minimum of seven days prior to purging and sampling. The groundwater field sheets are provided in Appendix D.

Groundwater Loggers

Groundwater loggers were deployed from the 16 August 2016 until 30 September 2016 to gauge the depth to groundwater and how this depth varies over time. The loggers were deployed in three GMWs across the network, i.e. MW1, MW2 and MW3. The findings are provided in Section 6.3.5.

Groundwater Sampling Program

The 2016 groundwater sampling program comprised three monitoring rounds across the current groundwater monitoring network within Point Moore.

- GMWs were gauged to determine the standing water level.
- Following gauging, GMWs were purged and samples collected with a low flow pump (less than 1 L/minute) (with reference to the methodology outlined in USEPA 540/5-95/504).

The wells were purged and sampled with low-density poly-ethylene tubing coupled to a Sample-Pro Micro purge (‘low flow’) pump system. The low flow pump provided an appropriate method for collection of representative samples for the required analytes and is recognised as best practice for groundwater sampling.

Field parameters measured during purging included temperature, pH, conductivity, dissolved oxygen and redox potential. Field parameters were recorded on field data sheets. Wells were purged until field parameters stabilised.

The variance associated with the above mentioned parameters required to establish chemical stabilisation are as follows:

- pH: 0.1 unit
- Temperature: 0.2^{o}C
- Eh (ORP): 10%
- DO: 10%
- SC: 10%

Samples at each bore were collected with new disposable gloves and placed directly into laboratory provided sample bottles. Each sample was identified by a label with the sample location, date, job number and depth. The samples were placed on ice in an insulated container, and kept cold during storage and transportation to the laboratory.

Decontamination Procedure

To ensure samples were collected without the potential presence of cross contamination, all reusable sampling equipment was decontaminated in accordance with the procedure and methods described in AS 4482.1 - 2005. In addition, all samples were handled by field staff with disposable nitrile gloves, which were replaced between each GMW.

Groundwater sampling equipment was decontaminated as follows:

- Washed and scrubbed in tap water;
- Washed and scrubbed in laboratory grade detergent (Decon90); and
- Rinsed in distilled or deionised (Grade 3) water.

Survey

Following installation, the monitoring wells were accurately surveyed to AHD and Geocentric Datum of Australia (GDA94), Map Grid Australia (MGA), Zone 50. As the reduced levels of the GMWs (top of casing levels) were accurately determined, measuring the depth to groundwater in the wells enabled groundwater flow directions beneath the study area to be determined.

6.2.4 Groundwater Laboratory Analysis Program

During each groundwater monitoring event (GME) four primary groundwater samples were submitted for analysis to National Association of Testing Authorities (NATA) accredited laboratories including the Australian Laboratory Services (ALS), SGS Australia (SGS) and mpl Laboratories (mpl). Analyses were selected to ascertain data pertaining the current status of groundwater contamination at Point Moore.

The four primary groundwater samples collected during each GME were submitted for laboratory determination of the following parameters:

- Microbiological quality: Total coliforms, *E. coli*, faecal coliforms and total plate count;
- Nutrients levels: Total phosphorus, ammonia-N, nitrate+nitrite-N, TKN and total nitrogen; and
- Other: Biological oxygen demand and total dissolved solids.

6.3 Results

6.3.1 Soil Investigation

Field Observations

Based on the information gathered during the establishment of the GMWs, the underlying geology is calcareous medium to coarse grained sand. A summary of the geology encountered at MW1 is provided in Table 4, which is typical of the three new monitoring wells. The field logs for all new GMW are provided in Appendix C and the relevant photographs from the works are provided in Appendix I.

Table 4 Summary of Geology Encountered at MW1

Depth (m bgl)	Lithological Description
0 – 2.0	Fine sand, brown with minor loam
2.0 – 6.0	Calcareous coarse sand, grey to white, minor quartz

During the field logging of soil samples (i.e. visually inspection and sampling), there were no olfactory signs (i.e. odours or staining) of contamination that warranted further investigation, so no laboratory analyses of soil samples were undertaken.

6.3.2 Groundwater Investigation: August 2016

The first round of groundwater monitoring at MW1, MW2, MW3 and SHP8 occurred on 24 August 2016.

Field Observations

GMW locations are illustrated in Figure 11, and groundwater monitoring field forms are provided in Appendix D.

To determine groundwater flow direction, groundwater elevations from the newly installed GMWs and the existing GMW SHP8 were calculated from depth to groundwater and survey data. Survey data, depth to groundwater and groundwater elevations are presented in Table 5. Groundwater contours derived from this data are depicted in Figure 11.

Table 5 Groundwater Well Survey Data

ID	Easting	Northing	TOC elevation (m AHD)	Depth to water (m bTOC)	Groundwater Elevation (m AHD)
MW1	263938	6814127	2.608	2.36	0.248
MW2	263709	6813860	2.151	1.78	0.371
MW3	263934	6813674	3.009	2.67	0.339
SHP8	263885	6813915	2.427	2.1	0.327

Groundwater Quality Field Parameters

During purging of the groundwater wells, groundwater quality field parameters were measured with a multi-parameter water quality meter (temperature, pH, specific conductivity (SC), salinity, dissolved oxygen (DO), and oxidation-reduction potential (ORP)). This equipment was calibrated by the equipment supplier (Thermofisher Scientific) prior to use on-site and did not require adjusting for redox measurements. A calibration certificate for the water quality meter is presented in Appendix H. Completed groundwater field sheets including a summary of groundwater quality field parameters can be found in Appendix D.

Groundwater samples were described as follows:

- MW1: Colourless, minor particulate, slight H_2S odour;
- MW2: Colourless, slight H_2S odour;
- MW3: Colourless, minor particulates, slight H_2S odour; and
- SHP8: Colourless, slight H_2S odour.

Field parameters indicate that groundwater beneath the study area is generally brackish to saline, and is alkaline. Groundwater is aerobic and with a reducing condition. No indicators of contamination were noted during the sampling with the exception of organic odour noted in the wells.

Groundwater Analytical Results

The groundwater analytical results are tabulated in Table G1, Appendix G and the Laboratory certificates of analysis are presented in Appendix F. Review of quality control and assurance data completed as part of this GME is provided in Appendix E. Exceedances of the adopted criteria during this monitoring round are discussed next.

Reported Exceedances

The following exceedances were reported during the August 2016 GME:

- Ammonia exceeded the adopted EIL (0.91 mg/L) at MW1 (2.68 mg/L);

- Total nitrogen and total phosphorus exceeds the ANZECC (2000) marine inshore default trigger values in all GMWs;
- Nitrate was reported above the ANZECC (2000) Marine Inshore trigger value in MW1 and MW2; and
- Faecal coliforms and *E. coli* results were reported to have exceeded the ANZECC (2000) guideline values for primary contact recreation (150 cfu/100mL) at MW1, MW2 and MW3.

Whilst not an exceedance as ANZECC (2000) does not include guideline values for total coliforms, coliform results (coliforms by membrane filtration) reported in MW1 (250,000 cfu/100 mL) were two orders of magnitude higher than results for up-gradient GMWs including MW2 (1000 cfu/100mL), MW3 (3000 cfu/100mL) and SHP8 (200 cfu/100mL).

6.3.3 Groundwater Investigation: September 2016

The second round of groundwater monitoring at MW1, MW2, MW3 and SHP8 occurred on 22 September 2016.

Field Observations

The depth to groundwater and groundwater elevations are shown in Table 6.

Table 6 Groundwater Well Survey Data

ID	Easting	Northing	TOC elevation (m AHD)	Depth to water (m bTOC)	Groundwater Elevation (m AHD)
MW1	263938	6814127	2.608	2.43	0.178
MW2	263709	6813860	2.151	1.83	0.321
MW3	263934	6813674	3.009	2.68	0.329
SHP8	263885	6813915	2.427	2.08	0.347

Groundwater Quality Field Parameters

During purging of the groundwater wells, groundwater quality field parameters were measured with a multi-parameter water quality meter. A calibration certificate for the water quality meter is presented in Appendix H. The completed groundwater field sheets are reproduced in Appendix D.

Groundwater samples were described as follows:

- MW1: Colourless, particulate, H_2S odour;
- MW2: Colourless, H_2S odour;
- MW3: Colourless, particulates, H_2S odour; and
- SHP8: Colourless, slight H_2S odour.

Field parameters indicate that groundwater beneath the study area is generally brackish to saline, and is acidic to slightly alkaline. The low dissolved oxygen concentrations are indicative of an anaerobic environment with reducing conditions. A hydrogen sulphide odour and high level of particulates was noted during the sampling at all GMW locations. The reported temperatures in the GMWs are likely due to a faulty temperature sensor.

Groundwater Analytical Results

The groundwater analytical results are tabulated in Table G1, Appendix G and the Laboratory certificates of analysis are presented in Appendix F. Review of quality control and assurance data completed as part of this GME is provided in Appendix E. Exceedances of the adopted criteria are discussed next.

Reported Exceedances

The following exceedances were reported during the 22 September 2016 GME:

- Ammonia exceeded the ANZECC (2000) Marine Water 95% (0.91 mg/L) at MW1 and SHP8 (6.28 mg/L and 2.54 mg/L, respectively);
- Total nitrogen and total phosphorus exceeds the ANZECC (2000) default marine inshore trigger values for these parameters in all GMWs;
- Nitrate was reported above the ANZECC (2000) Marine Inshore trigger value in MW1 and 2; and
- Whilst faecal coliforms and *E. coli* were reported above the LOR at two GMWs, i.e. MW2 (1 cfu/100 mL) and MW3 (1 cfu/100 mL), no exceedances occurred.

6.3.4 Groundwater Investigation: October 2016

Field Observations

The third round of groundwater monitoring at MW1, MW2, MW3 and SHP8 occurred on 18 October 2016. The depth to groundwater and groundwater elevations are presented in Table 7.

Table 7 Groundwater Well Survey Data

ID	Easting	Northing	TOC elevation (m AHD)	Depth to water (m bTOC)	Groundwater Elevation (m AHD)
MW1	263938	6814127	2.608	2.41	0.198
MW2	263709	6813860	2.151	1.90	0.251
MW3	263934	6813674	3.009	2.71	0.299
SHP8	263885	6813915	2.427	2.17	0.257

Groundwater Quality Field Parameters

During purging of the groundwater wells, groundwater quality field parameters were measured with a multi-parameter water quality meter. A calibration certificate for the water quality meter is presented in Appendix H. The completed groundwater field sheets are reproduced in Appendix D.

Groundwater samples were described as follows:

- MW1: Colourless, minor suspended solids, H_2S odour;
- MW2: Colourless, H_2S odour, minor suspended solids;
- MW3: Colourless, minor suspended solids, no odour; and
- SHP8: Colourless, slight H_2S odour, minor suspended solids.

Field parameters indicate that groundwater beneath the study area is generally brackish to saline, and is alkaline. Though groundwater had reasonable oxygen levels, it also had reducing conditions. There were no indicators of contamination during sampling with the exception of organic odours. The temperature in MW1 was 0.6 ^{o}C higher than other GMWs.

Groundwater Analytical Results

The groundwater analytical results are tabulated in Table G1, Appendix G and the laboratory certificates of analysis are provided in Appendix F. The quality control and assurance report for this GME is provided in Appendix E. Exceedances of the adopted criteria are discussed next.

Reported Exceedances

The following exceedances were reported during the October 2016 GME:

- Ammonia exceeded the ANZECC (2000) Marine Water 95% (0.91 mg/L) at MW1 and MW2 (3.95 mg/L and 1.48 mg/L, respectively);
- Total nitrogen and total phosphorus exceeds the ANZECC (2000) Marine Inshore trigger values for these parameters in all GMWs;
- Nitrate was reported above the ANZECC (2000) Marine Inshore trigger value in MW1 and 2; and
- Whilst not an exceedance, faecal coliforms and *E. coli* were reported above the LOR at all GMWs (all samples reported a count of 1 cfu/mL).

6.3.5 Groundwater Data Loggers

Data loggers were deployed at MW1, MW2 and MW3 for 38 days (16 August to 22 September). This groundwater level data is presented in Figure 10 with the following key findings :

- Water levels of the three MGWs co-varied throughout the 38 day deployment. Hence, groundwater flow directions are seemingly uni-directional as depicted below in Figure 11.
- Groundwater levels across the groundwater network are influenced by coastal tidal variations to varying degrees as follows:
  - MW2 seemingly undergoes daily tidal-induced level variations of 0.05 m during spring tides and 0.01-0.02 m during neap tides. This suggests that connectivity to the marine waters is relatively rapid with concomitant relatively short travel times from the GMW to the marine environment;
  - In contrast, MW3 has much more muted tidal-induced level variations of 0.01-0.02 m during spring tides and no level variations during neap tides. This suggests that connectivity to the marine waters is substantially slower than MW2 with concomitant relatively long travel times from this GMW to the marine environment; and
  - Over the short measurement record of MW1 (only 16-24 August due to subsequent instrument failure), this GWM responds to tidal variations more akin to MW3 in a muted manner.

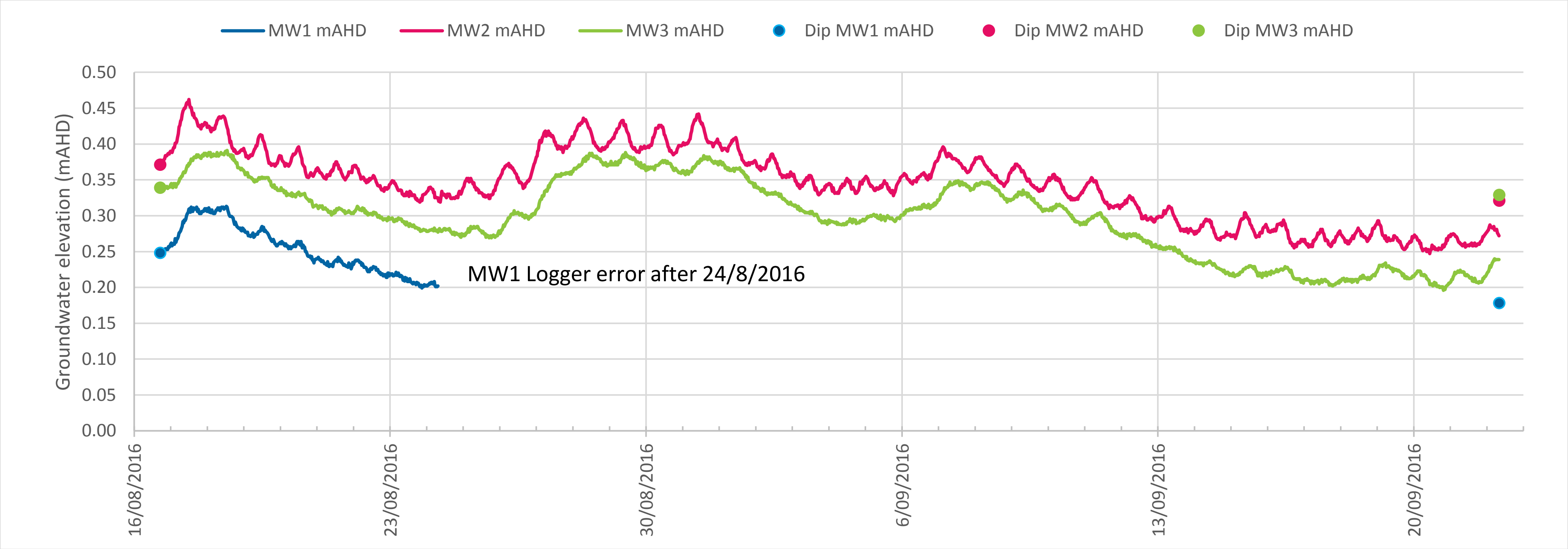


Figure 10 Groundwater Levels Logger Data for MW1, MW2 and MW3

Calculated Groundwater Flow

The groundwater contours depicted in Figure 11 indicate that groundwater beneath the study area flows towards the Indian Ocean, with groundwater in northern, western and southern portions of the study area flowing to the north, west and south, respectively. The lowest groundwater levels were reported in MW1.

Figure 11 Groundwater Contours, August 2016

6.4 Review of Laboratory Groundwater Quality Data

6.4.1 Summary of Data

A statistical summary of laboratory groundwater quality data obtained over the course of the monitoring program completed as part of this study is presented in Table 8. Trends apparent in the data are discussed in Section 6.4.2.

Table 8 Summary of Laboratory Groundwater Quality Data

		Water Quality Guidelines				Statistical Summary				
						Number of Results	Concentration			
Parameter	**Unit**	**ANZECC 2000 MW 95%**	**ANZECC 2000 Marine Inshore**	**ANZECC 2000 Primary Contact Recreation**	**ANZECC 2000 Secondary Contact Recreation**		**Minimum**	**Maximum**	**Mean**	**Median**
Ammonia as N	mg/L	**0.91**	-	-	-	12	0.13	**6.28**	**1.7**	0.675
BOD	mg/L	-	-	-	-	12	3	57	15	5.5
Coliform	cfu/100 mL	-	-	-	-	12	<1	250,000	21,185	5.5
Plate Count (36°C)	CFU/mL	-	-	-	-	12	17	68,000	13,140	4,950
Plate Count (22°C)	CFU/mL	-	-	-	-	12	12	70,000	13,483	3,300
Nitrate (as N)	mg/L	-	**0.05**	-	-	12	<0.01	**13.8**	**2.6**	0.04
Nitrite + Nitrate (as N)	mg/L	-	-	-	-	12	<0.01	14	2.7	0.04
Nitrite (as N)	mg/L	-	-	-	-	12	<0.01	1.85	0.2	0.005
Faecal Coliforms	CFU/100mL	-	-	150	1000	12	<1	400	92	1
E. Coli	cfu/100 mL	-	-	150	1000	12	<1	400	92	1
Total Dissolved Solids	mg/L	-	-			4	1,090	8,890	3,695	2,400
Total Dissolved Solids (Filtered)	mg/L	-	-	-	-	8	1,320	22,300	6,766	2,205
Total Kjeldahl Nitrogen (as N)	mg/L	-	-	-	-	12	0.6	6.7	2.5	2.3
Nitrogen (Total)	mg/L	-	**0.23**	-	-	12	**0.6**	**17.1**	**5.2**	**3.25**
Phosphorus (Total)	mg/L	-	**0.005**	-	-	12	**0.06**	**0.81**	**0.27**	**0.245**

Legend

ANZECC 2000 MW 95%	Indicates a level is equal to or above the ANZECC (2000) marine waters 95% species protection trigger value
ANZECC 2000 Marine Inshore	Indicates a level is equal to or above the ANZECC (2000) marine inshore trigger value
ANZECC 2000 Primary Contact Recreation	Indicates a level is equal to or above the ANZECC (2000) guideline value for primary contact recreation (e.g. swimming)
ANZECC 2000 Secondary Contact Recreation	Indicates a level is equal to or above the ANZECC (2000) guideline value for secondary contact recreation (e.g. boating, fishing)

6.4.2 Trends

GHD reviewed laboratory water quality data from the three surveys and the following trends were determined:

- Faecal coliforms and *E. coli* results were reported to have exceeded the ANZECC (2000) guideline valves for primary contact recreation (150 cfu/100mL) at MW1, MW2 and MW3 during the August GME. Follow up GMEs September and October reported faecal coliforms and *E. coli* results had declined (1 cfu/100 mL) across the groundwater network, with no exceedances recorded during these two rounds;
- Coliforms (coliform by membrane filter) were highest in the August survey (MW1 -250,000 CFU/mL, MW2 – 1000 CFU/mL, MW3 – 3000 CFU/mL and SHP8 – 200 CFU/mL), whereas the September survey had coliforms ranging from below the LOR (<1) to 10 CFU/mL (MW2, MW3); and the September GME reported that pH levels across the monitoring well network had largely declined from the August GME, however, in the October GME, pH levels inclined;
- In each monitoring round ammonia was reported above the adopted EIL in at least one GMW. Ammonia in MW1 increased from 2.68 mg/L in August to 6.28 mg/L in September, and subsequently declined in October. Ammonia in MW3 and SHP8 also exhibited a similar trend. A single exceedance of the adopted Ammonia EIL was reported at SHP8 during the September GME. Ammonia in MW2 declined between August and September then increased in October. There was a single exceedance of the adopted EIL in October at MW2;
- Nitrate was above the ANZECC (2000) default marine inshore trigger value at MW1 and MW2 for all three surveys. MW1 exhibited an increasing trend over the three surveys, while MW2 exhibited a decreasing trend; and
- Total nitrogen and total phosphorus were reported to have exceeded the ANZECC (2000) default marine inshore trigger values in the three GMEs and at all GMWs. Concentrations were relatively consistent in all GMEs.

With respect to the nutrient exceedances discussed above, Ammonia is the only nutrient species considered a toxicant in marine waters, and as a nutrient may stimulate algal growth and contribute toward eutrophication (Trefey et. Al, 2006). The other nutrients discussed above, whilst not directly toxic to marine life, may also act to stimulate plant growth and contribute towards eutrophication. Phosphorus will adsorb readily onto some mineral phases in soils, and is heavily retarded in some soil types such as the calcareous sands and limestones in the Point Moore area.

The cause of the significantly higher faecal coliform and *E. coli* levels recorded during the August 2016 GME is not clear. Whilst this GME was preceded by more rainfall than was the case for the other GMEs (5.6 mm was recorded at the Bureau of Meteorology's Geraldton Town weather station two days prior to the September GME, 1.6 mm was recorded three days prior to the September 2016 GME and no rainfall was recorded eight days prior to the October GME), it is unlikely that the increased levels would have been caused by the resultant higher rate of infiltration to groundwater. It is also considered unlikely that tidal variations caused this.

7. Discussion

7.1 Asset Condition

As many of the existing onsite systems were installed between 30 and 50 years ago, a significant number of the septic tanks and associated leach drains/soak wells are likely to have reached the end of their serviceable life. Information from the field investigation program verified this, with a number of the septic tanks observed to be in a “fair” condition, one septic tank system with covers that were on the verge of collapse, and several leach drains partially collapsed. During the field investigation there was not any evidence of saturated ground conditions above the leach drains.

An indicative estimate of the cost to construct new septic tanks and 2 x 6 m long leach drains sized for a two-bedroom dwelling, inclusive of the cost of the required plumbing modifications, is $10,000 per property.

7.2 Compliance with Current Standards

The properties in the study area are significantly smaller than the minimum lot size currently permitted for onsite wastewater disposal (typically 2,000 m^2). In addition, based on review of available information and the field investigation for this study:

- Many of the effluent disposal systems are undersized by current standards and are not configured as alternating systems;
- Many of the septic tanks and leach drains/soak wells do not comply with current horizontal setback requirements; and
- The inverts of the leach drains are estimated to be approximately 0.1 to 0.6 m above the water table, and the invert of the soak wells (assuming 1.5 m effective depth as above) is likely to be below water table (nil separation), hence current guidelines on the required vertical separation distance are not met. As natural purification processes are most effective in the aerobic unsaturated zone rather than in the soils below water table (Washington State Department of Health, 1990), the quality of effluent infiltrating to groundwater will be worse than would be the case if there was greater vertical separation between the leach drains/soak wells and groundwater. This situation will worsen as groundwater levels rise in the future (refer to discussion below).

7.3 Health Risks

7.3.1 Current Situation

Local groundwater is not used for irrigation or any other purpose, but does discharge to the nearby ocean. There is also a potential human health risk with regards to residents or others that could come into direct contact with groundwater when undertaking land-based activities. Conservative water quality assessment criteria based on default guideline values for primary contact recreation were used to assess the health risks posed by contact with groundwater. Elevated microorganism levels in sampled groundwater indicated wastewater-induced contamination above the adopted assessment criteria for one of the three monitoring rounds.

The current health risks posted by contact with groundwater are discussed below.

Risks Associated with Recreational Activities in Ocean

Based on studies done elsewhere at locations with similar hydrogeological conditions, e.g. detailed investigations completed at Halls Head (Mandurah) as reported in Toze et.al. (2010), groundwater quality will improve significantly over time as it flows (sub-surface) to the ocean. With respect to die-off of pathogenic microorganisms:

- The travel time for Point Moore groundwater to reach the inshore marine waters off the coast is uncertain. The groundwater level measurements and seemingly high connectivity to the ocean via tidal variations at GMW MW2 suggests that there are preferential flow paths to rapidly transport groundwater to the ocean for some portions of the study area, with travel times perhaps being in the order of days. In contrast, the muted tidal-induced variations at GMWs MW1 and MW3 suggest that transport times of groundwater to the ocean are likely to be substantially longer. As a conservative measure it has been assumed that the range of transport times from leach drains and soak wells across the Point Moore study area ranges from 2 days (e.g. MW2) to 20 days (e.g. perhaps from the centre of Point Moore). These travel times are likely to be more rapid than actually occurs, which is conservative as it reduces the time for die-off of bacteria and other pathogenic microorganisms (e.g. viruses and protozoa). For example, on the basis of other studies with similar hydrogeological settings, the minimum groundwater travel time from the Point Moore residential properties to the ocean would be estimated to be in the order of 40 days;
- The aquifer residence time for 1 log removal (90% reduction) of bacteria is approximately 2 days (Toze et al, 2010). In the case of bacteria, for every 2 days of aquifer residence time the level of bacteria would reduce by 90%;
- Hence, on the basis of the conservative superficial aquifer residence times adopted in this study (2 days to 20 days), the bacteria will be expected to undergo, from onsite effluent disposal systems to the point of groundwater discharge to the ocean, log reductions ranging between a 1 log (90% reduction in 2 days) and a 15 log ($1x10^{-13}$ % remaining) reduction. In short, for those septic systems that are located in preferential flow paths with relatively rapid transport times to the ocean, there is a risk of relatively direct pathways to deliver to the ocean groundwater with elevated pathogens that may pose a risk to human health.

Clearly, one ameliorating factor of the risk of high pathogen levels introduced into the marine environment via preferential groundwater pathways are the high levels of dilution that would typically occur where the groundwater discharges into the ocean. Hence, for the most part, it is considered unlikely that elevated levels of pathogens in groundwater flowing from the study area would pose a significant health risk in terms of primary contact recreation in the ocean near Point Moore. However, under conditions of calm winds and low wave climate, rates of dilution may be greatly reduced, thereby increasing the potential health risk. These conditions typically occur late in the bathing season from March-May.

Based on the above discussion it is not possible to discount the possibility that onsite disposal of effluent from the Point Moore residential properties is at least partly responsible for the observed seasonal spikes in *Enterococci* levels at the CGG's marine water quality monitoring sites near Point Moore (Section 2.4.2).

Other Risks

In addition to the health risk associated with recreational activities in the ocean near Point Moore, there is a risk that residents or others could come into direct contact with groundwater when completing excavation or trenching works, or undertaking dewatering operations, for:

- construction of foundations for new buildings or other structures,
- construction of installation of swimming pools;
- installation of new services, or maintenance of existing services; or

- landscaping/gardening projects.

The risk of such direct contact is a function of several factors, including the depth to groundwater. Whilst the depth to groundwater is currently approximately 1.5m or more across much of the study area, there are some areas (e.g. park north of Sailors Lane which includes land with a surface level below RL1.0m [Figure 1], some residential lots on the south side of Gunners Lane where the surface level is only marginally above RL1.0m [topographic data from CGG Inframaps]) where this depth may be in the order of 0.5m only. The risk of direct contact with groundwater is obviously greatest in such areas.

Whilst elevated faecal coliform and *E. coli* levels above adopted trigger values were only measured at the monitoring bores in one of the three monitoring rounds, it must be noted that testing for viruses and other pathogenic microorganisms (e.g. protozoa such as cryptosporidium and giardia) was not undertaken as part of this study, and that the rate of die-off of these other pathogens in groundwater is significantly slower than faecal coliforms, *E. coli* and other bacteria. In addition, the levels of pathogens in effluent infiltrating to groundwater is likely to be higher than is typically the case because of the limited (or non-existent in the case of soak wells) vertical separation distance between effluent disposal facilities and the water table (refer to Section 7.2). Given this, contact with groundwater in the study area is considered to present a health risk to residents and others in the study area. Whilst for works undertaken by CGG and service utilities it would be possible to mitigate these risks to an acceptable level through use of appropriate personal protective equipment and control measures, it would not be realistic to rely upon such measures to safeguard the health of local residents and others engaging in activities where they come into contact with groundwater.

7.3.2 Long term Future

In the long term, local groundwater levels will rise as sea levels rise. If sea levels rise by 0.9 m in 2110 as predicted, the groundwater levels at that time could be within approximately 0.6 m of the natural surface level at many properties. In some areas groundwater levels could rise above the natural surface level, in which case some areas could become permanently inundated with water containing elevated levels of pathogenic microorganisms.

As groundwater levels rise in the future the likelihood that residents or others could come into direct contact with groundwater will increase, which will in turn increase the public health risks posed by the onsite wastewater systems.

7.4 Environmental Risks

Conservative water quality assessment criteria based on inshore marine default trigger values for nutrients were adopted for the groundwater sampled from the GMWs (three rounds of sampling over two months). Nutrient levels in sampled groundwater indicated elevated wastewater-induced contamination above the adopted assessment criteria for all monitoring rounds.

As discussed in Section 7.3.1, high levels of dilution typically occur where groundwater discharges into the ocean. Given this dilution it is considered unlikely that elevated levels of nutrients in groundwater flowing from the study area are having any measurable impact on near shore marine ecosystems.

7.5 Long Term Wastewater Management

In the long term local groundwater levels will rise as sea levels rise, and the magnitude of the rise will severely constrain the potential to dispose of effluent generated in the study area using conventional onsite septic tank and leach drain/soak well systems. That is:

- If sea levels rise by 0.9 m in 2110 as predicted, the groundwater levels at that time could be within approximately 0.6 m of the natural surface level at many properties.
- If house and ground levels remain as-is, this groundwater level will be too high to enable the onsite disposal systems to function effectively, with potential for odour problems or saturated ground conditions in the vicinity of the onsite disposal systems, and an increased risk of residents or others coming into contact with effluent or contaminated groundwater.

Whilst alternative onsite systems may be able to be used in the long term, the small size of the lots would severely constrain the options are available for effluent disposal (e.g. aerobic treatment units with dedicated irrigation disposal areas could not be installed as insufficient area is available for the irrigation areas). Rather, if residential properties are to remain at Point Moore for the long term it is considered that a reticulated wastewater collection system would need to be installed that discharges wastewater to the Water Corporation’s Geraldton wastewater scheme.

Design and construction of a reticulated wastewater collection system to serve properties in the study area would be constrained by the small size of the lots and limited room available to construct sewers along property rear and side boundaries, the relatively flat topography of the area and the shallow depth to groundwater.

An indicative estimate of the cost to design and construct a conventional reticulated gravity sewer type wastewater collection system to serve all properties in the study area, inclusive of the cost of the house connections, as well as pump stations and pressure mains to discharge this wastewater to the Geraldton wastewater system, is $6M to $10M. This estimate, which assumes that the collection and conveyance infrastructure is constructed to Water Corporation design standards, equates to a cost of approximately $35,000 to $55,000 per property. Additional costs may also apply if the Water Corporation’s sewerage scheme needs to be upgraded to cope with the flows from Point Moore.

It would also be possible to serve the properties with a vacuum sewerage system, similar to that operated by the Geraldton Port Authority, or a pressure sewer type collection system. For both alternatives the required depth of the collection pipework would be significantly less than would be the case for a conventional gravity sewer type collection network, which is one of their main advantages. In the case of a vacuum sewerage scheme, wastewater from several properties would gravitate to local pits equipped with proprietary vacuum valves, and from these pits would be conveyed to a single vacuum pump station via vacuum sewers. Conventional wastewater pumps and a pressure main would then deliver the wastewater to the Water Corporation’s wastewater scheme. In the case of a pressure sewer system, wastewater from each property would gravitate to small proprietary pump stations equipped with high-head pumps (one pump station per property), and these pumps stations would pump wastewater into a small-diameter interconnected pressure main network that conveys the wastewater direct to the Water Corporation’s wastewater scheme, or more likely via a conventional wastewater pump station and pressure main. Whilst the capital cost of installing a vacuum sewerage system or pressure sewer type collection system to serve Point Moore residents may be significantly lower than the cost to install a conventional gravity sewer type collection system, ongoing operations and maintenance costs would be significantly higher for these alternative systems.

8. Conclusions

The overall objective of the study is to provide CGG and Point Moore stakeholders with data and documentation on the performance and compliance of the existing onsite wastewater treatment and disposal systems that assists CGG in the decision-making process relating to the future beyond the current lease expiry dates of 2025 and 2028 and potential obligations it has in relation to Point Moore lessees. Based on work completed in undertaking this study the following conclusions are made:

1. Observations made during the field investigation indicate that a significant number of the existing septic tanks and leach drains/soak wells are in a poor condition and require remedial works and in some cases replacement.
2. The properties in the study area are significantly smaller than the minimum lot size currently permitted for onsite wastewater disposal (typically 2,000 m^2), and many of the onsite systems do not comply with current standards in a number of respects (sizing, configuration, horizontal setbacks, vertical separation distance to groundwater). For many properties it would not be possible to upgrade the existing onsite systems to meet current standards, or install alternative onsite systems that comply with current standards.
3. Though local groundwater is not used for irrigation or any other purpose, it does discharge to the nearby ocean, and residents or others could come into contact with groundwater when undertaking a range of land based sub-surface activities. In relation to public health risks:
   - The potential for contact with groundwater when undertaking land based sub-surface activities such as excavation or trenching works is considered to represent a significant public health risk to residents and others undertaking such activities in the study area. This risk will increase over time as groundwater levels increase as a direct consequence of sea level rise.
   - Whilst data from the monitoring program indicates that for some portions of the study area groundwater travel times to the ocean may be short due to preferential groundwater pathways, it is considered unlikely that elevated levels of pathogens in groundwater flowing from the study area would pose a significant health risk to persons engaging in primary contact recreation in the ocean near Point Moore given natural purification processes in the aquifer and the high levels of dilution that would typically occur where the groundwater discharges into the ocean. However, under conditions of calm winds and low wave climate, rates of dilution may be greatly reduced, thereby increasing the potential health risk. These conditions typically occur late in the bathing season from March-May.
   - It is not possible to discount the possibility that onsite disposal of effluent from the Point Moore residential properties is at least partly responsible for the observed seasonal spikes in *Enterococci* levels at the CGG's marine water quality monitoring sites near Point Moore.
4. In the long term local groundwater levels will rise as sea levels rise, and the magnitude of the rise will severely constrain the potential to dispose of wastewater generated in the study area with the existing conventional onsite septic tank and leach drain/soak well systems approach.
5. If residential properties are to remain at Point Moore for the long term it is considered that a reticulated wastewater collection system would need to be installed that discharges wastewater to the Water Corporation's Geraldton wastewater scheme. An indicative estimate of the cost to design and construct a conventional gravity sewer type wastewater

collection system to serve all properties in the study area, inclusive of the cost of the house connections, as well as the pump stations and pressure mains to discharge this wastewater to the Geraldton wastewater system, is $6M to $10M. This equates to a cost of approximately $35,000 to $55,000 per property, which is likely to be prohibitively expensive. Whilst alternative wastewater collection technologies exist that may be able to be implemented at a significantly lower capital cost, ongoing costs for these systems would be higher than the ongoing costs associated with a conventional gravity sewer type collection system.

6. Whilst nutrient levels in sampled groundwater indicated elevated wastewater-induced contamination above the adopted assessment criteria for all monitoring rounds, given the high levels of dilution typically occur where groundwater discharges into the ocean it is considered unlikely that elevated levels of nutrients in groundwater flowing from the study area are having any measurable impact on near shore marine ecosystems.

9. References

ANZECC (2000). *National Water Quality Management Guidelines*, Australian and New Zealand Environment and Conservation Council.

BoM (2016) *Atlas of Groundwater Dependent Ecosystems*. Retrieved from: http://www.bom.gov.au/water/groundwater/gde/map.shtml

CGG (2016a) Point Moore Residential Onsite Effluent Treatment and Disposal (ROETD) Study Design Brief.

CGG (2016b) Recreational Beach Sampling. Map Scale: 1:70,000.

Department of Environment and Conservation (2006) Contaminated Sites Act 2003 and associated Contaminated Sites Regulations 2006, Department of Environment and Conservation, Perth, December 2006.

Department of Environment Regulation (2014) *Assessment and management of contaminated sites*, Contaminated Sites Management Series.

DoH (2003) Draft Country Sewerage Policy, DRAFT from 22 September 2002 SOCWM Meeting, Amended September 2003, http://www.public.health.wa.gov.au/cproot/2662/2/Draft%20Country%20Sewerage%20Policy.pdf

DoH (2011) *Understanding Septic Tank Systems*, Department of Health, May 2011. Retrieved from: http://www.esperance.wa.gov.au/sites/default/files/publication/files/understanding_septic_tank_systems.pdf

DoH (2016) Letter to: Bob Davis (Acting Chief Executive Officer, City of Greater Geraldton). 15 February 2016. Point Moore Coastal Inundation Study (Ref: D-16-01701 EM/10/0002)

DoL (2016) Letter to: Michael Dufour (Addressed to the Chief Executive Officer, City of Greater Geraldton). 4 January 2016. RE: Point Moore Coastal Inundation Study. (Ref::3275-1959).

DoP (2016a) RE: ACTION: Point Moore Inundation Study – Department of Planning Position Statement. [email]

DoP (2016b) Letter to Michael Dufour, 7 January 2016. Point Moore Coastal Inundation Study. (Ref: TPS/1287)

Department of Water (2016a) *Department of Water Perth Groundwater Atlas*. Retreived from: http://www.water.wa.gov.au/idelve/hydroatlas/

Department of Water (2016b) Water Information Reporting. Retrieved from: http://wir.water.wa.gov.au/

National Environment Protection Council (NEPC) National Environment Protection (Assessment of Site Contamination) Amendment Measure (NEPM) 2013 No. 1 (NEPC 1999).

NHMRC (2004) *Australian Drinking Water Guidelines,* National Health and Medical Research Council.

NHMRC (2008) *Guidelines for Managing Risk in Recreational Waters*, National Health and Medical Research Council.

M P Rogers (2015) *Point Moore Inundation & Coastal Processes Study.* Prepared for the City of Greater Geraldton.

Standards Australia (1998) AS5667-11-1998 *Guidance on sampling of groundwaters*, Standards Australia, NSW.

Standards Australia / Standards New Zealand. (1998a). AS 5667.1 - 1998 Water Quality Sampling – Part 1: Guidance on the design of sampling programs. Standards Australia, NSW.

Standards Australia / Standards New Zealand. (1998b). AS 5667.11 - 1998 Water Quality Sampling - Part 11: Guidance on sampling of groundwaters. Standards Australia, NSW.

Standards Australia / Standards New Zealand. (2012). AS/NZS 1547 - 2012 *Onsite wastewater management*. Standards Australia, NSW.

Toze S, Bekele E, Page D, Sidhu J and Shackleton M (2010). *Use of static Quantitative Microbial Risk Assessment to determine pathogen risks in an unconfined carbonate aquifer used for Managed Aquifer Recharge*. Water Research, vol. 44, no. 4, pp. 1038 – 1049.

Trefey, M.G., Davis, G.B, Johnston, C.D., Gardiner, A.G., Pollock, D.W. and Smith, A.J. (2006) *Status of Groundwater Quality in the Cockburn Sound Catchment, Final Report to Cockburn Sound Management Council*, CSIRO.

US Environment Protection Agency (US EPA). (1989). *Risk Assessment Guidance for Superfund*, Volume 1 Human Health Evaluation Manual, Part A. EPA/540/1-89/002.

US Environmental Protection Agency (1996) *Low-flow (Minimal Drawdown) Ground-Water Sampling Procedures* (EPA/540/S-95/504), US Environmental Protection Agency, Washington.

Washington State Department of Health (1990). *Vertical Separation, A Review of Available Scientific Literature from Fifteen Other States*, Office of Health and Safety.

Appendices

Appendix A – Nearshore Sampling Tabulated Exceedances

Table A1 Nearshore *Enterococci* Levels, Exceedance of ANZECC (2000) Recreational Water Quality Guidelines

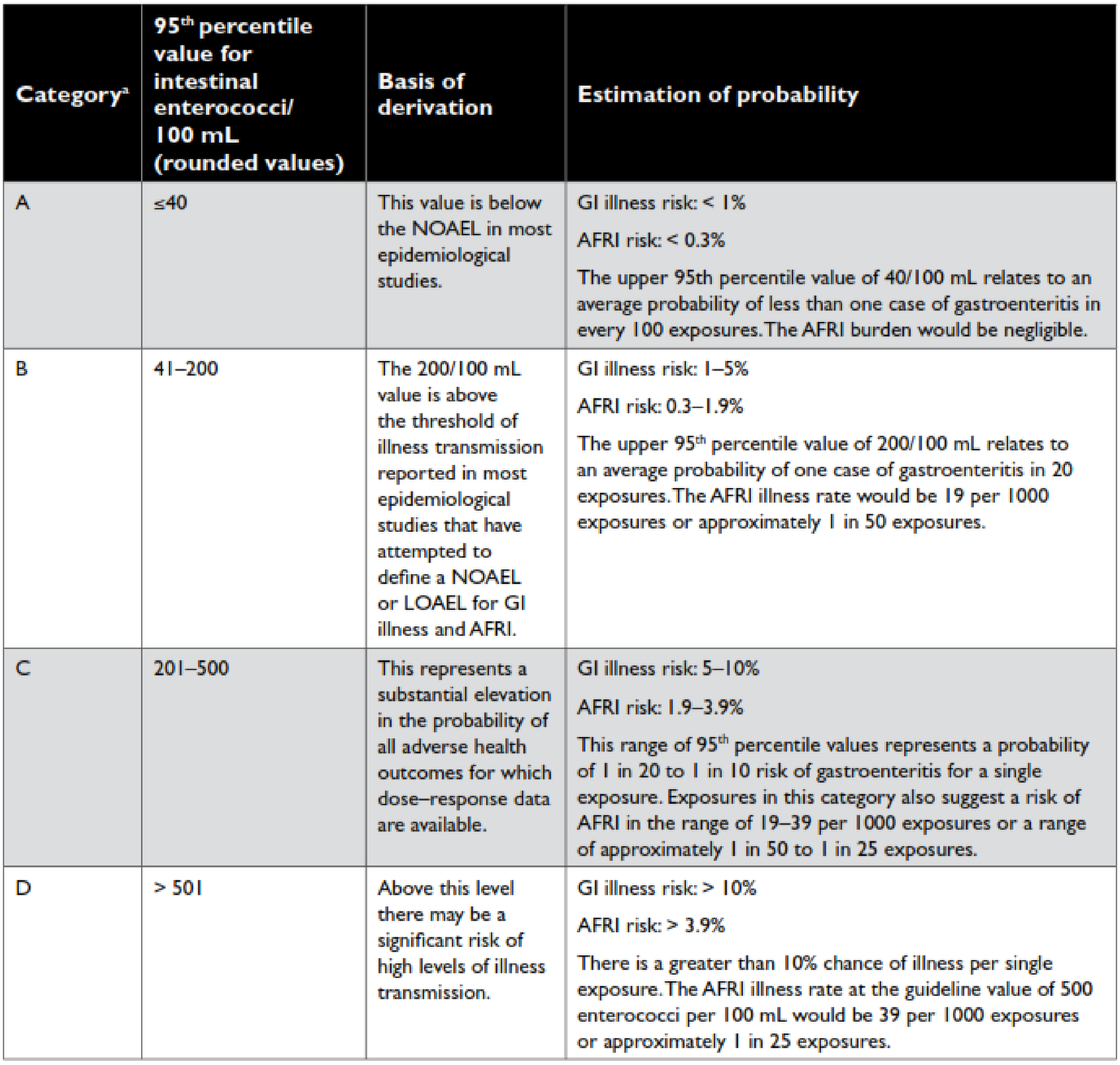
Location (Date)	Enterococci (MPN/100mL)	Exceed - ANZECC (2000) Recreational Primary Contact – Lower Limit – 35 cfu/100 mL	Exceed – ANZECC (2000) Recreational Secondary Contact – Upper Limit – 100 cfu/100mL	Exceed –ANZECC (2000) Secondary Contact Lower Limit – 230 cfu/100mL	Exceed – ANZECC (2000) Secondary Contact – Upper Limit – 730 cfu/100mL
Point Moore (9/4/2013)	41	Yes	No	No	No
Pages Beach (9/4/2013)	73	Yes	No	No	No
Point Moore (8/1/2014)	54	Yes	No	No	No
Point Moore (15/1/2015)	84	Yes	No	No	No
Pages Beach (15/04/2015)	170	Yes	Yes	No	No
Pages Beach (12/03/2015)	230	Yes	Yes	Yes	No
Pages Beach (3/02/2016)	910	Yes	Yes	Yes	Yes
Pages Beach (19/04/2016)	97	Yes	No	No	No

Table A2 **Nearshore *Enterococci* Levels, Exceedance of Criteria that Define NHMRC (2008) Recreational Water Quality Categories**

Location (Date)	Enterococci (MPN/100mL)	Exceed – NHMRC Category A – 40 cfu/100 mL	Exceed – NHMRC (2008) Category B lower limit – 41 cfu/100mL	Exceed –NHMRC (2008) Category B – Upper Limit – 200 cfu/100 mL	Exceed – NHMRC (2008) – Category C – 201 cfu/100 mL	Exceed – NHMRC – Category D - >500 cfu/100mL
Point Moore (9/4/2013)	41	Yes	Yes	No	No	No
Pages Beach (9/4/2013)	73	Yes	Yes	No	No	No
Point Moore (8/1/2014)	54	Yes	Yes	No	No	No
Point Moore (15/1/2015)	84	Yes	Yes	No	No	No
Pages Beach (15/04/2015)	170	Yes	Yes	No	No	No
Pages Beach (12/03/2015)	230	Yes	Yes	Yes	No	No
Pages Beach (3/02/2016)	910	Yes	Yes	Yes	Yes	Yes
Pages Beach (19/04/2016)	97	Yes	Yes	No	No	No

Basis of the derivation of the limits for each category provided in Table A2 are provided in Table A3.

Table A3 Basis of derivation of percentile values for determining microbial water quality categories (NHMRC, 2008)



Category[a]	**95th percentile value for intestinal enterococci/ 100 mL (rounded values)**	**Basis of derivation**	**Estimation of probability**
A	≤40	This value is below the NOAEL in most epidemiological studies.	GI illness risk: < 1% AFRI risk: < 0.3% The upper 95th percentile value of 40/100 mL relates to an average probability of less than one case of gastroenteritis in every 100 exposures. The AFRI burden would be negligible.
B	41–200	The 200/100 mL value is above the threshold of illness transmission reported in most epidemiological studies that have attempted to define a NOAEL or LOAEL for GI illness and AFRI.	GI illness risk: 1–5% AFRI risk: 0.3–1.9% The upper 95th percentile value of 200/100 mL relates to an average probability of one case of gastroenteritis in 20 exposures. The AFRI illness rate would be 19 per 1000 exposures or approximately 1 in 50 exposures.
C	201–500	This represents a substantial elevation in the probability of all adverse health outcomes for which dose–response data are available.	GI illness risk: 5–10% AFRI risk: 1.9–3.9% This range of 95th percentile values represents a probability of 1 in 20 to 1 in 10 risk of gastroenteritis for a single exposure. Exposures in this category also suggest a risk of AFRI in the range of 19–39 per 1000 exposures or a range of approximately 1 in 50 to 1 in 25 exposures.
D	> 501	Above this level there may be a significant risk of high levels of illness transmission.	GI illness risk: > 10% AFRI risk: > 3.9% There is a greater than 10% chance of illness per single exposure. The AFRI illness rate at the guideline value of 500 enterococci per 100 mL would be 39 per 1000 exposures or approximately 1 in 25 exposures.

Appendix B – Point Moore Inundation and Coastal Processes Study Summary Report

Point Moore Inundation & Coastal Processes Study

In Western Australia, coastal development is guided by State Planning Policy 2.6: The State Coastal Planning Policy (SPP2.6). This policy outlines the general requirements for new development on the coastline in terms of avoiding or managing risks caused by coastal inundation (flooding) or coastal erosion.

SPP2.6 outlines that new development should be safe from coastal inundation caused by an extreme inundation event that has a 0.2% chance of occurring each year. In other words, this event would occur once every 500 years on average. Another way to say this is that the event would have an Average Recurrence Interval (abbreviated to ARI) of 500 years.

For coastal erosion, SPP2.6 states that new development should be safe from an erosion event that has a 1% chance of occurring each year (or would occur once every 100 years on average – i.e. the 100 year ARI event).

In addition to these storm events, the potential impacts of sea level rise and ongoing changes to the shoreline need to be considered when determining appropriate areas for new development.

While the SPP2.6 guidelines relate mainly to the requirements for new development, where existing development does not meet the guidelines there is a general requirement to take action in order to reduce any risks to acceptable levels.

In 2015 a study was completed in order to understand which areas of Point Moore could be impacted by coastal inundation and erosion. This study was completed in accordance with the requirements of SPP2.6. The study involved detailed modelling and assessment of the following items:

- Detailed cyclone storm surge modelling to determine the potential inundation caused by severe cyclones.
- Analysis of available water level records to determine the potential inundation caused by non-cyclonic events.
- Modelling the potential beach and dune erosion caused by severe events.
- Assessment of historical and potential future shoreline movement caused by the action of natural coastal processes.
- Assessment of the effects of potential sea level rise (assuming 0.9 metres of sea level rise by year 2110 as required by SPP2.6) on the coastal inundation and erosion.

The results of this study are summarised on the attached plans. Further details and description of these plans are provided overleaf.

The attached plans show the areas that could be impacted by coastal erosion or inundation for the Present Day, as well as the years 2030, 2070 and 2110. A description of what these plans mean, and how to read them, is provided below.

Coastal Processes Allowance Plan

The Coastal Processes Allowance Plan shows 4 different coloured lines. Each of these lines represents the extent of possible impact of coastal erosion over each planning horizon. The locations of these lines have been determined in accordance with the requirements of SPP2.6. As an example, anything on the ocean side of the **red** line could be vulnerable to coastal erosion by the year 2110.

Coastal Inundation Mapping Plans

The Inundation Mapping Plans show areas that could be inundated by different events for each of the timeframes outlined above. Each of the different plots represents a different timeframe. The different colours represent the potential areas of inundation associated with different event severities. On each of the plots, the area that is shaded **purple** represents the area that would be inundated during the 20 year ARI event; the area that is shaded **blue** represents the additional area that would be inundated during the 100 year ARI event; and the area that is shaded **green** represents the additional area that could be inundated by the 500 year ARI event.

The difference between the plots (as each plot represents a different time), is caused by the potential impact of sea level rise.

Coastal Inundation Depth Plans

The Inundation Depth Plans have been prepared to show the potential depth of inundation caused by the 20, 100 and 500 year ARI events at the year 2030, as well as the 500 year ARI event in 2110. The different colours on these plans show the different inundation depths, as indicated on the legend. For example, anything that is shaded **pink** on the plan would have an inundation depth of between 2.0 and 2.5 metres.

Combined Coastal Vulnerability Mapping Plans

The Combined Coastal Vulnerability Mapping Plans identify the areas that would be impacted by the 500 year ARI inundation event and/or the Coastal Processes Allowance for each timeframe. For example, on the plan depicting the year 2030, the shading depicts the area that would be subject to inundation during the 500 year ARI event as well as the area that would be potentially vulnerable to coastal erosion by 2030 (as shown on the Coastal Processes Allowance Plan).

The significance of these combined plans is that the shaded areas represent the areas that would not be developable under SPP2.6 for each of the different timeframes.

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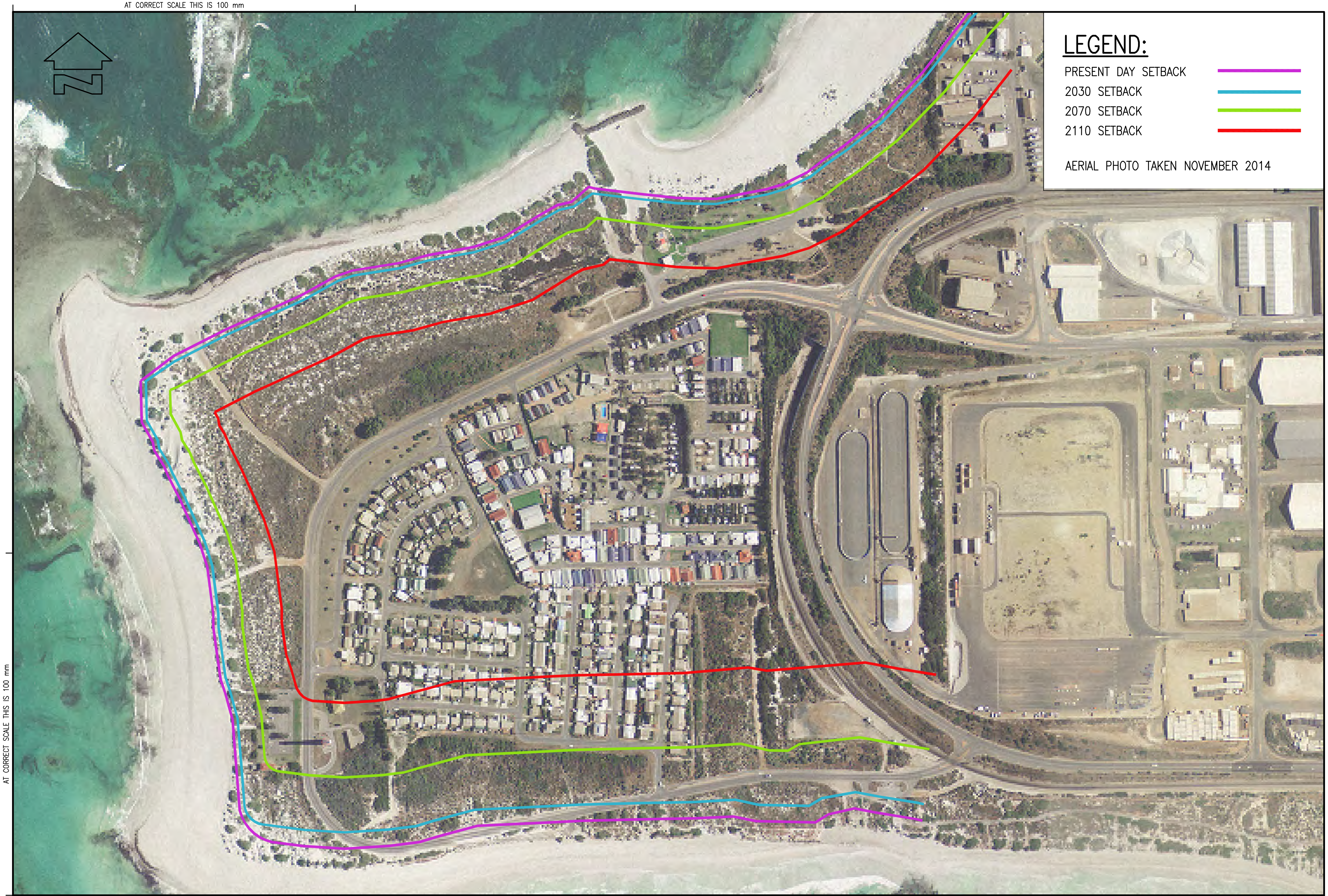

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m p rogers & associates pl
coastal and port engineers

Suite 1, 128 Main Street
Osborne Park 6017
Western Australia

t: +61 8 9254 6600
f: +61 8 9254 6699
admin@coastsandports.com.au

POINT MOORE COASTAL EROSION AND INUNDATION STUDY

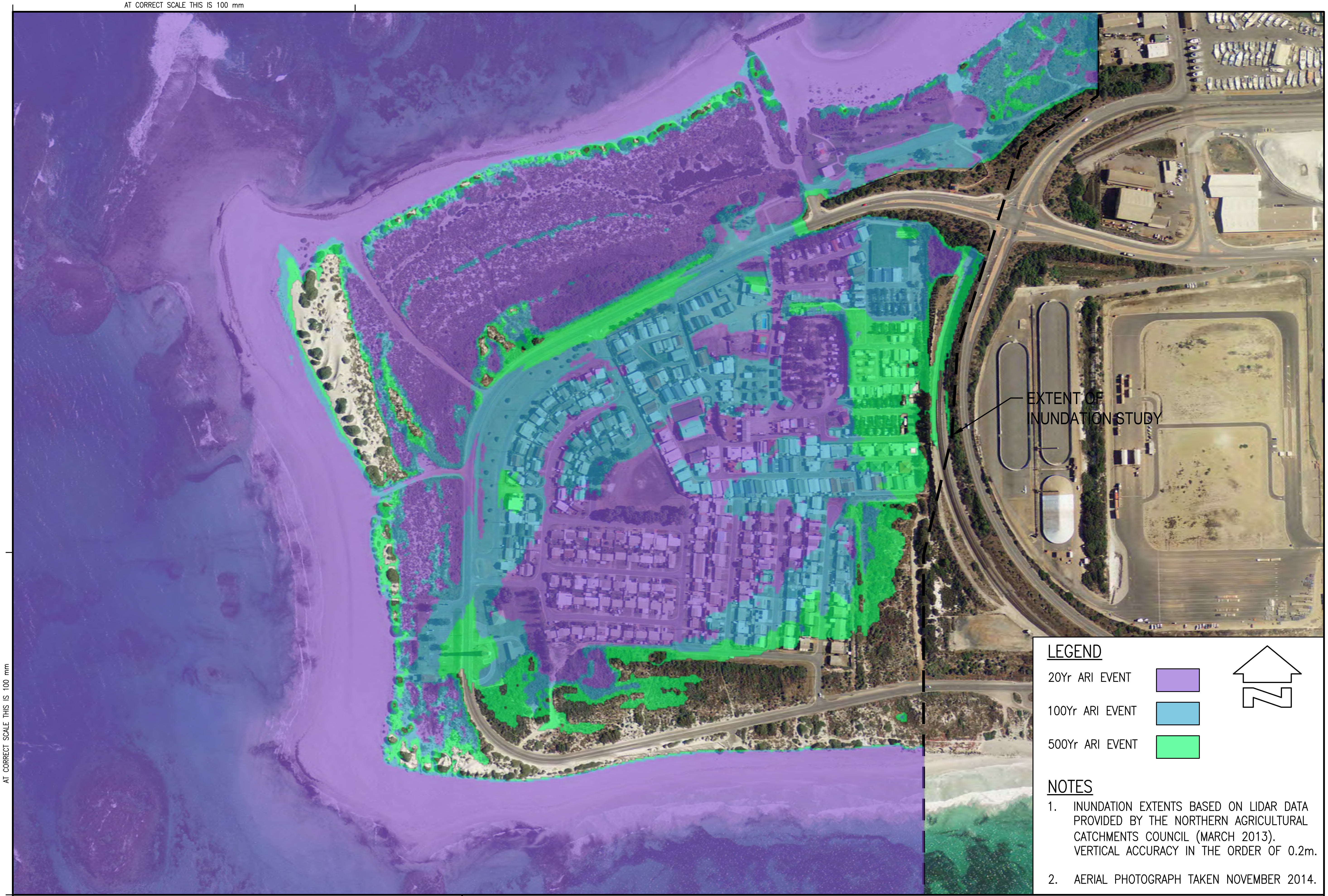
COASTAL PROCESSES ALLOWANCES

SCALE AT A3 1:4,000

DECEMBER 2015

D1242–01–02(D)

AT CORRECT SCALE THIS IS 100 mm



LEGEND

20Yr ARI EVENT	🟪
100Yr ARI EVENT	🟦
500Yr ARI EVENT	🟩

NOTES

1. INUNDATION EXTENTS BASED ON LIDAR DATA PROVIDED BY THE NORTHERN AGRICULTURAL CATCHMENTS COUNCIL (MARCH 2013). VERTICAL ACCURACY IN THE ORDER OF 0.2m.
2. AERIAL PHOTOGRAPH TAKEN NOVEMBER 2014.

AT CORRECT SCALE THIS IS 100 mm

m p rogers & associates pl
coastal and port engineers

Suite 1, 128 Main Street
Osborne Park 6017
Western Australia
t: +61 8 9254 6600
f: +61 8 9254 6699
admin@coastsandports.com.au

POINT MOORE COASTAL EROSION AND INUNDATION STUDY

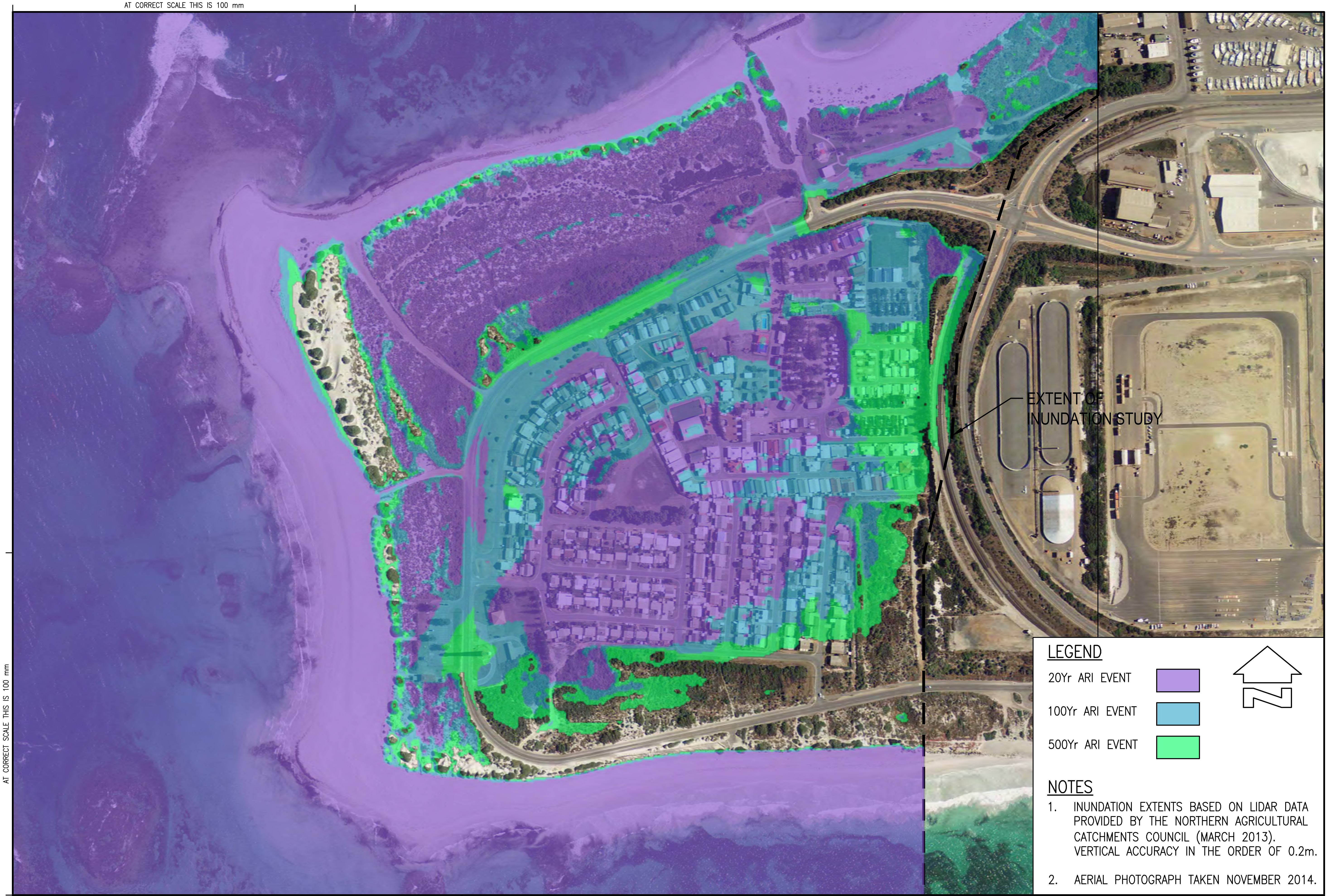
INUNDATION MAPPING – PRESENT DAY

SCALE AT A3 1:4,000

JULY 2015

D1242-02-01(B)

P:\MRA Paying Jobs\K1242 CGG – Point Moore Inundation Study\MRA DWGs\Innundation\Present Day\K1242-PresentDay



LEGEND

20Yr ARI EVENT	🟪
100Yr ARI EVENT	🟦
500Yr ARI EVENT	🟩

NOTES

1. INUNDATION EXTENTS BASED ON LIDAR DATA PROVIDED BY THE NORTHERN AGRICULTURAL CATCHMENTS COUNCIL (MARCH 2013). VERTICAL ACCURACY IN THE ORDER OF 0.2m.

2. AERIAL PHOTOGRAPH TAKEN NOVEMBER 2014.

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POINT MOORE COASTAL EROSION AND INUNDATION STUDY

INUNDATION MAPPING – 2030 (+0.07 SLR)

JULY 2015

SCALE AT A3 1:4,000

D1242-02-02(B)

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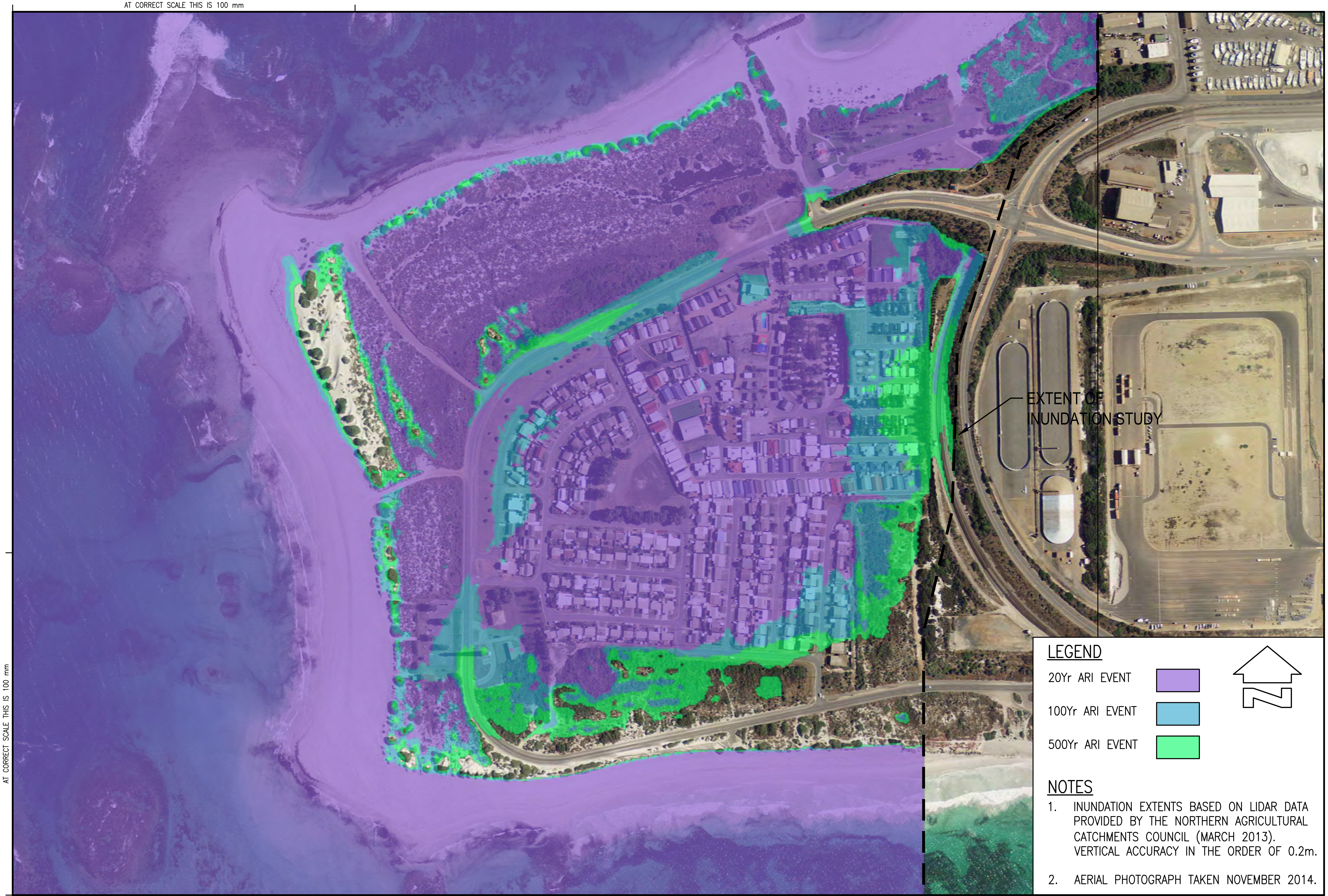
AT CORRECT SCALE THIS IS 100 mm



LEGEND

20Yr ARI EVENT 🟪

100Yr ARI EVENT 🟦

500Yr ARI EVENT 🟩

NOTES

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POINT MOORE COASTAL EROSION AND INUNDATION STUDY

INUNDATION MAPPING – 2070 (+0.39 SLR)

SCALE AT A3 1:4,000

JULY 2015

D1242-02-03(B)

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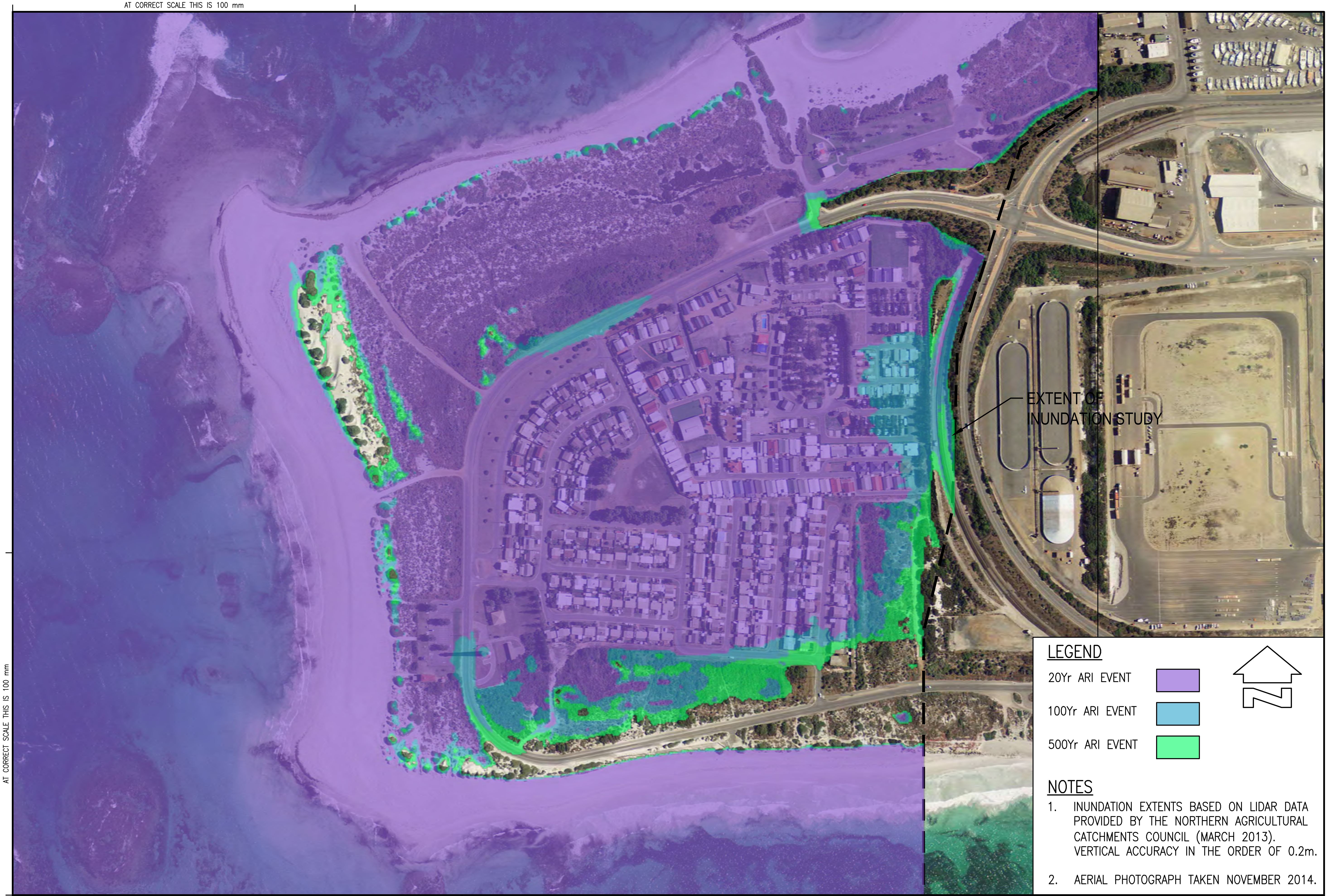
AT CORRECT SCALE THIS IS 100 mm



LEGEND

20Yr ARI EVENT	🟪
100Yr ARI EVENT	🟦
500Yr ARI EVENT	🟩

NOTES

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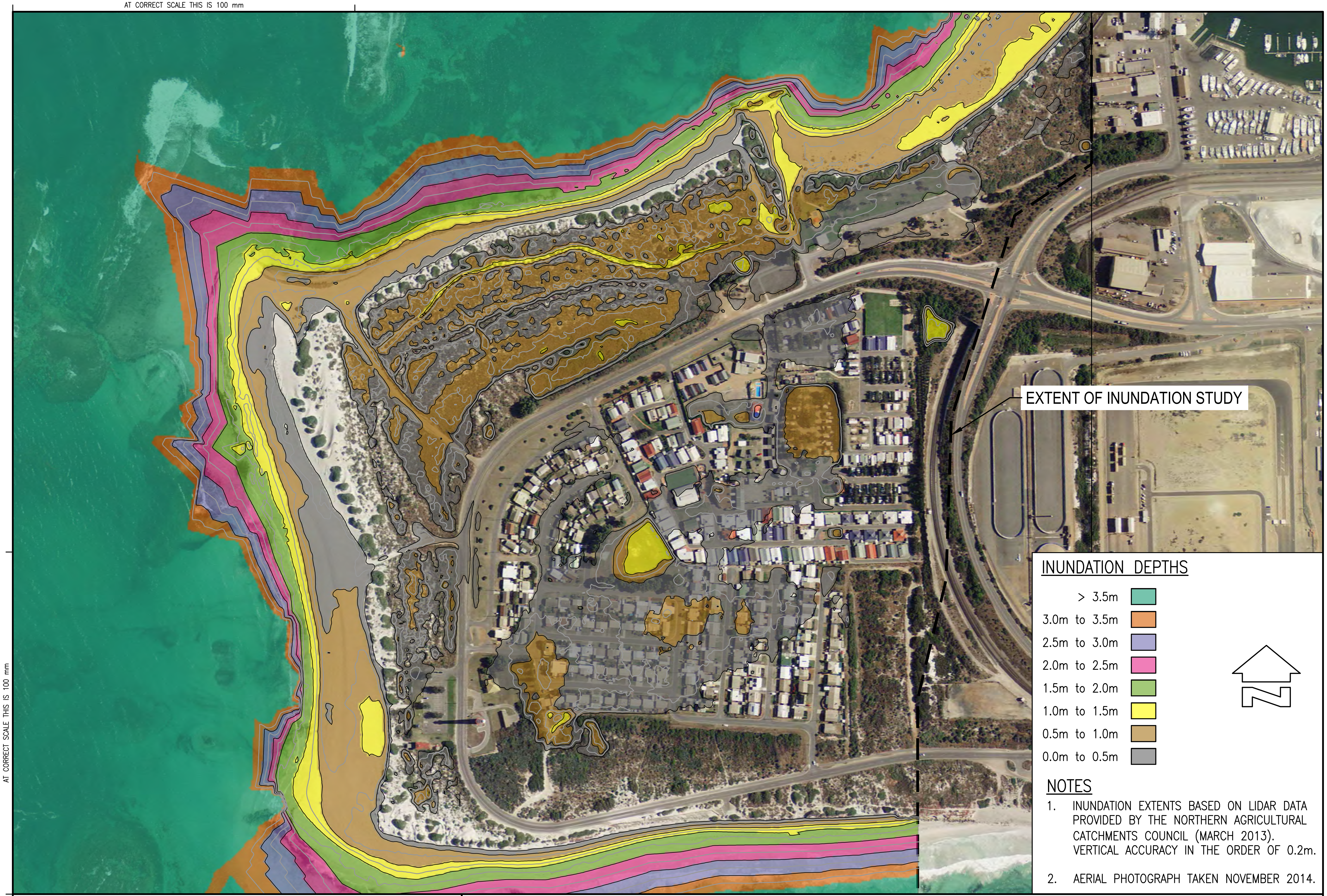
POINT MOORE COASTAL EROSION AND INUNDATION STUDY
INUNDATION MAPPING – 2110 (+0.9 SLR)

SCALE AT A3 1:4,000

JULY 2015
D1242-02-04(B)

AT CORRECT SCALE THIS IS 100 mm



NOTES

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POINT MOORE COASTAL EROSION AND INUNDATION STUDY

INUNDATION DEPTHS – 2030 20YR ARI EVENT

SCALE AT A3 1:4,000

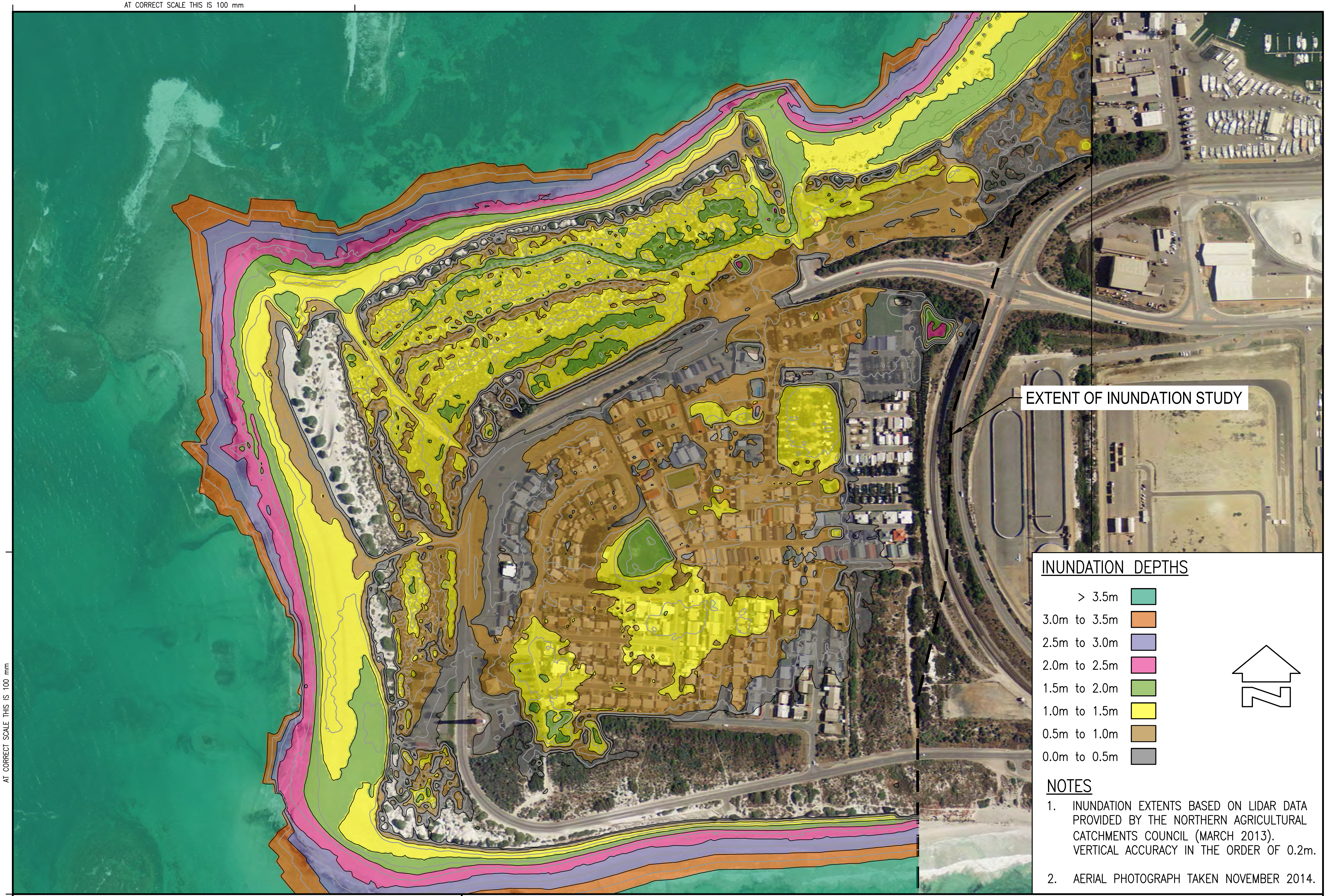
JULY 2015

D1242-03-01(A)

P:\MRA Paying Jobs\K1242 CGG – Point Moore Inundation Study\MRA DWGs\Innundation\Additional Mapping\2030 20Yr ARI\K1242-2030 20Yr ARI

AT CORRECT SCALE THIS IS 100 mm

AT CORRECT SCALE THIS IS 100 mm



INUNDATION DEPTHS

> 3.5m	🟦
3.0m to 3.5m	🟧
2.5m to 3.0m	🟪
2.0m to 2.5m	🟥
1.5m to 2.0m	🟩
1.0m to 1.5m	🟨
0.5m to 1.0m	🟫
0.0m to 0.5m	⬛

NOTES

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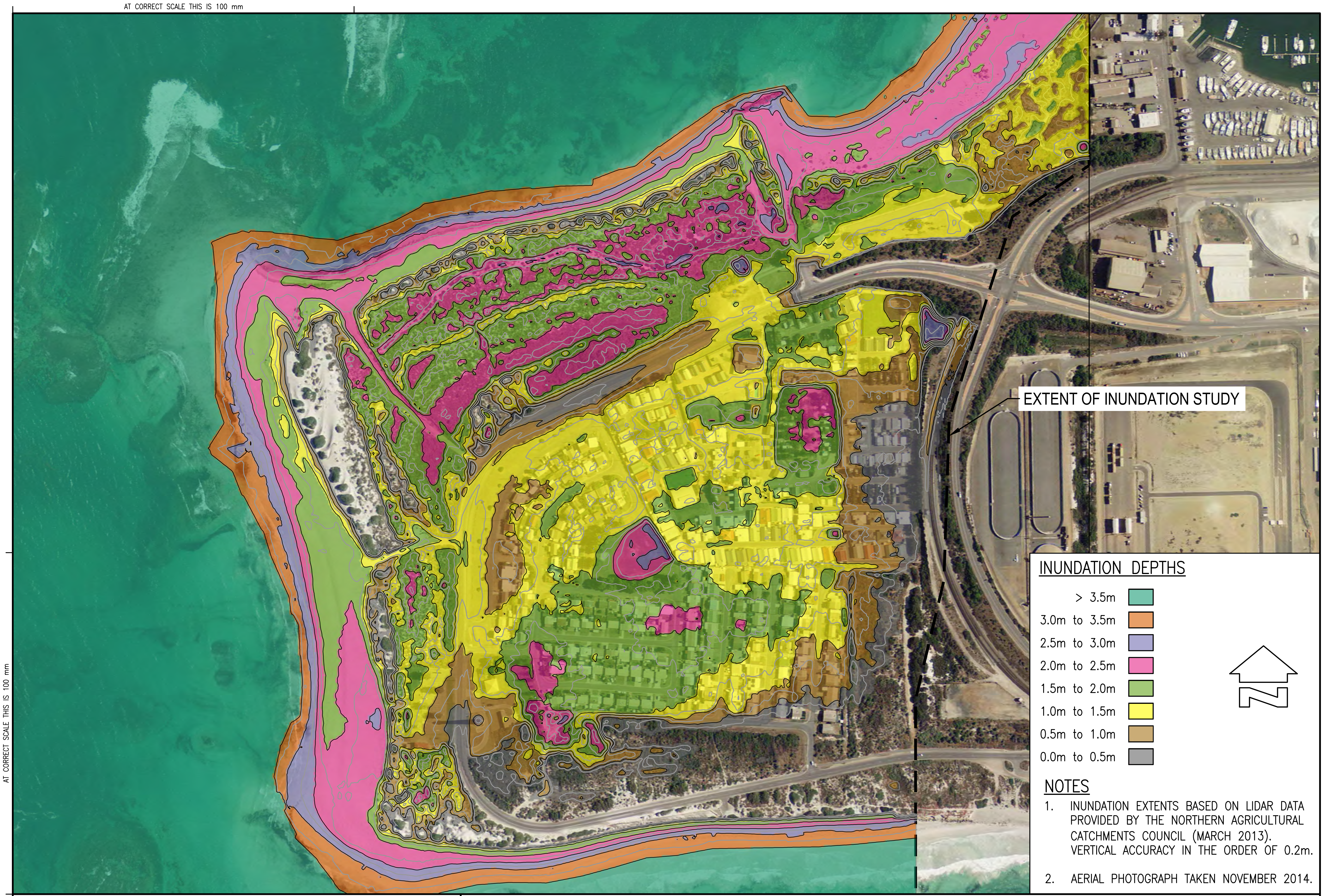
POINT MOORE COASTAL EROSION AND INUNDATION STUDY

INUNDATION DEPTHS – 2030 100YR ARI EVENT

SCALE AT A3 1:4,000

JULY 2015

D1242-03-02(A)



INUNDATION DEPTHS

> 3.5m	🟦
3.0m to 3.5m	🟧
2.5m to 3.0m	🟪
2.0m to 2.5m	🟥
1.5m to 2.0m	🟩
1.0m to 1.5m	🟨
0.5m to 1.0m	🟫
0.0m to 0.5m	⬛

N

NOTES

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POINT MOORE COASTAL EROSION AND INUNDATION STUDY

INUNDATION DEPTHS – 2030 500YR ARI EVENT

SCALE AT A3 1:4,000

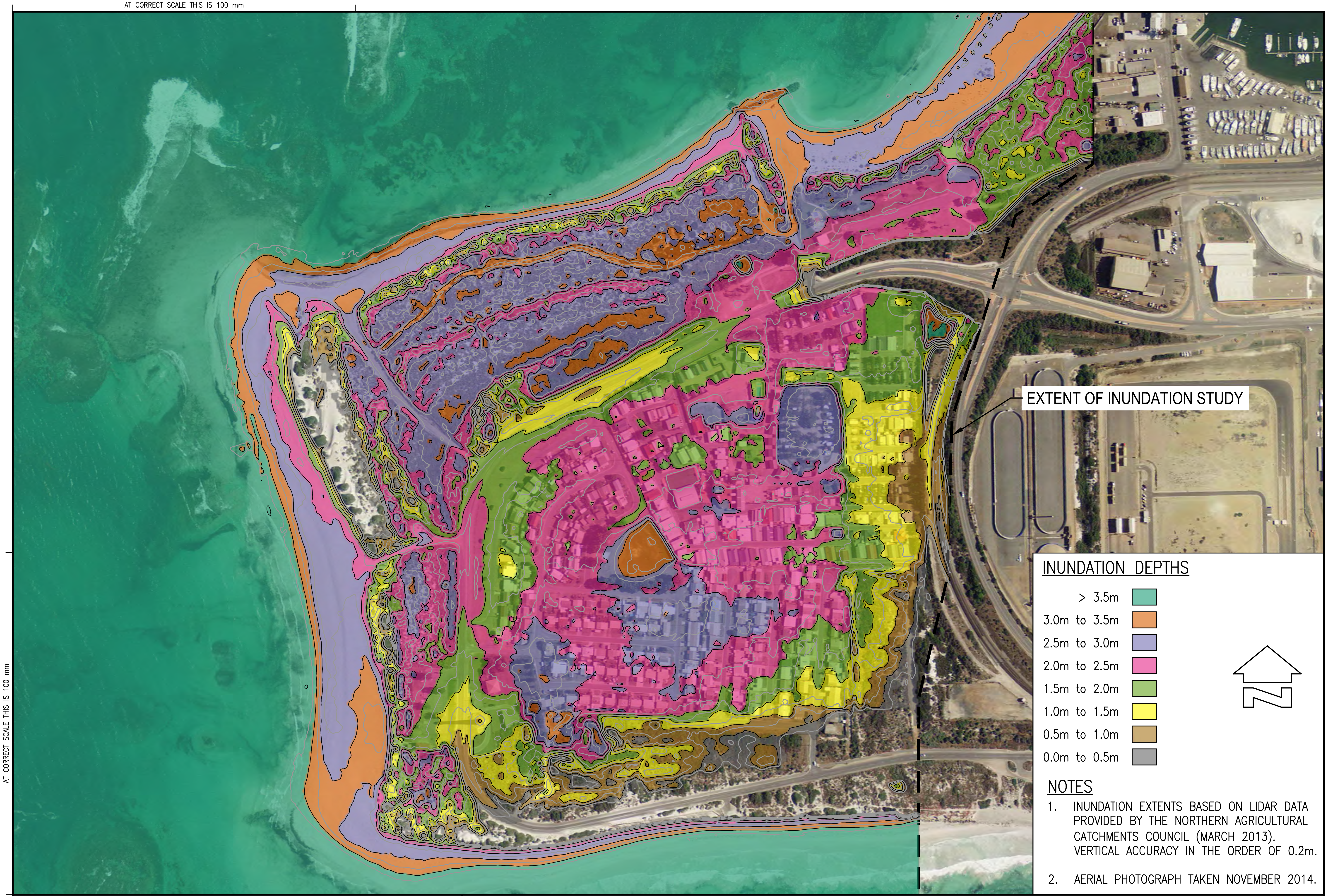
JULY 2015

D1242-03-03(A)

P:\MRA Paying Jobs\K1242 CGG – Point Moore Inundation Study\MRA DWGs\Innundation\Additional Mapping\2030 500Yr ARI\K1242-2030 500Yr ARI

AT CORRECT SCALE THIS IS 100 mm

AT CORRECT SCALE THIS IS 100 mm



INUNDATION DEPTHS

> 3.5m	🟦
3.0m to 3.5m	🟧
2.5m to 3.0m	🟪
2.0m to 2.5m	🟥
1.5m to 2.0m	🟩
1.0m to 1.5m	🟨
0.5m to 1.0m	🟫
0.0m to 0.5m	⬜

NOTES

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POINT MOORE COASTAL EROSION AND INUNDATION STUDY

INUNDATION DEPTHS – 2110 500YR ARI EVENT

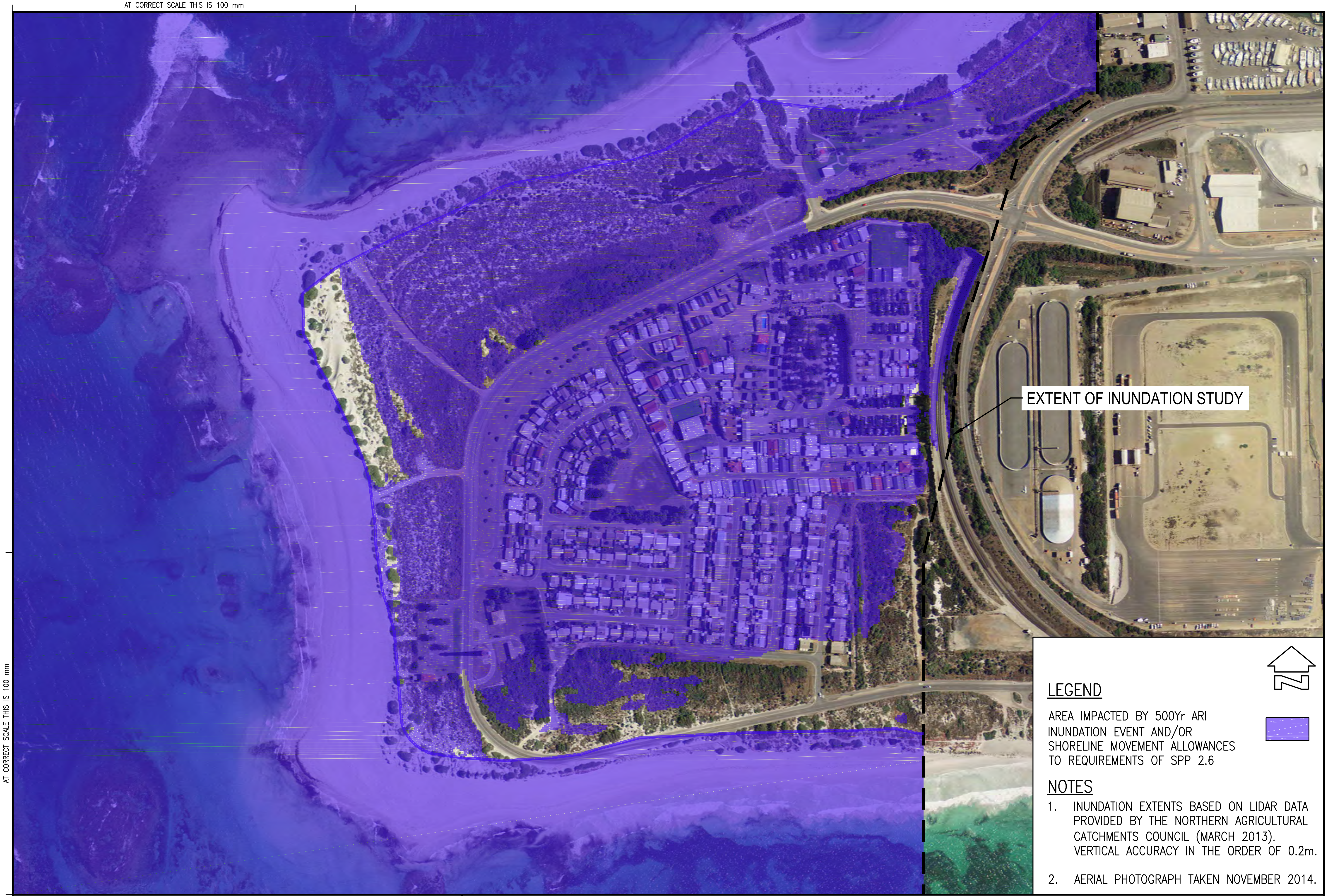
SCALE AT A3 1:4,000

JULY 2015

D1242-03-04(A)

AT CORRECT SCALE THIS IS 100 mm

AT CORRECT SCALE THIS IS 100 mm



LEGEND

AREA IMPACTED BY 500Yr ARI INUNDATION EVENT AND/OR SHORELINE MOVEMENT ALLOWANCES TO REQUIREMENTS OF SPP 2.6 ▨

NOTES

1. INUNDATION EXTENTS BASED ON LIDAR DATA PROVIDED BY THE NORTHERN AGRICULTURAL CATCHMENTS COUNCIL (MARCH 2013). VERTICAL ACCURACY IN THE ORDER OF 0.2m.
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POINT MOORE COASTAL EROSION AND INUNDATION STUDY

COMBINED COASTAL VULNERABILITY MAPPING – PRESENT DAY

SCALE AT A3 1:4,000

DECEMBER 2015

D1242-06-01(B)

P:\MRA Paying Jobs\K1242 CGG – Point Moore Inundation Study\MRA DWGs\Innundation\Combined Mapping\D1242-06-01

AT CORRECT SCALE THIS IS 100 mm

AT CORRECT SCALE THIS IS 100 mm

LEGEND

AREA IMPACTED BY 500Yr ARI INUNDATION EVENT AND/OR SHORELINE MOVEMENT ALLOWANCES TO REQUIREMENTS OF SPP 2.6 ▨

NOTES

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POINT MOORE COASTAL EROSION AND INUNDATION STUDY

COMBINED COASTAL VULNERABILITY MAPPING – 2030 (+0.07 SLR)

SCALE AT A3 1:4,000

DECEMBER 2015

D1242-06-02(B)

P:\MRA Paying Jobs\K1242 CGG – Point Moore Inundation Study\MRA DWGs\Innundation\Combined Mapping\D1242-06-02

AT CORRECT SCALE THIS IS 100 mm

AT CORRECT SCALE THIS IS 100 mm

LEGEND

AREA IMPACTED BY 500Yr ARI INUNDATION EVENT AND/OR SHORELINE MOVEMENT ALLOWANCES TO REQUIREMENTS OF SPP 2.6 ▨

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POINT MOORE COASTAL EROSION AND INUNDATION STUDY

COMBINED COASTAL VULNERABILITY MAPPING – 2070 (+0.39 SLR)

SCALE AT A3 1:4,000

DECEMBER 2015

D1242-06-03(B)

P:\MRA Paying Jobs\K1242 CGG – Point Moore Inundation Study\MRA DWGs\Innundation\Combined Mapping\D1242-06-03

AT CORRECT SCALE THIS IS 100 mm

LEGEND

AREA IMPACTED BY 500Yr ARI INUNDATION EVENT AND/OR SHORELINE MOVEMENT ALLOWANCES TO REQUIREMENTS OF SPP 2.6	🟪

NOTES

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POINT MOORE COASTAL EROSION AND INUNDATION STUDY

COMBINED COASTAL VULNERABILITY MAPPING – 2110 (+0.9 SLR)

DECEMBER 2015

SCALE AT A3 1:4,000

D1242-06-04(B)

Appendix C – Groundwater Monitoring Well Logs

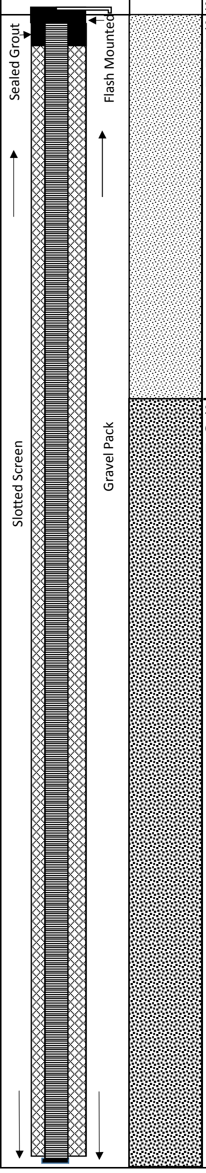
Bore Log

ENVIRONMENTAL

Groundwater Well: MW1

Page: 1 of 3

Client	City of Greater Geraldton	**Drill Co:**	Harrington drilling	**Easting**	**263, 938**
Project	Point Moore ROETDS	**Driller:**	James Harrington	**Northing**	**6,814,127**
Job No.	6134536	**Rig Type:**	HD1	**Grid Ref**	
Location	Point Moore	**Total Depth:**	6	**Elevation**	**2.608 (top of casing, mAHD)**
Date	15/08/2016	**Diameter (mm):**	50	**Logged by**	S Petts
				Checked by	A. Nagle



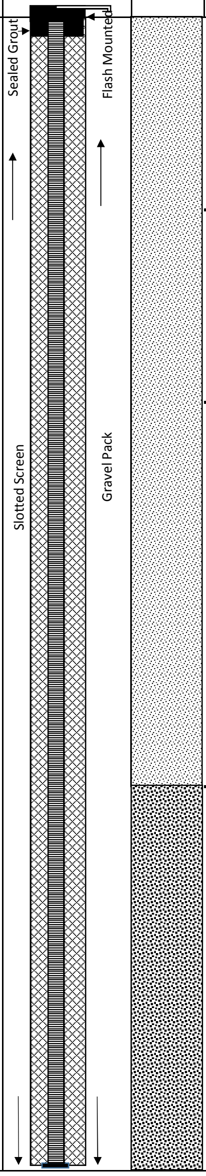
Depth (metres)	Drilling Method	Sample ID	Water	Well Details	Graphic Log	Lithological Description Soil Type (Classification Group Symbol); Particle ; Size; Colour; Secondary/Minor Component	Consistency	Moisture	CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase, liquids, imported fill, ash.
0.1		MW1_0.5				SM Fine Fine Sand Brown Sub-angular Layer Quartz Weakly Cemented Minor loam Loam (gravel)		D	No odour, no signs of contamination
0.5								D	No sampling beyond 3 m, inadequate sample amount.
1.0		MW1_1.0						M	No odours or stains
1.5		MW1_1.5							No odours or stains
2.0		MW1_2.0				SW Coarse Coarse Sand White Sub-angular Layer Quartz Weakly Cemented		M	No odours or stains
2.5		MW1_2.5	▼					W	No odours or stains
3.0		MW1_3.0						W	No odours or stains
3.5		MW1_3.5						W	No odours or stains
4.0		ns						W	No odours or stains
4.5		ns						W	No odours or stains
5.0		ns						W	No odours or stains
5.5		ns						W	No odours or stains
								W	No odours or stains

Bore Log

ENVIRONMENTAL

Groundwater Well: MW2
Page: 2 of 3

Client	City of Greater Geraldton	**Drill Co:**	Harrington Drilling	**Easting**	**263,709**
Project	Point Moore ROETDS	**Driller:**	James Harrington	**Northing**	**6,813,860**
Job No.	6134536	**Rig Type:**	HD1	**Grid Ref**	
Location	Point Moore	**Total Depth:**	6	**Elevation**	**2.151 (top of casing, mAHD)**
Date	15/08/2016	**Diameter (mm):**	50	**Logged by**	S Petts **Checked by** A. Nagle

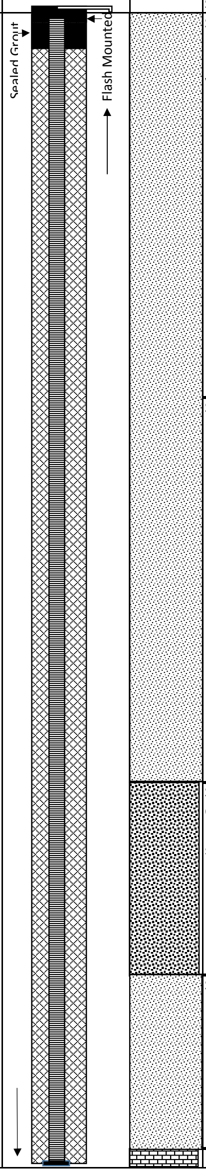


Depth (metres)	Drilling Method	Sample ID	Water	Well Details	Graphic Log	Lithological Description Soil Type (Classification Group Symbol); Particle; Size; Colour Secondary/ Minor Component	Consistency	Moisture	CONTAMINANT INDICATORS Odours, staining, waste materials separate phase, liquids, imported fill, ash.
0.1						SM Fine Fine Sand Brown Sub-angular Layer Quartz Weakly Cemented Minor Loam		D	No odours or stains
0.5		MW2_0.5 QC01 QC02						D	No odours or stains
1.0		MW2_1.0				SM Fine Fine Sand Brown Sub-angular Layer Quartz Weakly Less Loam		M	No odours or stains
1.5		MW2_1.5							No odours or stains
2.0		MW2_2.0	▼			SW Medium Medium Sand brown to White Sub-angular Layer Quartz Weakly Cemented		M	No odours or stains
2.5		MW2_2.5						W	No odours or stains
3.0		ns no sample retreivable						W	No odours or stains
3.5		MW2_3.5						W	No odours or stains
4.0		MW2_4.0				SW Coarse Coarse Sand Grey Sub-angular Layer Quartz Weakly Cemented		W	No odours or stains
4.5		MW2_4.5						W	No odours or stains
5.0		MW2_5.0						W	No odours or stains
5.5		MW2_5.5						W	No odours or stains
		MW2_6.0						W	No odours or stains

Bore Log
ENVIRONMENTAL

Groundwater Well: MW3
Page: 3 of 3

Client	City of Greater Geraldton	**Drill Co:**	**Harrington Drilling**	**Easting**	**263,934**		
Project	Point Moore ROETDs	**Driller:**	**James Harrington**	**Northing**	**6,813,674**		
Job No.	6134536	**Rig Type:**	**HD1**	**Grid Ref**			
Location	Point Moore	**Total Depth:**	**6m**	**Elevation**	**3.009 (top of casing, mAHD)**		
Date	15/08/2016	**Diameter (mm):**	**50**	**Logged by**	S Petts	**Checked by**	A. Nagle



Depth (metres)	Drilling Method	Sample ID	Water	Lithological Description Soil Type (Classification Group Symbol); Particle; Size; Colour; Secondary/Minor Component	Consistency	Moisture	CONTAMINANT INDICATORS Odours, staining, waste materials separate phase, liquids, imported fill, ash.
0.1				SP Fine Fine Sand Brown Sub-angular Layer Quartz Weakly Cemented very minor loam		D	No odours or stains
0.5		MW3_0.5 QC03 QC04				D	No odours or stains
1.0		MW3_1.0				M	No odours or stains
1.5		MW3_1.5					No odours or stains
2.0		MW3_2.0		SP Fine Medium Sand White Sub-angular Layer Quartz Weakly Cemented		M	No odours or stains
2.5		MW3_2.5				W	No odours or stains
3.0		MW3_3.0	▼			W	No odours or stains
3.5		MW3_3.5				W	No odours or stains
4.0		MW3_4.0		SW Coarse Coarse Sand Grey Sub-angular Layer Quartz Weakly Cemented shell grit		W	No odours or stains
4.5		MW3_4.5				W	No odours or stains
5.0		MW3_5.0		SM Fine Fine Sand Grey Sub-angular Layer Quartz		W	No odours or stains
5.5		MW3_5.5				W	No odours or stains
		MW3_6.0		Limestone Layer		W	

Appendix D – Groundwater Quality Field Data Sheets

Groundwater Monitoring – Data Sheet

Client: CGG		**BORE ID: MW1**
Project: Point Moore Groundwater Assessment		**Job No.: 6134772**
Location: Marine Terrace	**Casing diameter: 50 mm**	**Total Depth: 5.99 m**

BORE CONSTRUCTION

Head-works	☒ Flush	☐Monument	☐ Casing	☐ Locked	**Datum Point**	☒ Cover/ Monument	☐ Inner Casing	**Datum Elev.:2.608m** ☐ **Local** ☒ **AHD**

PURGING DETAILS

Method:	**Date: 2016**		**Undertaken By: S.Petts**	**Flow Rate:** 0.005 **L/S**
PID reading: N/A	**Water Column: 3.57 m**		**Req Purge Vol. ^{1}: N/A**	**Actual Vol. Purged:**
	Time	**Depth to LNAPL (m)**	**Depth to water (m)**	**Depth to DNAPL (m)**
Start	0830	**-**	**2.36**	-
Finish	0930	**-**	**2.36**	-

PURGING MEASUREMENTS ^{2}

Vol. Purged (L)	**Elapsed Time (min)**	**Spec. Cond.** (µS/cm)	**Act. Cond.** (µS/cm)	**TDS (ppt)**	**Temp. (ºC)**	**Salinity (ppt)**	**pH**	**DO %Sat**	**DO (mg/L)**	**ORP (mV)**	**Comments – Turbidity, Colour, Odour, etc.**
1	5	20,050	18,085	13.03	20.2	12.1	7.31	98.45	9.20	-164	Colourless, minor sulphur type odour
2	10	19,116	17,708	56.2	21.1	11.5	7.33	94.20	6.14	-199	
3	12	18,647	17,451	51.2	21.5	11.2	7.34	86.14	5.59	-202	
4	15	17,233	18,439	42.1	21.6	11.0	7.35	55.64	5.03	-207	
5	17	17,910	16,782	45.3	21.7	10.7	7.36	50.96	4.60	-210	
		+/-3.0%			**+/-3.0%**		**+/- 0.1**	**+/-10%**	**+/-3.0%**	**+/- 10 mV**	

Comments (e.g. condition of headworks, colour, odour):

SAMPLING DETAILS		**Sample ID: MW1**		
Date	**Time:**	**Undertaken By:** S Petts		
PID reading: N/A	**Depth to LNAPL: N/A**	**Depth to Water: 2.42m**	**Depth to DNAPL: N/A**	
Flow Rate: 0.005 L/s	**Vol. Removed: 5L**	**Sampling Method: Low Flow**		
Temp.: 21.7 ºC	**DO:** 4.60 mg/L	**pH:** 7.36	**Spec. Cond:** 17,910 uS/cm	**ORP: -210** mV
DO: 50.9%Sat	**Salinity:** 10.7 ppt	**TDS:** 45.3 ppt		

Comments (e.g. containers, filtration): QC01 - Blind, QC02 – Split, QC03 – Rinsate, QC04 – Field Blank

CoC Number:24082015	**Checked by:** Steven Petts	**Date:** 24/08/2016

1 **Bores to be purged dry, until pH, T and EC readings stabilise or a minimum of 3 to 5 times the water column volumes. Water column volumes can be calculated from the following casing volumes per unit length: 40 mm ID - 1 L/m; 50 mm ID – 2 L/m; 100 mm ID 8 L/m.**

2 **Calibration details to be recorded in the instrument –specific calibration book, or in field notes as required by local procedures.**

Groundwater Monitoring – Data Sheet

Client: CGG		**BORE ID: MW2**
Project: Point Moore Groundwater Assessment		**Job No.: 6134772**
Location: Captains Cres	**Casing diameter: 50 mm**	**Total Depth: 6.10 m**

BORE CONSTRUCTION

Head-works	☒ Flush	☐Monument	☐ Casing	☐ Locked	**Datum Point**	☒ Cover/ Monument	☐ Inner Casing	**Datum Elev.:2.151m** ☐ **Local** ☒ **AHD**

PURGING DETAILS

Method: Low Flow	**Date:** 24/08/2016		**Undertaken By: S.Petts**	**Flow Rate:** 0.008 **L/S**
PID reading: N/A	**Water Column: 4.24 m**		**Req Purge Vol.** [1]**: N/A**	**Actual Vol. Purged:**
	Time	**Depth to LNAPL (m)**	**Depth to water (m)**	**Depth to DNAPL (m)**
Start	1000	**-**	**1.78**	-
Finish	1100	**-**	**1.78**	-

PURGING MEASUREMENTS [2]

Vol. Purged (L)	**Elapsed Time (min)**	**Spec. Cond.** (µS/cm)	**Act. Cond.** (µS/cm)	**TDS (ppt)**	**Temp. (ºC)**	**Salinity (ppt)**	**pH**	**DO %Sat**	**DO (mg/L)**	**ORP (mV)**	**Comments – Turbidity, Colour, Odour, etc.**
1	2	15,159	12,459	234.4	15.6	8.88	8.42	86.6	8.99	-164	Colourless, minor H_2S odour
2	4	2,637	2,274	755.3	17.8	1.37	8.34	61.7	6.1	-162	
3	6	2,970	3,283	64.87	20.2	1.73	7.47	29.6	2.8	-205	
4	8	3,408	3,107	72.1	20.4	1.81	7.37	24.5	2.3	-206	
5	10	3,419	3,125	74.0	20.5	1.81	7.43	22.1	2.1	-207	
6	12	3,450	3,128	74.2	20.6	1.81	7.48	22.5	2.2	-207	
7	14	3,500	3,150	75.1	20.6	1.81	7.45	22.2	2.1	-206	
		+/-3.0%			**+/-3.0%**		**+/- 0.1**	**+/-10%**	**+/-3.0%**	**+/- 10 mV**	

Comments (e.g. condition of headworks, colour, odour):

SAMPLING DETAILS		**Sample ID: MW2**		
Date: 24/08/2016	**Time: 11:00**	**Undertaken By:** S Petts		
PID reading: N/A	**Depth to LNAPL: N/A**	**Depth to Water: 1.86 m**	**Depth to DNAPL: N/A**	
Flow Rate: 0.008 L/s	**Vol. Removed:** 7 L	**Sampling Method:** Low Flow		
Temp.: 21.7 ºC	**DO:** 2.08 mg/L	**pH:** 7.43	**Spec. Cond:** 3,419 uS/cm	**ORP:** -207 mV
DO: 22.1 %Sat	**Salinity:** 1.81 ppt	**TDS:** 2.22 ppt		

Comments (e.g. containers, filtration):

CoC Number:24082015	**Checked by:** Steven Petts	**Date:** 24/08/2016

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[1] **Bores to be purged dry, until pH, T and EC readings stabilise or a minimum of 3 to 5 times the water column volumes. Water column volumes can be calculated from the following casing volumes per unit length: 40 mm ID - 1 L/m; 50 mm ID – 2 L/m; 100 mm ID 8 L/m.**

[2] **Calibration details to be recorded in the instrument –specific calibration book, or in field notes as required by local procedures.**

Groundwater Monitoring – Data Sheet

Client: CGG		**BORE ID: MW3**
Project: Point Moore Groundwater Assessment		**Job No.: 6134772**
Location: Astrolabe Ln	**Casing diameter:** **50 mm**	**Total Depth: 5.84 m**

BORE CONSTRUCTION

Head-works	☒ Flush	☐Monument	☐ Casing	☐ Locked	**Datum Point**	☒ Cover/ Monument	☐ Inner Casing	**Datum Elev.:3.009m** ☐ **Local** ☒ **AHD**

PURGING DETAILS

Method: Low Flow	**Date:** 24/08/2016		**Undertaken By: S.Petts**	**Flow Rate:** 0.004 **L/S**
PID reading: N/A	**Water Column: 3.13 m**		**Req Purge Vol.** [1]**: N/A**	**Actual Vol. Purged:**
	Time	**Depth to LNAPL (m)**	**Depth to water (m)**	**Depth to DNAPL (m)**
Start	1100	**-**	**2.67**	-
Finish	1200	**-**	**2.67**	-

PURGING MEASUREMENTS [2]

Vol. Purged (L)	**Elapsed Time (min)**	**Spec. Cond.** (µS/cm)	**Act. Cond.** (µS/cm)	**TDS (ppt)**	**Temp. (°C)**	**Salinity (ppt)**	**pH**	**DO %Sat**	**DO (mg/L)**	**ORP (mV)**	**Comments – Turbidity, Colour, Odour, etc.**
1	4	2,333	2,259	41.3	23.3	1.21	7.84	22.6	2.1	-192	Minor particulates, colourless, H_2S odour
2	8	2,415	2,300	42.0	23.4	1.21	7.83	22.7	2.1	-193	
3	12	2,336	2,261	36.4	23.3	1.21	7.81	22.6	2.05	-196	
4	16	2,314	2,248	33.1	23.4	1.20	7.83	17.9	1.69	-204	
5	20	2,219	2,233	34.9	23.7	1.19	7.83	14.2	1.28	-211	
		+/-3.0%			**+/-3.0%**		**+/- 0.1**	**+/-10%**	**+/-3.0%**	**+/- 10 mV**	

Comments (e.g. condition of headworks, colour, odour):

SAMPLING DETAILS		**Sample ID: MW3**		
Date: 24/08/2016	**Time: 1145**	**Undertaken By:** S Petts		
PID reading: N/A	**Depth to LNAPL: N/A**	**Depth to Water: 2.71 m**	**Depth to DNAPL: N/A**	
Flow Rate: 0.04 L/s	**Vol. Removed: 5L**	**Sampling Method: Low Flow**		
Temp.: 23.7 °C	**DO:** 1.28 mg/L	**pH:** 7.83	**Spec. Cond:** 2,219 uS/cm	**ORP: -211** mV
DO: 14.2%Sat	**Salinity:** 1.19 ppt	**TDS:** 34.9 ppt		
Comments (e.g. containers, filtration):				
CoC Number:24082015		**Checked by:** Steven Petts	**Date:** 24/08/2016	

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1 **Bores to be purged dry, until pH, T and EC readings stabilise or a minimum of 3 to 5 times the water column volumes. Water column volumes can be calculated from the following casing volumes per unit length: 40 mm ID - 1 L/m; 50 mm ID – 2 L/m; 100 mm ID 8 L/m.**

2 **Calibration details to be recorded in the instrument –specific calibration book, or in field notes as required by local procedures.**

Groundwater Monitoring – Data Sheet

Client: CGG		**BORE ID: SHP8**
Project: Point Moore Groundwater Assessment		**Job No.: 6134772**
Location: Coxswain Park	**Casing diameter:** 50 mm	**Total Depth: 4.72 m**

BORE CONSTRUCTION

Head-works	☐ Flush	☒ Monument	☒ Casing	☐ Locked	**Datum Point**	☒ Cover/ Monument ☐ Inner Casing	**Datum Elev.:2.427m** ☐ **Local** ☒ **AHD**

PURGING DETAILS

Method: Low Flow	**Date:** 24/08/2016		**Undertaken By: S.Petts**	**Flow Rate:** 0.005 **L/S**
PID reading: N/A	**Water Column:** 2.42 m		**Req Purge Vol.** [1]**: N/A**	**Actual Vol. Purged:**
	Time	**Depth to LNAPL (m)**	**Depth to water (m)**	**Depth to DNAPL (m)**
Start	1230	**-**	**2.1**	-
Finish	1330	**-**	**2.1**	-

PURGING MEASUREMENTS [2]

Vol. Purged (L)	**Elapsed Time (min)**	**Spec. Cond.** (μS/cm)	**Act. Cond.** (μS/cm)	**TDS (ppt)**	**Temp. (ºC)**	**Salinity (ppt)**	**pH**	**DO %Sat**	**DO (mg/L)**	**ORP (mV)**	**Sal(ppt)** **Comments – Turbidity, Colour, Odour, etc.**
1	5	6,410	5,917	6.99	20.98	3.54	7.72	31.2	3.2	-221	Colourless, H_2S odour
2	7	6,497	5,987	5.58	20.95	3.57	7.72	30.2	3.1	-222	
3	9	6,587	5,974	5.01	20.91	3.58	7.73	30.1	3.1	-221	
4	11	6,588	5,879	5.01	20.91	3.58	7.73	29.3	3.01	-221	
5	13	6,496	5,988	4.22	20.91	3.59	7.73	29.3	3.01	-221	
		+/-3.0%			**+/-3.0%**		**+/- 0.1**	**+/-10%**	**+/-3.0%**	**+/- 10 mV**	

Comments (e.g. condition of headworks, colour, odour):

SAMPLING DETAILS

SAMPLING DETAILS		**Sample ID: SHP8**		
Date: 24/08/2016	**Time: 13:20**	**Undertaken By:** S Petts		
PID reading: N/A	**Depth to LNAPL: N/A**	**Depth to Water: 2.3 m**	**Depth to DNAPL: N/A**	
Flow Rate: -L/s	**Vol. Removed: 5 L**	**Sampling Method: Low Flow**		
Temp.: 20.9 °C	**DO:** 29.32 mg/L	**pH:** 7.73	**Spec. Cond:** 6,696 uS/cm	**ORP:** -221 mV
DO: 29.3% Sat	**Salinity:** 3.59 ppt	**TDS:** 24.80 ppt		

Comments (e.g. containers, filtration):

CoC Number:24082015	**Checked by:** Steven Petts	**Date:** 24/08/2016

[1] **Bores to be purged dry, until pH, T and EC readings stabilise or a minimum of 3 to 5 times the water column volumes. Water column volumes can be calculated from the following casing volumes per unit length: 40 mm ID - 1 L/m; 50 mm ID – 2 L/m; 100 mm ID 8 L/m.**

[2] **Calibration details to be recorded in the instrument –specific calibration book, or in field notes as required by local procedures**

Groundwater Monitoring – Data Sheet

Client: CGG		**BORE ID: MW1**
Project: Point Moore Groundwater Assessment		**Job No.: 6134772**
Location: Marine Terrace	**Casing diameter: Location: Marine**	**Total Depth:** 5.93

BORE CONSTRUCTION

Head-works	☒ Flush	☐Monument	☐ Casing	☐ Locked	**Datum Point**	☐ Cover/ Monument	☒ Inner Casing	**Datum Elev.:** **m** ☐ **Local** ☒ **AHD**

PURGING DETAILS

Method: Low Flow Pump	**Date: 2016**	**Undertaken By: S.Petts**	**Flow Rate:** **L/s**
PID reading: **N/Appm**	**Water Column:** **3.5m**	**Req Purge Vol. [1]:** **-L**	**Actual Vol. Purged:** **-L**

	Time	Depth to LNAPL (m)	Depth to water (m)	Depth to DNAPL (m)
Start	09:00	**-**	**2.43**	-
Finish	10:15	**-**	**2.43**	-

PURGING MEASUREMENTS [2]

Vol. Purged (L)	Elapsed Time (min)	EC (mS/cm)	Temp. (ºC)	Salinity (ppm)	pH	DO %Sat	DO (ppm)	Eh (mV)	Comments – Turbidity, Colour, Odour, etc.
1	10	31.6	28.1	-	6.94	-	1.08	-282	SO_2 odour, colourless, suspended solids
2	14	31.7	28.1	-	6.97	-	0.3	-283	
3	18	31.7	28.1	-	6.96	-	0.36	-276	
4	23	31.6	28.3	-	6.93	-	0.4	-273	
		+/-3.0%	**+/-3.0%**		**+/- 0.1**	**+/-10%**	**+/-3.0%**	**+/- 10 mV**	

Comments (e.g. condition of headworks, colour, odour):

SAMPLING DETAILS

SAMPLING DETAILS		**Sample ID: MW1**	
Date 22/09/2016	**Time:10:00**	**Undertaken By: S Petts**	
PID reading: **- ppm**	**Depth to LNAPL:** **- m**	**Depth to Water:** **2.43 m**	**Depth to DNAPL** **- m**

Flow Rate: **0.09L/s**	**Vol. Removed:** **4L**	**Sampling Method:** **Low Flow**		
Temp.: **28.3ºC**	**DO:0.4** **-ppm mg/L**	**pH:** **6.93**	**EC: 31.6** **mS/cm**	**Eh:-273** **mV**
	DO:- **%Sat**		**Salinity:** **-ppm mg/L**	

Comments (e.g. containers, filtration): QC01_20160922, RB - QC03_20160922, FB - QC04_20160922

CoC Number: 20160922	**Checked by:** **S Petts**	**Date:** **22/09/2016**

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[1] Bores to be purged dry, until pH, T and EC readings stabilise or a minimum of 3 to 5 times the water column volumes. Water column volumes can be calculated from the following casing volumes per unit length: 40 mm ID - 1 L/m; 50 mm ID – 2 L/m; 100 mm ID 8 L/m.

[2] Calibration details to be recorded in the instrument –specific calibration book, or in field notes as required by local procedures.

Groundwater Monitoring – Data Sheet

Client: CGG		**BORE ID: MW2**
Project: Point Moore Groundwater Assessment		**Job No.: 6134772**
Location: Captain Cres	**Casing diameter:** 50 **mm**	**Total Depth:** 6.03

BORE CONSTRUCTION

Head-works	☒ Flush	☐ Monument	☐ Casing	☐ Locked	**Datum Point**	☐ Cover/ Monument	☒ Inner Casing	**Datum Elev.:** **m**	☐ **Local** ☒ **AHD**

PURGING DETAILS

Method: Low Flow Pump	**Date: 22/09/2016**	**Undertaken By: S.Petts**	**Flow Rate:** **0.07L/s**
PID reading: **N/Appm**	**Water Column:** **4.2m**	**Req Purge Vol. [1]:** **-L**	**Actual Vol. Purged:** **-L**

	Time	Depth to LNAPL (m)	Depth to water (m)	Depth to DNAPL (m)
Start	10:15	**-**	**1.83**	-
Finish	11:30	**-**	**1.83**	

PURGING MEASUREMENTS [2]

Vol. Purged (L)	Elapsed Time (min)	EC (mS/cm)	Temp. (°C)	Salinity (ppm)	pH	DO %Sat	DO (ppm)	Eh (mV)	Comments – Turbidity, Colour, Odour, etc.
1	4	2.63	25.7	-	7.06	-	1.02	-33	**Colourless, Odourless, some suspended solids**
2	8	2.6	25.7	-	7.05	-	1.02	-30	
3	13	2.4	25.8	-	7.04	-	0.94	-36	
4	17	2.41	25.7	-	7.06	-	0.94	-35	
5	20	2.36	25.6	-	7.07	-	0.93	-35	
6	24	2.38	25.5	-	7.10	-	0.91	-37	
7	29	2.38	25.4	-	7.11	-	0.88	-39	
		+/-3.0%	**+/-3.0%**		**+/- 0.1**	**+/-10%**	**+/-3.0%**	**+/- 10 mV**	

Comments (e.g. condition of headworks, colour, odour):

SAMPLING DETAILS | **Sample ID: MW2**

Date **22/09/2016**	**Time:** 11:00	**Undertaken By: S Petts**		
PID reading: **- ppm**	**Depth to LNAPL:** **- m**	**Depth to Water:** **1.83 m**	**Depth to DNAPL** **- m**	
Flow Rate: **0.07L/s**	**Vol. Removed:** **7L**	**Sampling Method:** **Low Flow**		
Temp.: **25.4 °C**	**DO: 0.88** **-ppm mg/L**	**pH:** **6.11**	**EC:** **2.38 mS/cm**	**Eh:** **-39mV**
	DO: **-% Sat**		**Salinity:** **-ppm mg/L**	

Comments (e.g. containers, filtration):

CoC Number: 20160922	**Checked by:** **S Petts**	**Date:** **22/09/2016**

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[1] **Bores to be purged dry, until pH, T and EC readings stabilise or a minimum of 3 to 5 times the water column volumes. Water column volumes can be calculated from the following casing volumes per unit length: 40 mm ID - 1 L/m; 50 mm ID – 2 L/m; 100 mm ID 8 L/m.**

Groundwater Monitoring – Data Sheet

Client: CGG		**BORE ID: MW3**
Project: Point Moore Groundwater Assessment		**Job No.: 6134772**
Location: Astrolabe Ln	**Casing diameter: 50 mm**	**Total Depth: 5.90 m**

BORE CONSTRUCTION

Head-works	☒ Flush	☐ Monument	☐ Casing	☐ Locked	**Datum Point**	☐ Cover/ Monument	☒ Inner Casing	**Datum Elev.:** m	☐ Local	☒ AHD

PURGING DETAILS

Method: Low Flow	**Date: 2016**	**Undertaken By: S.Petts**	**Flow Rate:** 0.09L/s
PID reading: N/Appm	**Water Column:** m	**Req Purge Vol. [1]:** L	**Actual Vol. Purged:** L

	Time	**Depth to LNAPL (m)**	**Depth to water (m)**	**Depth to DNAPL (m)**
Start	1200	-	2.68	-
Finish	1240	-	2.68	

PURGING MEASUREMENTS [2]

Vol. Purged (L)	**Elapsed Time (min)**	**EC** (mS/cm)	**Temp. (°C)**	**Salinity (ppm)**	**pH**	**DO %Sat**	**DO (ppm)**	**Eh (mV)**	**Comments – Turbidity, Colour, Odour, etc.**
1	10	2.84	27.9	-	7.42	-	0.42	-170	Colourless, SO_2 odour, suspended solids
2	14	2.80	28.0	-	7.39	-	0.21	-202	
3	18	2.72	28.1	-	7.35	-	0.13	-227	
4	22	2.62	28.1	-	7.34	-	0.09	-240	
5	26	2.56	28.1	-	7.34	-	0.06	-249	
		+/-3.0%	+/-3.0%		+/- 0.1	+/-10%	+/-3.0%	+/- 10 mV	

Comments (e.g. condition of headworks, colour, odour):

SAMPLING DETAILS		**Sample ID: MW3**	
Date 22/09/2016	**Time:12:30**	**Undertaken By: S Petts**	
PID reading: - ppm	**Depth to LNAPL:** - m	**Depth to Water:** 2.68 m	**Depth to DNAPL** - m

Flow Rate: 0.09 L/s	**Vol. Removed:** 9L	**Sampling Method:** Low Flow Pump		
Temp.: 27.8 °C	**DO:** -ppm mg/L	**pH:** 5.95	**EC:** 5.95 mS/cm	**Eh:** -10mV
	DO: 71.8%Sat		**Salinity:** -ppm mg/L	

Comments (e.g. containers, filtration):

All metals field filtered

CoC Number: 20160922	**Checked by:** S Petts	**Date:** 22/09/2016

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[1] Bores to be purged dry, until pH, T and EC readings stabilise or a minimum of 3 to 5 times the water column volumes. Water column volumes can be calculated from the following casing volumes per unit length: 40 mm ID - 1 L/m; 50 mm ID – 2 L/m; 100 mm ID 8 L/m.

[2] Calibration details to be recorded in the instrument –specific calibration book, or in field notes as required by local procedures.

Groundwater Monitoring – Data Sheet

Client: CGG		**BORE ID: SHP8**
Project: Point Moore Groundwater Assessment		**Job No.: 6134772**
Location: Coxswain Park	**Casing diameter: 50 mm**	**Total Depth: 4.76 m**

BORE CONSTRUCTION

Head-works	☐ Flush	☒ Monument	☐ Casing	☐ Locked	**Datum Point**	☐ Cover/ Monument	☒ Inner Casing	**Datum Elev.:** m	☐ **Local** ☒ **AHD**

PURGING DETAILS

Method: Low Flow	**Date: 2016**	**Undertaken By: S.Petts**	**Flow Rate:** L/s
PID reading: N/A ppm	**Water Column:** 1.8 m	**Req Purge Vol.** [1]**:** -L	**Actual Vol. Purged:** 8L

	Time	Depth to LNAPL (m)	Depth to water (m)	Depth to DNAPL (m)
Start	1310	-	**2.08**	-
Finish	1340	-	**2.08**	

PURGING MEASUREMENTS [2]

Vol. Purged (L)	Elapsed Time (min)	EC (mS/cm)	Temp. (ºC)	Salinity (ppm)	pH	DO %Sat	DO (ppm)	Eh (mV)	Comments – Turbidity, Colour, Odour, etc.
1	**5**	11.49	27.6	-	6.89		0.67	-285	Colourless, SO_2 odour, suspended solids
2	**10**	8.95	27.5		6.74		0.2	301	
3	**15**	8.94	28		6.73		0.09	-308	
4	**17**	9.04	27.7		6.67		0.16	287	
5	**20**	9.06	27.7		6.63		0.07	300	
6	**23**	8.97	27.7		6.58		**0.05**	-306	
		+/-3.0%	**+/-3.0%**		**+/- 0.1**	**+/-10%**	**+/-3.0%**	**+/- 10 mV**	

Comments (e.g. condition of headworks, colour, odour):

SAMPLING DETAILS

		Sample ID: SHP8	
Date 22/09/2016	**Time:** 1330	**Undertaken By: S Petts**	
PID reading: - ppm	**Depth to LNAPL:** - m	**Depth to Water:** 2.08 m	**Depth to DNAPL** - m
Flow Rate: 0.06L/s	**Vol. Removed:** 6L	**Sampling Method:** Low Flow	

Temp.: 27.7 ºC	**DO: 0.05** -ppm mg/L	**pH:** 6.58	**EC:** 8.97 mS/cm	**Eh:** -306mV
	DO: -%Sat		**Salinity:** -ppm mg/L	

Comments (e.g. containers, filtration):

All metals field filtered

CoC Number: 20160310	**Checked by:** S Petts	**Date:** 22/9/16

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[1] Bores to be purged dry, until pH, T and EC readings stabilise or a minimum of 3 to 5 times the water column volumes. Water column volumes can be calculated from the following casing volumes per unit length: 40 mm ID - 1 L/m; 50 mm ID – 2 L/m; 100 mm ID 8 L/m.

[2] Calibration details to be recorded in the instrument –specific calibration book, or in field notes as required by local procedures.

Groundwater Monitoring – Data Sheet

Client: CGG		**BORE ID: MW1**
Project: Point Moore Groundwater Assessment		**Job No.: 6134772**
Location: Marine Terrace	**Casing diameter: Location: Marine**	**Total Depth:** 5.91

BORE CONSTRUCTION

Head-works	☒ Flush	☐Monument	☐ Casing	☐ Locked	**Datum Point**	☐ Cover/ Monument	☒ Inner Casing	**Datum Elev.:** m	☐ Local ☒ AHD

PURGING DETAILS

Method: Low Flow Pump	**Date: 2016**	**Undertaken By: S.Petts**	**Flow Rate:** **0.006L/s**
PID reading: **N/Appm**	**Water Column:** **3.51 m**	**Req Purge Vol. [1]:** **-L**	**Actual Vol. Purged:** **-L**

	Time	Depth to LNAPL (m)	Depth to water (m)	Depth to DNAPL (m)
Start	8:30	**-**	**2.41**	-
Finish	1000	**-**	**2.41**	-

PURGING MEASUREMENTS [2]

Vol. Purged (L)	Elapsed Time (min)	EC (mS/cm)	Temp. (°C)	Turbidity (NTU)	pH	DO %Sat	DO (ppm)	Eh (mV)	Comments – Turbidity, Colour, Odour, etc.
1	5	20.7	28.1	6.7	7.34	7.4	-	-289	S2O odour, some TSS, colourless
2	8	17.23	27.9	9.7	7.32	11.4	-	-279	
3	10	16.26	27.9	9.1	7.44	23.6	-	-274	
4	12	16.11	27.9	7.5	7.46	14.8	-	-273	
5	15	15.89	27.9	8.4	7.48	15.4	-	-272	
6	18	15.82	27.9	5.2	7.50	15.4	-	-271	
		+/-3.0%	**+/-3.0%**		**+/- 0.1**	**+/-10%**	**+/-3.0%**	**+/- 10 mV**	

Comments (e.g. condition of headworks, colour, odour):

SAMPLING DETAILS		**Sample ID: MW1**	
Date **18/10/2016**	**Time:10:00**	**Undertaken By: S Petts**	
PID reading: **- ppm**	**Depth to LNAPL:** **- m**	**Depth to Water:** **2.41 m**	**Depth to DNAPL** **- m**

Flow Rate: **0.006 L/s**	**Vol. Removed:** **6L**	**Sampling Method:** **Low Flow**		
Temp.: **27.9 °C**	**DO:** **-ppm mg/L**	**pH:** **7.50**	**EC: 15.82** **mS/cm**	**Eh:** **-271 mV**
	DO: **15.4 %Sat**		**Turbidity** **5.2 NTU**	

Comments (e.g. containers, filtration):QC01_20161018(blind), QC02_20161018(split), QC03_20161018 (RB)

QC04_20161018(FB)

CoC Number: **20161018**	**Checked by:** **S Petts**	**Date:** **18/10/2016**

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[1] Bores to be purged dry, until pH, T and EC readings stabilise or a minimum of 3 to 5 times the water column volumes. Water column volumes can be calculated from the following casing volumes per unit length: 40 mm ID - 1 L/m; 50 mm ID – 2 L/m; 100 mm ID 8 L/m.

[2] Calibration details to be recorded in the instrument –specific calibration book, or in field notes as required by local procedures.

Groundwater Monitoring – Data Sheet

Client: CGG		**BORE ID: MW2**
Project: Point Moore Groundwater Assessment		**Job No.: 6134772**
Location: Captain Cres	**Casing diameter:** 50 mm	**Total Depth:** 6.02

BORE CONSTRUCTION

Head-works	☒ Flush	☐ Monument	☐ Casing	☐ Locked
Datum Point	☐ Cover/ Monument	☒ Inner Casing		
Datum Elev.:	m	☐ Local	☒ AHD	

PURGING DETAILS

Method: Low Flow Pump	**Date: 18/10/2016**	**Undertaken By: S.Petts**	**Flow Rate:** 0.005L/s
PID reading: N/Appm	**Water Column:** 4.12 m	**Req Purge Vol. [1]:** -L	**Actual Vol. Purged:** -L

	Time	Depth to LNAPL (m)	Depth to water (m)	Depth to DNAPL (m)
Start	1015	-	1.90	-
Finish	1050	-	1.90	

PURGING MEASUREMENTS [2]

Vol. Purged (L)	Elapsed Time (min)	EC (mS/cm)	Temp. (ºC)	Turbidity (NTU)	pH	DO %Sat	DO (ppm)	Eh (mV)	Comments – Turbidity, Colour, Odour, etc.
1	5	2.17	20.2	-0.8	7.84	17.1	-	-179	S2O Odour, colourless, slight SS
2	8	2.16	20.3	-1.7	7.91	20	-	-177	
3	11	2.16	20.3	-0.3	8.09	19.0	-	-180	
4	14	2.18	20.3	-0.7	7.97	18.5	-	-180	
5	17	2.17	20.4	-0.8	7.94	18.2	-	-182	
6	20	2.17	20.4	-1.5	7.90	19.0	-	-183	
		+/-3.0	+/-1.0		+/- 0.1	+/-10%	+/-1.0	+/- 10 mV	

Comments (e.g. condition of headworks, colour, odour):

SAMPLING DETAILS

Sample ID: MW2

Date 18/10/2016	**Time: 10:40**	**Undertaken By: S Petts**	
PID reading: - ppm	**Depth to LNAPL:** - m	**Depth to Water:** 1.90 m	**Depth to DNAPL** - m
Flow Rate: 0.005 L/s	**Vol. Removed:** 6L	**Sampling Method:** Low Flow	
Temp.: 20.4 ºC	**DO:** -ppm mg/L	**pH:** 7.84	**EC: 2.17** mS/cm
Eh:-183 mV	**DO:** 19.0% Sat	**Turbidity** -1.5 NTU	

Comments (e.g. containers, filtration):

CoC Number: 20161018	**Checked by:** S Petts	**Date:** 18/10/2016

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1 Bores to be purged dry, until pH, T and EC readings stabilise or a minimum of 3 to 5 times the water column volumes. Water column volumes can be calculated from the following casing volumes per unit length: 40 mm ID - 1 L/m; 50 mm ID – 2 L/m; 100 mm ID 8 L/m.

Groundwater Monitoring – Data Sheet

Client: CGG		**BORE ID: MW3**
Project: Point Moore Groundwater Assessment		**Job No.: 6134772**
Location: Astrolabe Ln	**Casing diameter:** 50 mm	**Total Depth:** 5.87 m

BORE CONSTRUCTION

Head-works	☒ Flush	☐ Monument	☐ Casing	☐ Locked	**Datum Point**	☐ Cover/ Monument	☒ Inner Casing	**Datum Elev.:** m	☐ Local ☒ AHD

PURGING DETAILS

Method: Low Flow	**Date: 2016**	**Undertaken By: S.Petts**	**Flow Rate:** 0.004 L/s
PID reading: N/Appm	**Water Column:** 3.16 m	**Req Purge Vol. [1]:** L	**Actual Vol. Purged:** L

	Time	Depth to LNAPL (m)	Depth to water (m)	Depth to DNAPL (m)
Start	1100	-	2.71	-
Finish	1140	-	2.71	-

PURGING MEASUREMENTS [2]

Vol. Purged (L)	Elapsed Time (min)	EC (uS/cm)	Temp. (°C)	Turbidity (NTU)	pH	DO %Sat	DO (ppm)	Eh (mV)	Comments – Turbidity, Colour, Odour, etc.
1	5	2.24	22.7	21.2	7.96	17.4	-	-137	No odourm colourless, some SS
2	9	2.22	22.7	17.3	-	23.6	-	-147	
3	12	2012	22.8	9.7	-	25.1	-	-145	
4	15	2055	22.7	8.3	7.65	25.9	-	-147	
5	19	2063	22.7	8.5	8.02	25.3	-	-149	
6	23	2062	22.7	6.4	7.96	26.0	-	-151	
		+/-3.0%	+/-3.0%		+/- 0.1	+/-10%	+/-3.0%	+/- 10 mV	

Comments (e.g. condition of headworks, colour, odour):

Water meter issues, pH reading error

SAMPLING DETAILS

Sample ID: MW3			
Date 18/10/2016	**Time:** 11:30	**Undertaken By: S Petts**	
PID reading: - ppm	**Depth to LNAPL:** - m	**Depth to Water:** 2.71 m	**Depth to DNAPL** - m
Flow Rate: 0.004 L/s	**Vol. Removed:** 6 L	**Sampling Method:** Low Flow Pump	

Temp.: 22.7 °C	**DO:** -ppm mg/L	**pH:** 7.96	**EC:** 2062 uS/cm	**Eh:** -151 mV
	DO: 26.0 %Sat		**Turbidity** 6.4 NTU	

Comments (e.g. containers, filtration):

All metals field filtered

CoC Number: 20161018	**Checked by:** S Petts	**Date:** 18/10/2016

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[1] Bores to be purged dry, until pH, T and EC readings stabilise or a minimum of 3 to 5 times the water column volumes. Water column volumes can be calculated from the following casing volumes per unit length: 40 mm ID - 1 L/m; 50 mm ID – 2 L/m; 100 mm ID 8 L/m.

[2] Calibration details to be recorded in the instrument –specific calibration book, or in field notes as required by local procedures.

Groundwater Monitoring – Data Sheet

Client: CGG		**BORE ID: SHP8**
Project: Point Moore Groundwater Assessment		**Job No.: 6134772**
Location: Coxswain Park	**Casing diameter:** 50 mm	**Total Depth:** 5.85 m

BORE CONSTRUCTION

Head-works	☐ Flush	☒ Monument	☐ Casing	☐ Locked	**Datum Point**	☐ Cover/ Monument	☒ Inner Casing	**Datum Elev.:** m	☐ Local ☒ AHD

PURGING DETAILS

Method: Low Flow	**Date: 2016**	**Undertaken By:** S.Petts	**Flow Rate:** 0.004 L/s
PID reading: N/A ppm	**Water Column:** 3.68 m	**Req Purge Vol. [1]:** -L	**Actual Vol. Purged:** 8L

	Time	Depth to LNAPL (m)	Depth to water (m)	Depth to DNAPL (m)
Start	1145		2.17	-
Finish	1230		2.17	

PURGING MEASUREMENTS [2]

Vol. Purged (L)	Elapsed Time (min)	EC (mS/cm)	Temp. (ºC)	Turbidity (NTU)	pH	DO %Sat	DO (ppm)	Eh (mV)	Comments – Turbidity, Colour, Odour, etc.
1	5	3.69	20.2	-3.7	7.63	11.1	-	-226	Colourless, slight S2O odour, some SS
2	9	3.71	20.3	-3.2	7.66	13.8	-	-225	
3	14	3.74	20.3	-3.2	7.65	13.8	-	-224	
4	17	3.77	20.2	-3.2	7.69	15.6	-	-223	
5	20	3.79	20.2	-3.7	7.70	16.3	-	-222	
		+/-3.0%	+/-3.0%		+/- 0.1	+/-10%	+/-3.0%	+/- 10 mV	

Comments (e.g. condition of headworks, colour, odour):

SAMPLING DETAILS

SAMPLING DETAILS		**Sample ID: SHP8**		
Date 18/10/2016	**Time: 1220**	**Undertaken By: S Petts**		
PID reading: - ppm	**Depth to LNAPL:** - m	**Depth to Water:** 2.17 m	**Depth to DNAPL** - m	
Flow Rate: 0.004 L/s	**Vol. Removed:** 5L	**Sampling Method:** Low Flow		
Temp.: 20.2 ºC	**DO:** -ppm mg/L	**pH:** 7.70	**EC:** 3.79 mS/cm	**Eh:** -222 mV
	DO: 16.3 %Sat		**Turbidity** -3.7 NTU	

Comments (e.g. containers, filtration):

All metals field filtered

CoC Number: 20161018	**Checked by:** S Petts	**Date:** 18/10/2016

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[1] Bores to be purged dry, until pH, T and EC readings stabilise or a minimum of 3 to 5 times the water column volumes. Water column volumes can be calculated from the following casing volumes per unit length: 40 mm ID - 1 L/m; 50 mm ID – 2 L/m; 100 mm ID 8 L/m.

[2] Calibration details to be recorded in the instrument –specific calibration book, or in field notes as required by local procedures.

Appendix E – Quality Assurance and Quality Control

E1 Introduction

The Quality Assurance/Quality Control (QA/QC) procedures are based on the DER Assessment and management of contaminated sites (DER 2014), ASC NEPM (NEPC 1999), AS 4482.1 – 2005 (Standards Australia 2005), AS 4482.2 – 1999 (Standards Australia 1999) and AS 5667 – 1998 (Standards Australia 1998). QA involves all of the actions, procedures, checks and decisions, undertaken to ensure the representativeness and integrity of samples and accuracy and reliability of analytical results. QC involves protocols to monitor and measure the effectiveness of QA procedures.

E2 Field Work Program

E2.1 Field Quality Assurance Procedures

All field work was conducted with reference to the DER (2014) and GHD's Standard Field Operating Procedures, which ensures all environmental samples are collected by a set of uniform and systematic methods, as required by GHD's QA system. The procedures undertaken as part of the soil and groundwater assessments includes:

- Decontamination Procedures: Included the use of new disposable gloves for the collection of each sample, decontamination of the sampling equipment between each sampling event and the use of sampling containers provided by the laboratory;
- Sample Identification Procedures: Collected samples are immediately transferred to sample containers of appropriate composition and preservation for the required laboratory analysis. All sample containers were clearly labelled with a sample number, sample location, sample depth, sample date and sampler's initials. The sample containers were transferred to a chilled esky for sample preservation prior to and during shipment to the testing laboratory;
- Chain of Custody Information Requirements: A chain of custody form was completed and forwarded to the testing laboratory with all sample batches and in some instances emailed separately to the laboratory prior to the Esky's arrival to the laboratories. The purpose of this was to provide the laboratory notification of samples requiring extraction upon arrival; and
- Sample blind duplicate and split duplicate, rinsate blank and field blank frequency.

E2.2 Groundwater Sampling and Analysis Quality Control

The DER Contaminated Sites Management Guidelines outlines the requirements for Quality Control (QC) sampling protocols. The QC samples collected during the investigation are described below and presented in **Table E1**.

Blind (Intra-laboratory) Duplicates

Blind (Intra-laboratory) duplicate samples were used to identify the variation in the analyte concentration between samples collected from the same sampling point and the repeatability of the laboratory's analysis.

Split (Inter-laboratory) Duplicates

Inter-laboratory duplicate samples provide an indication of the repeatability of the results between laboratories.

Rinsate Blanks

Rinsate blank samples are water samples collected from decontaminated, re-used field equipment and used primarily to assess whether the decontamination procedure is effective and if cross-contamination has led to positive observations in subsequent samples.

Rinsate samples were collected by pouring laboratory supplied ultra-high purity rinsate water over the probe of water quality meters and interface probes or running it through the pump and collecting it in laboratory supplied containers. Rinsate samples are then transferred to a chilled esky for sample preservation prior to and during shipment to the testing laboratory.

Field Blanks

Field blank samples were used to estimate contamination of a sample during the collection procedure.

Field blank samples are collected by pouring laboratory supplied rinsate water into laboratory supplied bottles onsite. Field blank samples are then transferred to a chilled esky for sample preservation prior to and during shipment to the testing laboratory.

Table E1   Quality Control Sampling Frequency

Sample	Sample Collection Frequency
Blind (Intra-laboratory) Duplicates	1:20 samples
Split (Inter-laboratory) Duplicates	1:20 samples
Equipment Rinsate Blanks	1 per matrix per day
Field Blanks	1 per matrix per day

E2.3 Relative Percent Difference Calculations

Blind and split duplicate samples were assessed by calculating the relative percentage difference (RPD) between the primary, blind and split samples.

A quantitative measure of the accuracy of the analytical results reported was made by calculating the RPDs between the primary, blind and split results in accordance with the procedure described in AS 4482.1 - 2005. According to AS 4482.1 - 2005 typical RPDs are expected to range between 30% and 50%; however, this may be higher for organics and for low concentrations of analytes. GHD uses 50% as the general assessment criteria.

Where a result was reported below the laboratory limit of reporting (LOR) for one of the duplicate pair samples, the sample will be assigned the concentration of the LOR for RPD calculation purposes.

E3 Laboratory Program

Samples were dispatched to various nominated NATA accredited laboratories for the analytes of concern, with Chain of Custody documentation acknowledging the transference of samples from the Site to the laboratory. The primary and blind duplicate samples were dispatched to ALS Laboratory Group. The split duplicate samples were dispatched to SGS Environmental.

E3.1 Laboratory Analytical Methods

Laboratory methods used by the primary and secondary laboratories are considered suitable for environmental contaminant analysis and are based on established internationally recognised procedures. Each of the laboratories were NATA accredited for the proposed analysis.

Table E2 Laboratory Methods, LORs and Laboratory Holding Times for Groundwater Analysis

Analyte	Method	Limits of Reporting (LOR)	Holding Times
Ammonia	APHA 4500-NH 3 B/C	0.05 mg/L	1 day
Nitrite	APHA 4110/4500-NO_2	0.05 mg/L	2 days
Nitrate	APHA 4110	0.05 mg/L	2 days
Total Nitrogen	APHA 4500-N	0.05 mg/L	28 days
Total Dissolved Solids	APHA 2540C	10 µg/L	7 days
E. coli (MF)	AS4275:21-2005	1 cfu/100 mL	24 hours

E3.2 Laboratory Quality Control Procedures

The following laboratory QC procedures were used during the investigation.

Laboratory Duplicate Samples

Laboratory duplicate sample analysis were the analysis of a laboratory derived duplicate sample from the process batch, at a rate equivalent to one in twenty samples per analytical batch, or one sample per batch if less than twenty samples are analysed in a batch. A laboratory duplicate provides data on the analytical precision and reproducibility of the analytical results.

The permitted ranges for the RPD of Laboratory Duplicates, as specified in ALS Method QWI-EN/38 are dependent on the magnitude of results in comparison to the level of reporting. For RPD results that are less than ten times the limit of reporting (LOR) there are no limits, for results between ten and twenty times the LOR the adopted criteria are 0% - 50% and for results greater than twenty times LOR the criteria are 0% - 20%.

Method Blank Samples

Method or analysis blank sample analysis is the analysis of a sample that is as free as possible of the analytes of interest, but has been prepared the same as the samples under investigation. The analysis is to ascertain if laboratory reagents, glassware and other laboratory consumables contribute to the observed concentration of analytes in the process batch. If below the maximum acceptable method blank (20% of the practical quantitation limit), the contribution is subtracted from the gross analytical signal for each analysis before calculating the sample analyte concentration. GHD notes that the subtraction of the method blank concentration is not appropriate for some organic analytes.

Laboratory Control Spike Samples

Laboratory control spike analysis is the analysis of either a reference material or a control matrix fortified with analytes representative of the analyte class. The purpose of laboratory control spike samples is to monitor method precision and accuracy independent of the sample matrix. Typically, the percent recovery of the laboratory control spike sample is compared to the dynamic recovery limits based on the statistical analysis of the processed laboratory control spike sample analysis.

Matrix Spike Samples

Matrix spike sample analysis is the analysis of one or more replicate portions of samples from the batch, after fortifying the additional portion(s) with known quantities of the analyte(s) of interest. The percent recovery of target analyte(s) from matrix spike samples is used to determine the bias of the method in the specific sample matrix.

Surrogate Spike Samples

Surrogate spike samples are samples with known additions of known amounts of compounds, which are similar to the analytes of interests in terms of extractability, recovery through clean-up procedures and response to chromatographic or other measurement. Surrogate compounds may be alkylated or halogenated analogues or structural isomers of analytes of interest. The purpose of surrogate spikes, which are added immediately before the sample extraction step, is to provide a check for every analysis that no gross processing errors have occurred, which could have led to significant analyte loss or faulty calculation.

Internal Standards

Internal standards are known additions of known amounts of compounds which are not found in real samples, will not interfere with quantification of analytes of interest and may be separately and independently quantified. The purpose of internal standards in instrumental techniques is to provide independent signals, which serve to check the consistency of the analytical step. Internal standards are often used for organic compounds and some inorganic compounds.

E4 Data Management

Laboratory results were reviewed within five working days of receipt from the laboratory.

The individual testing laboratory conducted an assessment of the laboratory QC program, internally, however the results will also be independently reviewed and assessed by GHD, to ensure that no issues exist with the data prior to undertaking any data interpretation. GHD reviewed the Laboratories' quality control certificate and identified any outliers. The outliers identified are discussed in the sections below.

Following receipt of data, the groundwater results were converted to ESDAT format and compared against the adopted criteria provided in Section 6.1 Subsequent to this the ESDAT format was modified to ensure that only test pits location relevant to the Site were presented. All data will be stored in an electronic format as well as produced in hard copy. The hard copies were stored along with chain of custody (CoC) forms in the project file. The CoC forms and laboratory certificates are presented in Appendix F.

E5 Sampling and Analysis Quality Control Results: Groundwater

E5.1 Sample Duplicates

The blind and split duplicated QC samples collected for the 2016 GME is listed in Table E3. The split sample was not analysed for microbes as a result of issues associated with sample receipts department. The split sample was processed outside the 24 hour holding and therefore the laboratory was advised not to proceed with analysing this sample for microbes.

Table E3 Sample Duplicates

Primary Sample	QC Sample	Description	Date	Analyses
MW1	QC01_20160824	Blind – ALS	24/08/2016	Ammonia, BOD, E. coli, Faecal coliforms, total coliforms, nitrates, nitrite, TDS, TKN, total nitrogen, total phosphorus
MW1	QC02_20160824	Split – SGS	24/08/2016	Ammonia, BOD, nitrates, nitrite, TDS, TKN, total nitrogen, total phosphorus
MW1	QC01_20160923	Blind – ALS	23/09/2016	Ammonia, BOD, E. coli, Faecal coliforms, total coliforms, nitrates, nitrite, TDS, TKN, total nitrogen, total phosphorus
MW1	QC02_20160923	Split – mpl	23/09/2016	Ammonia, BOD, E. coli, Faecal coliforms, total coliforms, nitrates, nitrite, TDS, TKN, total nitrogen, total phosphorus
MW1	QC01_20161018	Blind – ALS	18/10/2016	Ammonia, BOD, E. coli, Faecal coliforms, total coliforms, nitrates, nitrite, TDS, TKN, total nitrogen, total phosphorus
MW1	QC02_20161018	Split – mpl	18/10/2016	Ammonia, BOD, E. coli, Faecal coliforms, total coliforms, nitrates, nitrite, TDS, TKN, total nitrogen, total phosphorus

Rinsate and Field Blanks

The rinsate and field blanks collected during the groundwater investigation undertaken in 2016 are listed in Table E4.

Table E4 Rinsate and Field Blanks

QC Sample	Description	Date	Analysis
QC03_20160824	Rinsate blank	24/08/2016	Ammonia, BOD, Nitrate, Nitrite, TDS, TKN, total nitrogen and total phosphorus
QC04_20160824	Field blank	24/08/2016	Ammonia, BOD, Nitrate, Nitrite, TDS, TKN, total nitrogen and total phosphorus
QC03_20160922	Rinsate blank	23/09/2016	Ammonia, BOD, Nitrate, Nitrite, TDS, TKN, total nitrogen and total phosphorus
QC04_20160922	Field blank	23/09/2016	Ammonia, BOD, Nitrate, Nitrite, TDS, TKN, total nitrogen and total phosphorus
QC03_20161018	Rinsate blank	18/10/2016	Ammonia, BOD, Nitrate, Nitrite, TDS, TKN, total nitrogen and total phosphorus
QC03_20161018	Field blank	18/10/2016	Ammonia, BOD, Nitrate, Nitrite, TDS, TKN, total nitrogen and total phosphorus

A summary of the reported detects within field and rinsate blank samples is provided:

- QC03_20160824 (rinsate sample) detected BOD above the LOR (5 mg/L). Primary samples reported BOD to range between 4 mg/L and 7 mg/L. Considering two primary samples reported BOD below 5 mg/L, it is unlikely that this detect would impact the overall integrity of the data;
- QC03_20160922 (rinsate sample) detected TDS above the LOR (20 mg/L). Considering the concentrations of Primary samples which reported TDS to range between 1,320 mg/L to 22,400 mg/L, which were reported in three orders of magnitude greater this QC sample; therefore, it is considered that this would no impact on the integrity of the data;
- QC03_20161018 (rinsate sample) and QC04_20161018 (field blank) reported total dissolved solids, ammonia marginally above the LOR. It is likely that the source of this contamination is associated within laboratory supplied water and therefore it is considered that this would no impact on the integrity of the data;

- QC04_20161018 (field blank) reported nitrate and nitrite, the source of this contamination is unknown. Notwithstanding this, the detects are equal to the LOR and considering that two primary samples reported both these CoPC below the LOR. It is therefore considered unlikely that this detect would impact the overall integrity of the data;

Relative Percentage Difference Calculation Results

During the 2016 GME, 79 RPDs were calculated on field samples with six RPDs exceeding the recovery limit of 50%. RPDs for the groundwater investigation are presented in Appendix G and the RPD exceedances are summarised in Table E5.

Table E5 Groundwater RPDs Greater than 50%

Primary/Duplicate Sample Name	Analytes with RPD exceeding 50%	Comment
MW1/QC01_20160824	Coliform (200%)	The primary sample (250, 000 cfu/100 mL) was reported higher than the blind sample (200 cfu/100 mL). These two samples are in four orders of magnitude and the difference between the two samples is a result of the primary sample having a higher amount of particulate matter than the blind sample.
	Faecal Coliform (138%)	The blind sample (1100 cfu/100mL) was higher than the primary (200 cuf/100mL). The difference between the primary and blind is a result higher level of particulate, which may be masked by overgrowth of non-target organisms.
	E. coli (138%)	
MW1/QC02_20160923	BOD (144%)	The primary sample reported a concentration (31 mg/L) above the LOR, while the split duplicated reported a concentration below the L0R (<1 mg/L). The elevated RPD suggested that the primary laboratory may have over reported the BOD concentration. By considering the primary sample concentration when evaluating the groundwater quality, GHD considers that a conservative approach has been implemented in this regard and secondary laboratory is unlikely to have impacted upon data quality and the overall conclusions drawn.
	Plate Count 36^{o}C (67%)	The split sample (340 cfu/100 mL) was higher than the primary. The different incubation temperatures used by the primary and secondary laboratory, likely has attributed to the different plate count. With consideration to the above, the elevated RPD value for this duplicate is not considered to have significantly impacted upon the overall data quality.
	Plate Count 22^{o}C (67%)	The split sample (260 cfu/100 mL) was higher than the primary. The different incubation temperatures used by the primary and secondary laboratory, likely has attributed to the different plate count. With consideration to the above, the elevated RPD value for this duplicate is not considered to have significantly impacted upon the overall data quality.

Primary/Duplicate Sample Name	Analytes with RPD exceeding 50%	Comment
	Nitrite as N (197%)	The primary sample was reported below the LOR (0.01 mg/L) while the secondary reported a concentration above the LOR (0.006 mg/L). The RPD is a reflection of the different LOR used by the primary and secondary. The secondary utilises a low LOR, as the detected concentration in secondary is below the primary laboratory's LOR. With consideration to the above, the elevated RPD value for this duplicate is not considered to have significantly impacted upon the overall data quality.
	Nitrate as N (195%)	The primary sample reported a concentration (0.05 mg/L) above the LOR, while the split duplicated reported a concentration below the L0R (<0.005 mg/L). The difference between the primary and secondary are the laboratory limit of reporting. Notwithstanding this, the elevated RPD suggested that the primary laboratory may have over reported the BOD concentration. By considering the primary sample concentration when evaluating the groundwater quality, GHD considers that a conservative approach has been implemented in this regard and secondary laboratory is unlikely to have impacted upon data quality and the overall conclusions drawn.
MW1	BOD (81%)	The primary sample (33 mg/L) was higher than the split sample (14 mg/L). The elevated RPD suggested that the primary laboratory may have over reported the BOD concentration. By considering the primary sample concentration when evaluating the groundwater quality, GHD considers that a conservative approach has been implemented in this regard and secondary laboratory is unlikely to have impacted upon data quality and the overall conclusions drawn

E5.2 Laboratory Quality Control Results

Laboratory Duplicates

There were no RPD outliers for laboratory duplicate samples reported by ALS or SGS

Method Blank Samples

There were no method blank recovery value outliers reported by ALS or SGS. GHD considers that the analyses methods used were free from potential laboratory contamination and that the data is suitable for Site soil characterisation.

Laboratory Control Spike Samples

There were no laboratory control outliers reported by ALS or SGS. GHD considers the results from all analyses performed to be sufficiently accurate and independent of the sample matrix and therefore the data is suitable for soil characterisation.

Matrix Spike Samples

There were no matrix spike outliers reported by ALS or SGS for the 2016 groundwater investigation.

Surrogate Spike Samples

There were no surrogate recovery outliers reported by ALS or SGS for the 2016 GME.

E5.3 Review of Sample Management

Laboratory Holding Times

Analysis of samples within analyte specific holding times serves as a measure of QA. The official certificates of analysis and sample receipt notifications obtained from the contracted laboratories reported groundwater analysis was generally completed within specified holding times, with the non-conformance presented in Table E6.

Table E6 Holding Time Non-conformance

Analysis	Samples	Due for Analysis	Date Analysed	Comment
Nitrate Nitrogen and Nitrite Nitrogen	QC02	28/09/2016	29/09/2016	GHD compared the QC02 results with the primary. The reported concentrations appear to be in a similar order of magnitude.
Total Dissolved Solids	QC02	31/08/2016	1/09/2016	

Chain of Custody Forms and Sample Receipts

GHD used Chain of Custody (CoC) forms during the groundwater investigations to establish the traceability of samples and these are attached in Appendix F. A review of the CoC forms by GHD indicates that all prescribed sample transfer, transport and storage protocols were complied with. Sample receipts are presented in Appendix F.

E6 Quality Control and Quality Assurance Summary

The review of the QA/QC results indicates that, overall, the data reported is considered to be of an acceptable quality upon which to draw meaningful conclusions regarding impacts to groundwater at the Site and are within the scope of this investigation for the following reasons:

- **Data Representativeness:** The sampling methodology provided a uniform and systematic approach to the collection of all environmental samples. Laboratory and field QA/QC procedures were carried out to measure data representativeness. Consequently, data representativeness is considered to have been satisfied;
- **Completeness**: It is considered that the field QA/QC procedures carried out, such as the blind and split sample duplicate collection frequencies, and the analytes tested provides completeness in terms of the required number of field duplicate samples. Laboratory QA/QC sample analysis is considered sufficient to provide a complete overview of QA/QC procedures;
- **Precision:** GHD considers that laboratory results are acceptable for interpretation with regards to the suitability of the site for the proposed land use;
- **Accuracy:** Sampling procedures ensured that collection, preservation and laboratory analytical techniques are appropriate for analysis of environmental contaminants.
  - Rinsate blank, field blank and trip blank sample results have been discussed and results indicate that cross-contamination of samples through collection or transport of the samples to the laboratory is unlikely to have occurred and therefore is not considered to have impacted interpretation of contamination at the site.
- **Comparability:** All field work was conducted with reference to the DER Contaminated Sites Management Series Guidelines and GHD Standard Operating Procedures, which ensured all samples were collected by a set of uniform and systematic methods, as required by GHD’s QA system. GHD considers that the laboratory data are of a suitable quality for assessing the environmental status of the site.

Consequently, the review of QA procedures and QC results from the primary and secondary laboratories indicates that the analytical data are considered to be of an acceptable quality upon which to draw meaningful conclusions regarding the impacts to soil and groundwater at the site within the scope of this investigation. Any laboratory issues have been listed above and discussed within their relevant sections.

Appendix F – Chain of Custody and Laboratory Reports

CHAIN OF CUSTORDY RECORD AND ANALYSIS REQUEST

CLIENTS | PEOPLE | PERFORMANCE

GHD House 239 Adelaide Terrace Perth WA 6004
PO Box Y3106 Perth WA 6832
Telephone 08 6222 8222 Facsimile 08 6222 8555

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COC No.

Point Moore Groundwater Assessment

Laboratory:MGT

Client City of Greater Geraldton

Job No. 61/34772

Address: Unit 2, 91 Leach Highway, Kewdale WA 6105

Laboratory Contact: Natalie

Laboratory Quote No.

Turnaround Time

Job Manager (Invoice) Andrew Nagle

Email Address (Results)
andrew.nagle@ghd.com
steven. petts@ghd.com

					Container				**Analyses**														**Remarks**
GHD Sample ID	**Laboratory Sample ID**	**Date**	**Time**	**Sample Matrix** S-Soil/ SL-Sludge/ W-Water/ A-Air	**Type** B-Bottle/J-Jar/V-Vial/Bag/G-Glass/P-Plastic	**Preservative** Unpreserved/ HCl/ H2SO4/HNO3/Other	**No**	**Total Volume (mL)**														**Hold**	
MW1_0.5		15/08/2016		S	J	NA	1	250														☒	
MW1_1.0		15/08/2016		S	J	NA	1	250														☒	
MW1_1.5		15/08/2016		S	J	NA	1	250														☒	
MW1_2.0		15/08/2016		S	J	NA	1	250														☒	
MW1_2.5		15/08/2016		S	J	NA	1	250														☒	
MW1_3.0		15/08/2016		S	J	NA	1	250														☒	
MW1_3.5		15/08/2016		S	J	NA	1	250														☒	
MW2_0.5		15/08/2016		S	J	NA	1	250														☒	
MW2_1.0																							
MW2_1.5		15/08/2016		S	J	NA	1	250														☒	
MW2_2.0		15/08/2016		S	J	NA	1	250														☒	
MW2_2.5		15/08/2016		S	J	NA	1	250														☒	
MW2_3.5		15/08/2016		S	J	NA	1	250														☒	
MW2_4.0		15/08/2016		S	J	NA	1	250														☒	
MW2_4.5		15/08/2016		S	J	NA	1	250														☒	
MW2_5.0		15/08/2016		S	J	NA	1	250														☒	
MW2_5.5		15/08/2016		S	J	NA	1	250														☒	

MW2_6.0		15/08/2016		S	J	NA	1	250														☒	
QC01_15082016		15/08/2016		S	J	NA	1	250														☒	
QC02_15082016		15/08/2016		S	J	NA	1	250														☒	
MW3_0.5		15/08/2016		S	J	NA	1	250														☒	
MW3_1.0		15/08/2016		S	J	NA	1	250														☒	
MW3_1.5		15/08/2016		S	J	NA	1	250														☒	
MW3_2.0		15/08/2016		S	J	NA	1	250														☒	
MW3_2.5		15/08/2016		S	J	NA	1	250														☒	
MW3_3.0		15/08/2016		S	J	NA	1	250														☒	
MW3_3.5		15/08/2016		S	J	NA	1	250														☒	
MW3_4.0		15/08/2016		S	J	NA	1	250														☒	
MW3_4.5		15/08/2016		S	J	NA	1	250														☒	
MW3_5.0		15/08/2016		S	J	NA	1	250														☒	
MW3_5.5		15/08/2016		S	J	NA	1	250														☒	
MW3_6.0		15/08/2016		S	J	NA	1	250														☒	
QC03_15082016		15/08/2016		S	J	NA	1	250														☒	
QC04_15082016		15/08/2016		S	J	NA	1	250														☒	

Sampled by: S. Petts	Date/Time: 15/08/2016	Relinquished by: S.Petts	Date/ Time: 15/08/2016
Received by:	Date/Time:	Relinquished by:	Date/ Time:
Received by Lab:	Date/Time:	Courier/ Transport Company: NA	
Sample Conditions:	Remarks:		

ALS Environmental

CERTIFICATE OF ALLYSIS

Work Order	: **EP1607778**	Page	: 1 of 4
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: MR ANDREW NAGLE	Contact	: Lauren Biagioni
Address	: 999 HAY STREET PERTH WA 6000	Address	: 10 Hod Way Malaga WA Australia 6090
Telephone	: +61 08 6222 8222	Telephone	: 08 9209 7655
Project	: 61/34772 Point Moore Groundwater Assessment	Date Samples Received	: 25-Aug-2016 09:20
Order number	: ----	Date Analysis Commenced	: 25-Aug-2016
C-O-C number	: ----	Issue Date	: 31-Aug-2016 16:11
Sampler	: STEVEN PETTS		
Site	: ----		
Quote number	: ----		
No. of samples received	: 7		
No. of samples analysed	: 7		

ilac-MRA NATA

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Alini Goundar	Senior Analyst	Perth Microbiology, Malaga, WA
Jeremy Truong	Laboratory Manager	Perth Inorganics, Malaga, WA
Tyrone Cole	Inorganics Preparation Supervisor	Perth Inorganics, Malaga, WA

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.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

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.
~ = Indicates an estimated value.

- CFU = colony forming unit
- MF = membrane filtration
- TDS by method EA-015 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- MW002: estimate (~) is reported where the growth of bacteria is counted <10cfu and or >300cfu.
- MW006, estimate (~) is reported where the growth of presumptive bacteria on the filtered membrane is counted <10 cfu and/or >100 cfu.
- MW002 is ALS's internal code and is equivalent to AS4276.3.1.
- MW006 is ALS's internal code and is equivalent to AS4276.7.
- MW007 is ALS's internal code and is equivalent to AS4276.5.

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**MW1**	**QC01_20160824**	**MW2**	**MW3**	**SHP8**
			Client sampling date / time	[24-Aug-2016]	[24-Aug-2016]	[24-Aug-2016]	[24-Aug-2016]	[24-Aug-2016]
Compound	*CAS Number*	*LOR*	*Unit*	**EP1607778-001**	**EP1607778-002**	**EP1607778-003**	**EP1607778-004**	**EP1607778-005**
				Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**8890**	**8800**	**1480**	**1090**	**3320**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**2.68**	**2.86**	**0.53**	**0.57**	**0.36**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	**0.20**	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.19**	**0.18**	**13.8**	**0.02**	**0.02**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.19**	**0.18**	**14.0**	**0.02**	**0.02**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**3.0**	**2.9**	**3.1**	**0.7**	**1.5**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**3.2**	**3.1**	**17.1**	**0.7**	**1.5**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.29**	**0.30**	**0.21**	**0.06**	**0.31**
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	**6**	**6**	**7**	**4**	**4**
MW002: Heterotrophic Plate Count								
Heterotrophic Plate Count (22°C)	----	1	CFU/mL	**~49000**	**~60000**	**~13000**	**~70000**	**910**
Heterotrophic Plate Count (36°C)	----	1	CFU/mL	**~46000**	**~49000**	**~11000**	**~68000**	**110**
MW006: Faecal Coliforms & E.coli by MF								
Faecal Coliforms	----	1	CFU/100mL	**~200**	**1100**	**~400**	**~400**	**~100**
Escherichia coli	----	1	CFU/100mL	**~200**	**1100**	**~400**	**~400**	**~100**
MW007: Coliforms by MF								
Coliforms	----	1	CFU/100mL	**250000**	**~200**	**~1000**	**~3000**	**~200**

Analytical Results

Sub-Matrix: **WATER** **(**Matrix: **WATER)**			*Client sample ID*	**QC03_20160824**	**QC04_20160824**	**----**	**----**	**----**
			Client sampling date / time	[24-Aug-2016]	[24-Aug-2016]	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EP1607778-006**	**EP1607778-007**	**--------**	**--------**	**--------**
				Result	Result	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	<10	<10	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	<0.1	<0.1	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	----	----	----
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	**5**	<2	----	----	----
MW002: Heterotrophic Plate Count								
Heterotrophic Plate Count (22°C)	----	1	CFU/mL	----	----	----	----	----
Heterotrophic Plate Count (36°C)	----	1	CFU/mL	----	----	----	----	----
MW006: Faecal Coliforms & E.coli by MF								
Faecal Coliforms	----	1	CFU/100mL	----	----	----	----	----
Escherichia coli	----	1	CFU/100mL	----	----	----	----	----
MW007: Coliforms by MF								
Coliforms	----	1	CFU/100mL	----	----	----	----	----

ALS Environmental

QUALITY CONTROL REPORT

Work Order : **EP1607778**

Client : **GHD PTY LTD**
Contact : MR ANDREW NAGLE
Address : 999 HAY STREET
PERTH WA 6000
Telephone : +61 08 6222 8222
Project : 61/34772 Point Moore Groundwater Assessment
Order number : ----
C-O-C number : ----
Sampler : STEVEN PETTS
Site : ----
Quote number : ----
No. of samples received : 7
No. of samples analysed : 7

Page : 1 of 4

Laboratory : Environmental Division Perth
Contact : Lauren Biagioni
Address : 10 Hod Way Malaga WA Australia 6090
Telephone : 08 9209 7655
Date Samples Received : 25-Aug-2016
Date Analysis Commenced : 25-Aug-2016
Issue Date : 31-Aug-2016

ilac-MRA NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Alini Goundar	Senior Analyst	Perth Microbiology, Malaga, WA
Jeremy Truong	Laboratory Manager	Perth Inorganics, Malaga, WA
Tyrone Cole	Inorganics Preparation Supervisor	Perth Inorganics, Malaga, WA

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 hig

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 (%)*
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 564719)									
EP1607760-009	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	6310	6080	3.81	0% - 20%
EP1607760-001	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	6260	6170	1.45	0% - 20%
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 562898)									
EP1607778-001	MW1	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	2.68	2.72	1.60	0% - 20%
EP1607791-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.04	0.09	73.8	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 562895)									
EP1607778-001	MW1	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: 562899)									
EP1607778-001	MW1	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.19	0.17	10.2	0% - 50%
EP1607791-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.25	0.22	12.1	0% - 20%
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 566331)									
EP1607775-011	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	2.3	2.4	6.62	0% - 50%
EP1607778-006	QC03_20160824	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	0.1	0.00	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 566330)									
EP1607775-011	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.22	0.21	0.00	0% - 50%
EP1607778-006	QC03_20160824	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP030: Biochemical Oxygen Demand (BOD) (QC Lot: 562689)									
EP1607769-001	Anonymous	EP030: Biochemical Oxygen Demand	----	2	mg/L	4	4	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 Spike (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*
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 564719)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	99.0	83	111
				<10	293 mg/L	107	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 562898)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	109	87	115
EK057G: Nitrite as N by Discrete Analyser (QCLot: 562895)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	99.2	86	112
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 562899)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	112	92	112
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 566331)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	84.8	82	110
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 566330)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	86.8	70	130
EP030: Biochemical Oxygen Demand (BOD) (QCLot: 562689)								
EP030: Biochemical Oxygen Demand	----	2	mg/L	<2	198 mg/L	92.8	78	117

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*
EK055G: Ammonia as N by Discrete Analyser (QCLot: 562898)							
EP1607778-002	QC01_20160824	EK055G: Ammonia as N	7664-41-7	1 mg/L	96.8	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 562895)							
EP1607778-002	QC01_20160824	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	107	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 562899)							
EP1607778-002	QC01_20160824	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	111	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 566331)							
EP1607775-011	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	90.2	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 566330)							
EP1607775-011	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	97.6	70	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP1607778**	Page	: 1 of 6
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: MR ANDREW NAGLE	Telephone	: 08 9209 7655
Project	: 61/34772 Point Moore Groundwater Assessment	Date Samples Received	: 25-Aug-2016
Site	: ----	Issue Date	: 31-Aug-2016
Sampler	: STEVEN PETTS	No. of samples received	: 7
Order number	: ----	No. of samples analysed	: 7

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.**
- **NO Matrix Spike outliers occur.**
- **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

- **NO Quality Control Sample Frequency Outliers exist.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

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*
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H) MW1, QC01_20160824, MW2, MW3, SHP8, QC03_20160824, QC04_20160824	**24-Aug-2016**	**----**	----	----	**29-Aug-2016**	31-Aug-2016	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) MW1, QC01_20160824, MW2, MW3, SHP8, QC03_20160824, QC04_20160824	**24-Aug-2016**	**----**	----	----	**25-Aug-2016**	21-Sep-2016	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) MW1, QC01_20160824, MW2, MW3, SHP8, QC03_20160824, QC04_20160824	**24-Aug-2016**	**----**	----	----	**25-Aug-2016**	26-Aug-2016	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) MW1, QC01_20160824, MW2, MW3, SHP8, QC03_20160824, QC04_20160824	**24-Aug-2016**	**----**	----	----	**25-Aug-2016**	21-Sep-2016	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) MW1, QC01_20160824, MW2, MW3, SHP8, QC03_20160824, QC04_20160824	**24-Aug-2016**	**31-Aug-2016**	21-Sep-2016	✓	**31-Aug-2016**	21-Sep-2016	✓

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*
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) MW1, QC01_20160824, MW2, MW3, SHP8, QC03_20160824, QC04_20160824	**24-Aug-2016**	**31-Aug-2016**	21-Sep-2016	✓	**31-Aug-2016**	21-Sep-2016	✓
EP030: Biochemical Oxygen Demand (BOD)							
Clear Plastic Bottle - Natural (EP030) MW1, QC01_20160824, MW2, MW3, SHP8, QC03_20160824, QC04_20160824	**24-Aug-2016**	**----**	----	----	**25-Aug-2016**	26-Aug-2016	✓
MW002: Heterotrophic Plate Count							
Sterile Plastic Bottle - Sodium Thiosulfate (MW002) MW1, QC01_20160824, MW2, MW3, SHP8	**24-Aug-2016**	**----**	----	----	**25-Aug-2016**	25-Aug-2016	✓
MW006: Faecal Coliforms & E.coli by MF							
Sterile Plastic Bottle - Sodium Thiosulfate (MW006) MW1, QC01_20160824, MW2, MW3, SHP8	**24-Aug-2016**	**----**	----	----	**25-Aug-2016**	25-Aug-2016	✓
MW007: Coliforms by MF							
Sterile Plastic Bottle - Sodium Thiosulfate (MW007) MW1, QC01_20160824, MW2, MW3, SHP8	**24-Aug-2016**	**----**	----	----	**25-Aug-2016**	25-Aug-2016	✓

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)							
Ammonia as N by Discrete analyser	EK055G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Biochemical Oxygen Demand (BOD)	EP030	1	9	**11.11**	**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	1	7	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	20	**10.00**	**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 Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Biochemical Oxygen Demand (BOD)	EP030	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	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	20	**10.00**	**10.00**	✓	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 Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Biochemical Oxygen Demand (BOD)	EP030	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	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	20	**5.00**	**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 Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**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	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 Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**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*
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. 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)
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)
Biochemical Oxygen Demand (BOD)	EP030	WATER	In house: Referenced to APHA 5210 B. The 5-Day BOD test provides an empirical measure of the oxygen consumption capacity of a given water. A portion of the sample is diluted into oxygenated, nutrient rich water, and a seed added to begin biological decay. The initial dissolved oxygen content is measured, then the bottle is sealed and incubated for five days. The remaining dissolved oxygen is measured, and from the difference, the demand for oxygen, by biological decay, is determined. This method is compliant with NEPM (2013) Schedule B(3)
Heterotrophic (Total) Plate Count @ 22C and 36C	MW002	WATER	In house: Referenced to AS4276.3.1- 2007
Thermotolerant Coliforms & E.coli by Membrane Filtration	MW006	WATER	In house: Referenced to AS 4276.7 2007
Coliforms by Membrane Filtration	MW007	WATER	In house: Referenced to AS 4276.5 - 2007

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

CHAIN OF CUSTORDY RECORD AND ANALYSIS REQUEST

GHD CLIENTS PEOPLE PERFORMANCE

GHD House 239 Adelaide Terrace Perth WA 6004
PO Box Y3106 Perth WA 6832
Telephone 08 6222 8222 Facsimile 08 6222 8555

Page 1 of 1

COC No.

Point Moore Groundwater Assessment	Laboratory:SGS
Client City of Greater Geraldton	**Job No.** 61/34772
Address: 28 Reid Road, Perth Airport	
Laboratory Contact: Carrianne Graham	
Laboratory Quote No.	**Turnaround Time** Standard
Job Manager (Invoice) Andrew Nagle	**Email Address (Results)** andrew.nagle@ghd.com steven. petts@ghd.com

				Container					Analyses														Remarks
GHD Sample ID	**Laboratory Sample ID**	**Date**	**Time**	**Sample Matrix** S-Soil/ SL-Sludge/ W-Water/ A-Air	**Type** B-Bottle/J-Jar/V-Vial/Bag/G-Glass/P-Plastic	**Preservative** Unpreserved/ HCl/ H2SO4/HNO3/Other	**No**	**Total Volume (mL)**	Total Nitrogen, TKN, Nox, NO2, NO3, NH3, Total Phosphorus ✓	Biochemical Oxygen Demand ✓	TDS - Standard Level ✓	Total (Heterotrophic Plate Count at 22oC and 36oC (TPC) YEA	Total +Faecal Coliforms & E. Coli (MF)									Hold	PE110063
QC02	PE110063.001			W	BP	H2SO4	3	810	☒	☒	☒	☒	☒										

SGS Perth Environmental
PE110063 COC
Received: 24 – Aug – 2016

Sampled by: S. Petts	Date/Time: 24/08/2016	Relinquished by: S.Petts	Date/ Time: 24/08/2016
Received by:	.	Relinquished by:	Date/ Time:
Received by Lab: C. Tadena (Sample)	Date/Time: 25/8/16 @ 1035	Courier/ Transport Company: NA	
Sample Conditions:	Remarks:		

SGS

AUSTRALIA-ENVIRONMENTAL-PERTH AIRPORT- PROFORMA -QU101

REGISTRATION DETAILS

APPROVED BY: R. MA

Bottle Map **Sample Numbers:**	1L Plastic Green	500mL Plastic ACS Green	250mL Plastic Purple	500mL Amber Green	250mL Plastic Green	125mL Plastic Green	125mL UF/F Plastic Red	1L Amber Green	500mL Amber Orange	100mL Amber Green	40mL Glass Vial VOC	40mL Glass Vial HAA	~~500mL~~ 250 Plastic ACS Blue	~~250mL~~ 80mL Plastic ACS Orange	125mL Plastic Brown	250mL Glass Jar	125mL Glass Jar	1L Plastic Yellow	Lab Bottles Supplied	Ziplock Bag/ Other
1		1											1	1						

Job Number: PE 110063

# of Eskies: 1

Esky Numbers:

[✓ IB] / ICE / None

Temp: 12 °C

Tray Numbers: W-524

Registration comments:

Action Taken:

Registered By: CT 26/8/16

ANALYTICAL REPORT

Accreditation No. 2562

CLIENT DETAILS

Contact	Andrew Nagle
Client	GHD Pty Ltd
Address	(PO Box Y3106 PERTH WA 6832) 239 Adelaide Terrace EAST PERTH WA 6004
Telephone	08 6222 8222
Facsimile	08 6222 8555
Email	andrew.nagle@ghd.com
Project	**61/34772_Point Moore Groundwater**
Order Number	**61/34772**
Samples	1

LABORATORY DETAILS

Manager	Ros Ma
Laboratory	SGS Perth Environmental
Address	28 Reid Rd Perth Airport WA 6105
Telephone	(08) 9373 3500
Facsimile	(08) 9373 3556
Email	au.environmental.perth@sgs.com
SGS Reference	**PE110063 R0**
Date Received	24 Aug 2016
Date Reported	02 Sep 2016

COMMENTS

Accredited for compliance with ISO/IEC 17025. NATA accredited laboratory 2562(898/20210).

SIGNATORIES

Louise Hope		Rachel Harrison
Louise Hope Laboratory Technician	Michael McKay Inorganics and ARD Supervisor	Rachel Harrison Inorganics Team Leader

Parameter	Units	LOR	Sample Number PE110063.001 Sample Matrix Water Sample Date 24 Aug 2016 Sample Name QC02

Total Dissolved Solids (TDS) in water Method: AN113 Tested: 1/9/2016

Total Dissolved Solids Dried at 175-185°C	mg/L	10	**7500**

CBOD5 Method: AN183 Tested: 26/8/2016

Biochemical Oxygen Demand (CBOD5)	mg/L	5	<5

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA Method: AN258 Tested: 29/8/2016

Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.05	**0.17**
Nitrite, NO_2 as NO_2	mg/L	0.2	<0.2
Nitrate, NO_3 as NO_3	mg/L	0.2	**0.7**

Ammonia Nitrogen by FIA Method: AN261 Tested: 29/8/2016

Ammonia, NH_3	mg/L	0.05	**2.9**

TKN Kjeldahl Digestion by Discrete Analyser Method: AN281 Tested: 31/8/2016

Total Kjeldahl Nitrogen	mg/L	0.05	**3.1**

Total Phosphorus by Kjeldahl Digestion DA in Water Method: AN279/AN293(Sydney only) Tested: 31/8/2016

Total Phosphorus (Kjeldahl Digestion)	mg/L	0.02	**0.19**

Parameter	Units	LOR	Sample Number: PE110063.001 Sample Matrix: Water Sample Date: 24 Aug 2016 Sample Name: QC02
Calculated Nitrogen Forms - TN, organic N, inorganic N	**Method: AN281/292**	**Tested: 2/9/2016**	
Total Nitrogen (calc)	mg/L	0.05	3.2

QC SUMMARY

MB blank results are compared to the Limit of Reporting
LCS and MS spike recoveries are measured as the percentage of analyte recovered from the sample compared the the amount of analyte spiked into the sample.
DUP and MSD relative percent differences are measured against their original counterpart samples according to the formula : *the absolute difference of the two results divided by the average of the two results as a percentage.* Where the DUP RPD is 'NA' , the results are less than the LOR and thus the RPD is not applicable.

Ammonia Nitrogen by FIA Method: ME-(AU)-[ENV]AN261

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Ammonia, NH_3	LB121813	mg/L	0.05	<0.05	0%	NA

CBOD5 Method: ME-(AU)-[ENV]AN183

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Biochemical Oxygen Demand (CBOD5)	LB121787	mg/L	5	<5	4%	88 - 90%

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA Method: ME-(AU)-[ENV]AN258

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Nitrate/Nitrite Nitrogen, NOx as N	LB121813	mg/L	0.05	<0.05	0 - 5%	102 - 107%

TKN Kjeldahl Digestion by Discrete Analyser Method: ME-(AU)-[ENV]AN281

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Kjeldahl Nitrogen	LB121936	mg/L	0.05	<0.05	0 - 6%	105%

Total Dissolved Solids (TDS) in water Method: ME-(AU)-[ENV]AN113

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery	MS %Recovery	MSD %RPD
Total Dissolved Solids Dried at 175-185°C	LB121986	mg/L	10	<10	1%	104%	102%	2%

Total Phosphorus by Kjeldahl Digestion DA in Water Method: ME-(AU)-[ENV]AN279/AN293(Sydney only)

Parameter	QC Reference	Units	LOR	MB	DUP %RPD	LCS %Recovery
Total Phosphorus (Kjeldahl Digestion)	LB121936	mg/L	0.02	<0.02	0 - 4%	103%

METHOD	METHODOLOGY SUMMARY
	Nitrate and Nitrite by FIA: In an acidic medium, nitrate is reduced quantitatively to nitrite by cadmium metal. This nitrite plus any original nitrite is determined as an intense red-pink azo dye at 540 nm following diazotisation with sulphanilamide and subsequent coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. Without the cadmium reduction only the original nitrite is determined. Reference APHA 4500-NO3- F.
AN106	Conductivity and TDS by Calculation: Conductivity is measured by meter with temperature compensation and is calibrated against a standard solution of potassium chloride. Conductivity is generally reported as µmhos/cm or µS/cm @ 25°C. For soils, an extract with water is made at a ratio of 1:5 and the EC determined and reported on the extract, or calculated back to the as-received sample. Total Dissolved Salts can be estimated from conductivity using a conversion factor, which for natural waters, is in the range 0.55 to 0.75. SGS use 0.6. Reference APHA 2510 B.
AN113	Total Dissolved Solids: A well-mixed filtered sample of known volume is evaporated to dryness at 180°C and the residue weighed. Approximate methods for correlating chemical analysis with dissolved solids are available. Reference APHA 2540 C.
AN183	BOD: Serial dilutions of the sample are firstly combined with various reagents to aid bacterial growth and the sample is incubated for 5 days at 20°C. The difference between the initial and final oxygen contents of the sample is the amount of oxygen consumed by the bacteria. This is related to the organic loading of the sample therefore cBOD is the measure of the digestibility or bioavailability of organic matter in the sample. Reference APHA 5210 B. Internal Reference AN183
AN261	Ammonia by Continuous Flow Analyser: Ammonium in a basic medium forms ammonia gas, which is separated from the sample matrix by diffusion through a polypropylene membrane. The ammonia is reacted with phenol and hypochlorite to form indophenol blue at an intensity proportional to the ammonia concentration. The blue colour is intensified with sodium nitroprusside and the absorbance measured at 630 nm. The sensitivity of the automated method is 10-20 times that of the macro method. Reference APHA 4500-NH3 H.
AN279/AN293(Sydney)	The sample is digested with Sulphuric acid, K2SO4 and CuSO4. All forms of phosphorus are converted into orthophosphate. The digest is cooled and placed on the discrete analyser for colorimetric analysis.
AN281	An unfiltered water or soil sample is first digested in a block digestor with sulfuric acid, K2SO4 and CuSO4. The ammonia produced following digestion is then measured colourimetrically using the Aquakem 250 Discrete Analyser. A portion of the digested sample is buffered to an alkaline pH, and interfering cations are complexed. The ammonia then reacts with salicylate and hypochlorite to give a blue colour whose absorbance is measured at 660nm and compared with calibration standards. This is proportional to the concentration of Total Kjeldahl Nitrogen in the original sample.
AN281/292	Calculation of total nitrogen and organic nitrogen.

FOOTNOTES

IS	Insufficient sample for analysis.	LOR	Limit of Reporting
LNR	Sample listed, but not received.	↑↓	Raised or Lowered Limit of Reporting
*	NATA accreditation does not cover the performance of this service.	QFH	QC result is above the upper tolerance
		QFL	QC result is below the lower tolerance
**	Indicative data, theoretical holding time exceeded.	-	The sample was not analysed for this analyte
		NVL	Not Validated

Samples analysed as received.
Solid samples expressed on a dry weight basis.

Where "Total" analyte groups are reported (for example, Total PAHs, Total OC Pesticides) the total will be calculated as the sum of the individual analytes, with those analytes that are reported as <LOR being assumed to be zero. The summed (Total) limit of reporting is calcuated by summing the individual analyte LORs and dividing by two. For example, where 16 individual analytes are being summed and each has an LOR of 0.1 mg/kg, the "Totals" LOR will be 1.6 / 2 (0.8 mg/kg). Where only 2 analytes are being summed, the " Total" LOR will be the sum of those two LORs.

Some totals may not appear to add up because the total is rounded after adding up the raw values.

If reported, measurement uncertainty follow the ± sign after the analytical result and is expressed as the expanded uncertainty calculated using a coverage factor of 2, providing a level of confidence of approximately 95%, unless stated otherwise in the comments section of this report.

Results reported for samples tested under test methods with codes starting with ARS-SOP, radionuclide or gross radioactivity concentrations are expressed in becquerel (Bq) per unit of mass or volume or per wipe as stated on the report. Becquerel is the SI unit for activity and equals one nuclear transformation per second.
Note that in terms of units of radioactivity:
a. 1 Bq is equivalent to 27 pCi
b. 37 MBq is equivalent to 1 mCi

For results reported for samples tested under test methods with codes starting with ARS-SOP, less than (<) values indicate the detection limit for each radionuclide or parameter for the measurement system used. The respective detection limits have been calculated in accordance with ISO 11929.

The QC criteria are subject to internal review according to the SGS QAQC plan and may be provided on request or alternatively can be found here : http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical%20Documents/MP-AU-ENV-QU-022%20QA%20QC%20Plan.pdf

This document is issued, on the Client's behalf, by the Company under its General Conditions of Service available on request and accessible at http://www.sgs.com/en/terms-and-conditions. The Client's attention is drawn to the limitation of liability, indemnification and jurisdiction issues defined therein.

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STATEMENT OF QA/QC PERFORMANCE

PE110063 R0

CLIENT DETAILS

Contact	Andrew Nagle
Client	GHD Pty Ltd
Address	(PO Box Y3106 PERTH WA 6832) 239 Adelaide Terrace EAST PERTH WA 6004
Telephone	08 6222 8222
Facsimile	08 6222 8555
Email	andrew.nagle@ghd.com
Project	**61/34772_Point Moore Groundwater**
Order Number	**61/34772**
Samples	1

LABORATORY DETAILS

Manager	Ros Ma
Laboratory	SGS Perth Environmental
Address	28 Reid Rd Perth Airport WA 6105
Telephone	(08) 9373 3500
Facsimile	(08) 9373 3556
Email	au.environmental.perth@sgs.com
SGS Reference	**PE110063 R0**
Date Received	24 Aug 2016
Date Reported	02 Sep 2016

COMMENTS

All the laboratory data for each environmental matrix was compared to SGS' stated Data Quality Objectives (DQO). Comments arising from the comparison were made and are reported below.

The data relating to sampling was taken from the Chain of Custody document and was supplied by the Client.
This QA/QC Statement must be read in conjunction with the referenced Analytical Report.
The Statement and the Analytical Report must not be reproduced except in full.

All Data Quality Objectives were met with the exception of the following:

Extraction Date	Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA	1 item
	Total Dissolved Solids (TDS) in water	1 item
Analysis Date	Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA	1 item
	Total Dissolved Solids (TDS) in water	1 item

SAMPLE SUMMARY

Sample counts by matrix	1 water	Type of documentation received	COC
Date documentation received	26/8/2016	Samples received in good order	Yes
Samples received without headspace	Yes	Sample temperature upon receipt	12°C
Sample container provider	ALS	Turnaround time requested	Standard
Samples received in correct containers	Yes	Sufficient sample for analysis	Yes
Sample cooling method	Ice Bricks	Samples clearly labelled	Yes
Complete documentation received	Yes	Number of eskies/boxes received	1

HOLDING TIME SUMMARY

PE110063 R0

SGS holding time criteria are drawn from current regulations and are highly dependent on sample container preservation as specified in the SGS "Field Sampling Guide for Containers and Holding Time" (ref: GU-(AU)-ENV.001). Soil samples guidelines are derived from NEPM "Schedule B(3) Guideline on Laboratory Analysis of Potentially Contaminated Soils". Water sample guidelines are derived from "AS/NZS 5667.1 : 1998 Water Quality - sampling part 1" and APHA "Standard Methods for the Examination of Water and Wastewater" 21st edition 2005.

Extraction and analysis holding time due dates listed are calculated from the date sampled, although holding times may be extended after laboratory extraction for some analytes. The due dates are the suggested dates that samples may be held before extraction or analysis and still be considered valid.

Extraction and analysis dates are shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria. If the sampled date is not supplied then compliance with criteria cannot be determined. If the received date is after one or both due dates then holding time will fail by default.

Ammonia Nitrogen by FIA

Method: ME-(AU)-[ENV]AN261

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
QC02	PE110063.001	LB121813	24 Aug 2016	24 Aug 2016	21 Sep 2016	29 Aug 2016	21 Sep 2016	29 Aug 2016

CBOD5

Method: ME-(AU)-[ENV]AN183

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
QC02	PE110063.001	LB121787	24 Aug 2016	24 Aug 2016	26 Aug 2016	26 Aug 2016	02 Sep 2016	31 Aug 2016

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA

Method: ME-(AU)-[ENV]AN258

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
QC02	PE110063.001	LB121813	24 Aug 2016	24 Aug 2016	28 Aug 2016	29 Aug 2016†	28 Aug 2016	29 Aug 2016†

TKN Kjeldahl Digestion by Discrete Analyser

Method: ME-(AU)-[ENV]AN281

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
QC02	PE110063.001	LB121936	24 Aug 2016	24 Aug 2016	21 Sep 2016	31 Aug 2016	21 Sep 2016	02 Sep 2016

Total Dissolved Solids (TDS) in water

Method: ME-(AU)-[ENV]AN113

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
QC02	PE110063.001	LB121986	24 Aug 2016	24 Aug 2016	31 Aug 2016	01 Sep 2016†	31 Aug 2016	01 Sep 2016†

Total Phosphorus by Kjeldahl Digestion DA in Water

Method: ME-(AU)-[ENV]AN279/AN293(Sydney only)

Sample Name	Sample No.	QC Ref	Sampled	Received	Extraction Due	Extracted	Analysis Due	Analysed
QC02	PE110063.001	LB121936	24 Aug 2016	24 Aug 2016	21 Sep 2016	31 Aug 2016	21 Sep 2016	02 Sep 2016

Surrogate results are evaluated against upper and lower limit criteria established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). At least two of three routine level soil sample surrogate spike recoveries for BTEX/VOC are to be within 70-130% where control charts have not been developed and within the established control limits for charted surrogates. Matrix effects may void this as an acceptance criterion. Water sample surrogate spike recoveries are to be within 40-130%. The presence of emulsions, surfactants and particulates may void this as an acceptance criterion.

Result is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

No surrogates were required for this job.

Blank results are evaluated against the limit of reporting (LOR), for the chosen method and its associated instrumentation, typically 2.5 times the statistically determined method detection limit (MDL).

Result is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

Ammonia Nitrogen by FIA

Method: ME-(AU)-[ENV]AN261

Sample Number	Parameter	Units	LOR	Result
LB121813.001	Ammonia, NH_3	mg/L	0.05	<0.05
LB121813.025	Ammonia, NH_3	mg/L	0.05	<0.05
LB121813.049	Ammonia, NH_3	mg/L	0.05	<0.05
LB121813.073	Ammonia, NH_3	mg/L	0.05	<0.05
LB121813.097	Ammonia, NH_3	mg/L	0.05	<0.05

CBOD5

Method: ME-(AU)-[ENV]AN183

Sample Number	Parameter	Units	LOR	Result
LB121787.001	Biochemical Oxygen Demand (CBOD5)	mg/L	5	<5
LB121787.003	Biochemical Oxygen Demand (CBOD5)	mg/L	5	<5

TKN Kjeldahl Digestion by Discrete Analyser

Method: ME-(AU)-[ENV]AN281

Sample Number	Parameter	Units	LOR	Result
LB121936.001	Total Kjeldahl Nitrogen	mg/L	0.05	<0.05

Total Dissolved Solids (TDS) in water

Method: ME-(AU)-[ENV]AN113

Sample Number	Parameter	Units	LOR	Result
LB121986.001	Total Dissolved Solids Dried at 175-185°C	mg/L	10	<10

Total Phosphorus by Kjeldahl Digestion DA in Water

Method: ME-(AU)-[ENV]AN279/AN293(Sydney only)

Sample Number	Parameter	Units	LOR	Result
LB121936.001	Total Phosphorus (Kjeldahl Digestion)	mg/L	0.02	<0.02

DUPLICATES

Duplicates are calculated as Relative Percentage Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Ammonia Nitrogen by FIA

Method: ME-(AU)-[ENV]AN261

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
PE109968.007	LB121813.013	Ammonia, NH_3	mg/L	0.05	-0.0133571428	-0.0218571428	200	0
PE110086.002	LB121813.102	Ammonia, NH_3	mg/L	0.05	0.0497857142	0.0497857142	115	0

CBOD5

Method: ME-(AU)-[ENV]AN183

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
PE110067.001	LB121787.010	Biochemical Oxygen Demand (CBOD5)	mg/L	5	324	337	17	4

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA

Method: ME-(AU)-[ENV]AN258

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
PE109968.007	LB121813.013	Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.05	0.219	0.21	38	4
PE109995.001	LB121813.028	Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.05	34.44	33.99	15	1
PE109995.011	LB121813.039	Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.05	57.106	58.26	15	2
PE110020.001	LB121813.054	Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.05	3.24	3.575	16	0
PE110043.001	LB121813.065	Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.05	4.27	4.29	16	0
PE110079.005	LB121813.080	Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.05	14.37	15.169	15	5
PE110079.015	LB121813.091	Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.05	2.902	2.901	17	0
PE110086.002	LB121813.106	Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.05	7.633	7.556	16	1
PE110090.002	LB121813.111	Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.05	1.775	1.775	18	0

TKN Kjeldahl Digestion by Discrete Analyser

Method: ME-(AU)-[ENV]AN281

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
PE109742A.001	LB121936.027	Total Kjeldahl Nitrogen	mg/L	0.05	0.016	0.083	116	50
PE109987.001	LB121936.006	Total Kjeldahl Nitrogen	mg/L	0.05	55.313	58.528	15	6
PE110035.001	LB121936.015	Total Kjeldahl Nitrogen	mg/L	0.05	82.949	82.868	15	0
PE110082.006	LB121936.035	Total Kjeldahl Nitrogen	mg/L	0.05	12	13	15	6

Total Dissolved Solids (TDS) in water

Method: ME-(AU)-[ENV]AN113

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
PE110087.004	LB121986.015	Total Dissolved Solids Dried at 175-185°C	mg/L	10	049.342814048	064.19238780	16	1
PE110088.002	LB121986.023	Total Dissolved Solids Dried at 175-185°C	mg/L	10	00.118098612	08.25665257	16	1

Total Phosphorus by Kjeldahl Digestion DA in Water

Method: ME-(AU)-[ENV]AN279/AN293(Sydney only)

Original	Duplicate	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
PE109742A.001	LB121936.027	Total Phosphorus (Kjeldahl Digestion)	mg/L	0.02	0.013	0.012	175	0
PE109987.001	LB121936.006	Total Phosphorus (Kjeldahl Digestion)	mg/L	0.02	3.4	3.5	16	4
PE110035.001	LB121936.015	Total Phosphorus (Kjeldahl Digestion)	mg/L	0.02	8.053	7.817	15	3
PE110082.006	LB121936.035	Total Phosphorus (Kjeldahl Digestion)	mg/L	0.02	9.3	9.2	15	0

Laboratory Control Standard (LCS) results are evaluated against an expected result, typically the concentration of analyte spiked into the control during the sample preparation stage, producing a percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA /QC plan (Ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended dagger symbol (†) when outside suggested criteria.

CBOD5

Method: ME-(AU)-[ENV]AN183

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB121787.005	Biochemical Oxygen Demand (CBOD5)	mg/L	5	180	198	80 - 120	90
LB121787.007	Biochemical Oxygen Demand (CBOD5)	mg/L	5	180	198	80 - 120	88

Nitrate Nitrogen and Nitrite Nitrogen (NOx) by FIA

Method: ME-(AU)-[ENV]AN258

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB121813.002	Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.05	4.1	4	85 - 115	102
LB121813.027	Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.05	4.2	4	85 - 115	106
LB121813.052	Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.05	4.2	4	85 - 115	106
LB121813.077	Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.05	4.2	4	85 - 115	106
LB121813.102	Nitrate/Nitrite Nitrogen, NOx as N	mg/L	0.05	4.3	4	85 - 115	107

TKN Kjeldahl Digestion by Discrete Analyser

Method: ME-(AU)-[ENV]AN281

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB121936.002	Total Kjeldahl Nitrogen	mg/L	0.05	1.0	1	80 - 120	105

Total Dissolved Solids (TDS) in water

Method: ME-(AU)-[ENV]AN113

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB121986.002	Total Dissolved Solids Dried at 175-185°C	mg/L	10	310	300	80 - 120	104

Total Phosphorus by Kjeldahl Digestion DA in Water

Method: ME-(AU)-[ENV]AN279/AN293(Sydney only)

Sample Number	Parameter	Units	LOR	Result	Expected	Criteria %	Recovery %
LB121936.002	Total Phosphorus (Kjeldahl Digestion)	mg/L	0.02	0.52	0.5	80 - 120	103

MATRIX SPIKES

Matrix Spike (MS) results are evaluated as the percentage recovery of an expected result, typically the concentration of analyte spiked into a field sub-sample during the sample preparation stage. The original sample's result is subtracted from the sub-sample result before determining the percentage recovery. The criteria applied to the percentage recovery is established in the SGS QA/QC plan (ref: MP-(AU)-[ENV]QU-022). For more information refer to the footnotes in the concluding page of this report.

Recovery is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Total Dissolved Solids (TDS) in water

Method: ME-(AU)-[ENV]AN113

QC Sample	Sample Number	Parameter	Units	LOR	Result	Original	Spike	Recovery%
PE109998.001	LB121986.004	Total Dissolved Solids Dried at 175-185°C	mg/L	10	1300	270	1000	102

MATRIX SPIKE DUPLICATES

Matrix spike duplicates are calculated as Relative Percent Difference (RPD) using the formula: RPD = | OriginalResult - ReplicateResult | x 100 / Mean

The original result is the analyte concentration of the matrix spike. The Duplicate result is the analyte concentration of the matrix spike duplicate.

The RPD is evaluated against the Maximum Allowable Difference (MAD) criteria and can be graphically represented by a curve calculated from the Statistical Detection Limit (SDL) and Limiting Repeatability (LR) using the formula: MAD = 100 x SDL / Mean + LR

Where the Maximum Allowable Difference evaluates to a number larger than 200 it is displayed as 200.

RPD is shown in **Green** when within suggested criteria or **Red** with an appended reason identifer when outside suggested criteria. Refer to the footnotes section at the end of this report for failure reasons.

Total Dissolved Solids (TDS) in water

Method: ME-(AU)-[ENV]AN113

QC Sample	Sample Number	Parameter	Units	LOR	Original	Duplicate	Criteria %	RPD %
PE109998.001	LB121986.005	Total Dissolved Solids Dried at 175-185°C	mg/L	10	1300	1300	16	2

Samples analysed as received.

Solid samples expressed on a dry weight basis.

QC criteria are subject to internal review according to the SGS QA/QC plan and may be provided on request or alternatively can be found here: http://www.sgs.com.au/~/media/Local/Australia/Documents/Technical Documents/MP-AU-ENV-QU-022 QA QC Plan.pdf

*	NATA accreditation does not cover tthe performance of this service.
-	Sample not analysed for this analyte.
IS	Insufficient sample for analysis.
LNR	Sample listed, but not received.
LOR	Limit of reporting.
QFH	QC result is above the upper tolerance.
QFL	QC result is below the lower tolerance.

①	At least 2 of 3 surrogates are within acceptance criteria.
②	RPD failed acceptance criteria due to sample heterogeneity.
③	Results less than 5 times LOR preclude acceptance criteria for RPD.
④	Recovery failed acceptance criteria due to matrix interference.
⑤	Recovery failed acceptance criteria due to the presence of significant concentration of analyte (i.e. the concentration of analyte exceeds the spike level).
⑥	LOR was raised due to sample matrix interference.
⑦	LOR was raised due to dilution of significantly high concentration of analyte in sample.
⑧	Reanalysis of sample in duplicate confirmed sample heterogeneity and inconsistency of results.
⑨	Low surrogate recovery due to the sample emulsifying during extraction.
†	Refer to Analytical Report comments for further information.

CHAIN OF CUSTODY RECORD AND ANALYSIS REQUEST

GHD CLIENTS PEOPLE PERFORMANCE

GHD House 239 Adelaide Terrace Perth WA 6004
PO Box Y3106 Perth WA 6832
Telephone 08 6222 8222 Facsimile 08 6222 8555

Page 1 of 1 COC No.

Point Moore Groundwater Assessment

Client City of Greater Geraldton

Job No. 61/34772

Laboratory Quote No. EP/919/16

Turnaround Time Standard

Job Manager (Invoice) Andrew Nagle

Email Address (Results) andrew.nagle@ghd.com
steven. petts@ghd.com

Laboratory:ALS
Address: 10 Hod Way, Malaga 6090
Laboratory Contact: Lauren Biagioni

					Container				Analyses														Remarks
GHD Sample ID	Laboratory Sample ID	Date	Time	Sample Matrix S-Soil/SL-Sludge/ W-Water/ A-Air	Type B-Bottle/J-Jar/V-Vial/Bag/G-Glass/P Plastic	Preservative Unpreserved/ HCl/ H2SO4/HNO3/Other	No	Total Volume (mL)	NT-8	EP030	EA015H	MW002	M5									Hold	
MW1	1			W	BP	H2SO4	3	810	☒	☒	☒	☒	☒										
QC01_20160922	2			W	BP	H2SO4	3	810	☒	☒	☒	☒	☒										
MW2	3			W	BP	H2SO4	3	810	☒	☒	☒	☒	☒										
MW3	4			W	BP	H2SO4	3	810	☒	☒	☒	☒	☒										
SHP8	5			W	BP	H2SO4	3	810	☒	☒	☒	☒	☒										
QC03_20160922	6			W	BP	H2SO4	2	560	☒	☒	☒	☒											
QC04_20160922	7			W	BP	H2SO4	2	560	☒	☒	☒	☒											

Environmental Division
Perth
Work Order Reference
EP1608944

Telephone : + 61-8-9209 7655

Sampled by: S. Petts	Date/Time: 22/09/2016	Relinquished by: S.Petts	Date/ Time: 22/09/2016
Received by:	.	Relinquished by:	Date/ Time:
Received by Lab: M Wang	Date/Time: 23/9/16 1015	Courier/ Transport Company: NA	
Sample Conditions:	Remarks:		

ALS Environmental

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EP1608944**

Client : **GHD PTY LTD**
Contact : MR ANDREW NAGLE
Address : 999 HAY STREET
PERTH WA 6000

E-mail : andrew.nagle@ghd.com
Telephone : +61 08 6222 8222
Facsimile : +61 08 9429 6555

Project : 61/34772 Point Moore Groundwater Assessment
Order number : ----
C-O-C number : ----
Site : ----
Sampler : STEVEN PETTS

Laboratory : Environmental Division Perth
Contact : Lauren Biagioni
Address : 10 Hod Way Malaga WA Australia 6090

E-mail : Lauren.biagioni@alsglobal.com
Telephone : 08 9209 7655
Facsimile : +61-8-9209 7600

Page : 1 of 2

Quote number : EP2016GHDSER0029 (EP/919/16 V2)
QC Level : NEPM 2013 B3 & ALS QC Standard

Dates

Date Samples Received : 23-Sep-2016 10:15 AM
Client Requested Due Date : 03-Oct-2016

Issue Date : 23-Sep-2016
Scheduled Reporting Date : **03-Oct-2016**

Delivery Details

Mode of Delivery : Carrier
No. of coolers/boxes : 7
Receipt Detail :

Security Seal : Not intact.
Temperature : 18.9 - Ice Bricks present
No. of samples received / analysed : 7 / 7

General Comments

- This report contains the following information:
  - Sample Container(s)/Preservation Non-Compliances
  - Summary of Sample(s) and Requested Analysis
  - Proactive Holding Time Report
  - Requested Deliverables
- Please see scanned COC for sample discrepencies: extra samples , samples not received etc.
- Please direct any queries related to sample condition / numbering / breakages to Sample Receipt (SamplesPerth@alsenviro.com)
- Analytical work for this work order will be conducted at ALS Environmental Perth.
- Please direct any turnaround / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of Work Order.
- **pH analysis should be conducted within 6 hours of sampling.**

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

If no sampling time is provided, the sampling time will default to 15:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory for processing purposes and will be shown bracketed without a time component.

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - EA015H Total Dissolved Solids - High Level	WATER - EP030 BOD	WATER - M5 - ES/EB/FM FC, E.coli & TC by MF	WATER - MW002 (22C and 36C) Heterotrophic Colony Count (22C & 36C)	WATER - NT-08 Total Nitrogen + NO2 + NO3 + NH3 + Total P
EP1608944-001	[23-Sep-2016]	MW1	✓	✓	✓	✓	✓
EP1608944-002	[23-Sep-2016]	QC01_20160922	✓	✓	✓	✓	✓
EP1608944-003	[23-Sep-2016]	MW2	✓	✓	✓	✓	✓
EP1608944-004	[23-Sep-2016]	MW3	✓	✓	✓	✓	✓
EP1608944-005	[23-Sep-2016]	SHP8	✓	✓	✓	✓	✓
EP1608944-006	[23-Sep-2016]	QC03_20160922	✓	✓			✓
EP1608944-007	[23-Sep-2016]	QC04_20160922	✓	✓			✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

ACCOUNTS PAYABLE (Perth)		
- A4 - AU Tax Invoice (INV)	Email	ap-fss@ghd.com
ANDREW NAGLE		
- *AU Certificate of Analysis - NATA (COA)	Email	andrew.nagle@ghd.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	andrew.nagle@ghd.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	andrew.nagle@ghd.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	andrew.nagle@ghd.com
- Chain of Custody (CoC) (COC)	Email	andrew.nagle@ghd.com
- EDI Format - ENMRG (ENMRG)	Email	andrew.nagle@ghd.com
- EDI Format - ESDAT (ESDAT)	Email	andrew.nagle@ghd.com
- EDI Format - XTab (XTAB)	Email	andrew.nagle@ghd.com
STEVEN PETTS		
- *AU Certificate of Analysis - NATA (COA)	Email	steven.petts@ghd.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	steven.petts@ghd.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	steven.petts@ghd.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	steven.petts@ghd.com
- Chain of Custody (CoC) (COC)	Email	steven.petts@ghd.com
- EDI Format - ENMRG (ENMRG)	Email	steven.petts@ghd.com
- EDI Format - ESDAT (ESDAT)	Email	steven.petts@ghd.com
- EDI Format - XTab (XTAB)	Email	steven.petts@ghd.com

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EP1608944**	Page	: 1 of 4
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: MR ANDREW NAGLE	Contact	: Lauren Biagioni
Address	: 999 HAY STREET PERTH WA 6000	Address	: 10 Hod Way Malaga WA Australia 6090
Telephone	: +61 08 6222 8222	Telephone	: 08 9209 7655
Project	: 61/34772 Point Moore Groundwater Assessment	Date Samples Received	: 23-Sep-2016 10:15
Order number	: ----	Date Analysis Commenced	: 23-Sep-2016
C-O-C number	: ----	Issue Date	: 03-Oct-2016 20:21
Sampler	: STEVEN PETTS		
Site	: ----		
Quote number	: ----		
No. of samples received	: 7		
No. of samples analysed	: 7		

NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Alini Goundar	Senior Analyst	Perth Microbiology, Malaga, WA
Jeremy Truong	Laboratory Manager	Perth Inorganics, Malaga, WA
Tyrone Cole	Inorganics Preparation Supervisor	Perth Inorganics, Malaga, WA
Vinitha Kesavan	Analyst	Perth Microbiology, Malaga, WA

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.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

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.
~ = Indicates an estimated value.

- CFU = colony forming unit
- MF = membrane filtration
- MW006 and MW007: estimate (~) is reported where the growth of presumptive bacteria on the filtered membrane is counted <10 cfu and/or >100 cfu and where there are many non-target colonies; the typical colonies may be masked by overgrowth of non-target organisms. It may be informative to record this fact.
- MW002 is ALS's internal code and is equivalent to AS4276.3.1.
- MW006 is ALS's internal code and is equivalent to AS4276.7.
- MW007 is ALS's internal code and is equivalent to AS4276.5.

Analytical Results

Sub-Matrix: **WATER**
(Matrix: **WATER**)

			Client sample ID	**MW1**	**QC01_20160922**	**MW2**	**MW3**	**SHP8**
			Client sampling date / time	[23-Sep-2016]	[23-Sep-2016]	[23-Sep-2016]	[23-Sep-2016]	[23-Sep-2016]
Compound	CAS Number	LOR	Unit	**EP1608944-001**	**EP1608944-002**	**EP1608944-003**	**EP1608944-004**	**EP1608944-005**
				Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**22300**	**22400**	**2120**	**1320**	**10300**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**6.28**	**6.42**	**0.13**	**0.78**	**2.54**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	**1.85**	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.05**	<0.01	**9.95**	**0.01**	**0.03**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.05**	<0.01	**11.8**	**0.01**	**0.03**
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**6.7**	**6.7**	**2.0**	**0.9**	**3.3**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**6.8**	**6.7**	**13.8**	**0.9**	**3.3**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.81**	**0.90**	**0.14**	**0.08**	**0.38**
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	**31**	**22**	**4**	**5**	**22**
MW002: Heterotrophic Plate Count								
Heterotrophic Plate Count (22°C)	----	1	CFU/mL	**72**	**73**	**1700**	**2400**	**12**
Heterotrophic Plate Count (36°C)	----	1	CFU/mL	**170**	**140**	**12000**	**2100**	**17**
MW006: Faecal Coliforms & E.coli by MF								
Faecal Coliforms	----	1	CFU/100mL	<1	<1	**~<1**	**~1**	<1
Escherichia coli	----	1	CFU/100mL	<1	<1	**~<1**	**~1**	<1
MW007: Coliforms by MF								
Coliforms	----	1	CFU/100mL	<1	<1	**~10**	**~10**	<1

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**QC03_20160922**	**QC04_20160922**	**----**	**----**	**----**
			Client sampling date / time	[23-Sep-2016]	[23-Sep-2016]	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EP1608944-006**	**EP1608944-007**	**--------**	**--------**	**--------**
				Result	Result	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**20**	<10	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	<0.1	<0.1	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	----	----	----
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	<2	----	----	----
MW002: Heterotrophic Plate Count								
Heterotrophic Plate Count (22°C)	----	1	CFU/mL	----	----	----	----	----
Heterotrophic Plate Count (36°C)	----	1	CFU/mL	----	----	----	----	----
MW006: Faecal Coliforms & E.coli by MF								
Faecal Coliforms	----	1	CFU/100mL	----	----	----	----	----
Escherichia coli	----	1	CFU/100mL	----	----	----	----	----
MW007: Coliforms by MF								
Coliforms	----	1	CFU/100mL	----	----	----	----	----

ALS Environmental

QUALITY CONTROL REPORT

Work Order : **EP1608944**

Client : **GHD PTY LTD**
Contact : MR ANDREW NAGLE
Address : 999 HAY STREET
PERTH WA 6000
Telephone : +61 08 6222 8222
Project : 61/34772 Point Moore Groundwater Assessment
Order number : ----
C-O-C number : ----
Sampler : STEVEN PETTS
Site : ----
Quote number : ----
No. of samples received : 7
No. of samples analysed : 7

Page : 1 of 4

Laboratory : Environmental Division Perth
Contact : Lauren Biagioni
Address : 10 Hod Way Malaga WA Australia 6090

Telephone : 08 9209 7655
Date Samples Received : 23-Sep-2016
Date Analysis Commenced : 23-Sep-2016
Issue Date : 03-Oct-2016

NATA
Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Alini Goundar	Senior Analyst	Perth Microbiology, Malaga, WA
Jeremy Truong	Laboratory Manager	Perth Inorganics, Malaga, WA
Tyrone Cole	Inorganics Preparation Supervisor	Perth Inorganics, Malaga, WA
Vinitha Kesavan	Analyst	Perth Microbiology, Malaga, WA

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 hig

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 (%)*
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 602290)									
EP1608944-001	MW1	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	22300	21700	2.96	0% - 20%
EP1609004-002	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	227	222	2.45	0% - 20%
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 595630)									
EP1608932-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.03	0.04	0.00	No Limit
EP1608944-002	QC01_20160922	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	6.42	6.47	0.792	0% - 20%
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 595643)									
EP1608944-001	MW1	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP1608946-004	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: 595631)									
EP1608932-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	0.00	No Limit
EP1608944-002	QC01_20160922	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.02	0.00	No Limit
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 602454)									
EP1608944-005	SHP8	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	3.3	3.3	0.00	0% - 20%
EP1608957-004	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	0.5	1.0	61.4	No Limit
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 602453)									
EP1608944-005	SHP8	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.38	0.39	3.39	0% - 20%
EP1608957-004	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.05	0.05	0.00	No Limit
EP030: Biochemical Oxygen Demand (BOD) (QC Lot: 595538)									
EP1608905-002	Anonymous	EP030: Biochemical Oxygen Demand	----	2	mg/L	245	253	3.13	0% - 20%
EP1608944-004	MW3	EP030: Biochemical Oxygen Demand	----	2	mg/L	5	4	24.4	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 Spike (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*
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 602290)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	96.8	83	111
				<10	293 mg/L	112	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 595630)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	107	87	115
EK057G: Nitrite as N by Discrete Analyser (QCLot: 595643)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	107	86	112
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 595631)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	110	92	112
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 602454)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	85.4	82	110
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 602453)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	90.6	70	130
EP030: Biochemical Oxygen Demand (BOD) (QCLot: 595538)								
EP030: Biochemical Oxygen Demand	----	2	mg/L	<2	198 mg/L	90.4	78	117

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*
EK055G: Ammonia as N by Discrete Analyser (QCLot: 595630)							
EP1608932-002	Anonymous	EK055G: Ammonia as N	7664-41-7	1 mg/L	127	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 595643)							
EP1608944-002	QC01_20160922	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	91.1	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 595631)							
EP1608932-002	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	110	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 602454)							
EP1608944-006	QC03_20160922	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	88.1	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 602453)							
EP1608944-006	QC03_20160922	EK067G: Total Phosphorus as P	----	1 mg/L	95.9	70	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP1608944**	Page	: 1 of 6
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: MR ANDREW NAGLE	Telephone	: 08 9209 7655
Project	: 61/34772 Point Moore Groundwater Assessment	Date Samples Received	: 23-Sep-2016
Site	: ----	Issue Date	: 03-Oct-2016
Sampler	: STEVEN PETTS	No. of samples received	: 7
Order number	: ----	No. of samples analysed	: 7

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.**
- **NO Matrix Spike outliers occur.**
- **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

- **NO Quality Control Sample Frequency Outliers exist.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

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*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H) MW1, QC01_20160922, MW2, MW3, SHP8, QC03_20160922, QC04_20160922	**23-Sep-2016**	**----**	----	----	**30-Sep-2016**	30-Sep-2016	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) MW1, QC01_20160922, MW2, MW3, SHP8, QC03_20160922, QC04_20160922	**23-Sep-2016**	**----**	----	----	**23-Sep-2016**	21-Oct-2016	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) MW1, QC01_20160922, MW2, MW3, SHP8, QC03_20160922, QC04_20160922	**23-Sep-2016**	**----**	----	----	**23-Sep-2016**	25-Sep-2016	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) MW1, QC01_20160922, MW2, MW3, SHP8, QC03_20160922, QC04_20160922	**23-Sep-2016**	**----**	----	----	**23-Sep-2016**	21-Oct-2016	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) MW1, QC01_20160922, MW2, MW3, SHP8, QC03_20160922, QC04_20160922	**23-Sep-2016**	**03-Oct-2016**	21-Oct-2016	✓	**03-Oct-2016**	21-Oct-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*
EK067G: Total Phosphorus as P by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK067G)								
MW1, MW2, SHP8, QC04_20160922	QC01_20160922, MW3, QC03_20160922,	**23-Sep-2016**	**03-Oct-2016**	21-Oct-2016	✓	**03-Oct-2016**	21-Oct-2016	✓
EP030: Biochemical Oxygen Demand (BOD)								
Clear Plastic Bottle - Natural (EP030)								
MW1, MW2, SHP8, QC04_20160922	QC01_20160922, MW3, QC03_20160922,	**23-Sep-2016**	**----**	----	----	**23-Sep-2016**	25-Sep-2016	✓
MW002: Heterotrophic Plate Count								
Sterile Plastic Bottle - Sodium Thiosulfate (MW002)								
MW1, MW2, SHP8	QC01_20160922, MW3,	**23-Sep-2016**	**----**	----	----	**23-Sep-2016**	24-Sep-2016	✓
MW006: Faecal Coliforms & E.coli by MF								
Sterile Plastic Bottle - Sodium Thiosulfate (MW006)								
MW1, MW2, SHP8	QC01_20160922, MW3,	**23-Sep-2016**	**----**	----	----	**23-Sep-2016**	24-Sep-2016	✓
MW007: Coliforms by MF								
Sterile Plastic Bottle - Sodium Thiosulfate (MW007)								
MW1, MW2, SHP8	QC01_20160922, MW3,	**23-Sep-2016**	**----**	----	----	**23-Sep-2016**	24-Sep-2016	✓

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)							
Ammonia as N by Discrete analyser	EK055G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Biochemical Oxygen Demand (BOD)	EP030	2	18	**11.11**	**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
Total Dissolved Solids (High Level)	EA015H	2	15	**13.33**	**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 Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Biochemical Oxygen Demand (BOD)	EP030	1	18	**5.56**	**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
Total Dissolved Solids (High Level)	EA015H	2	15	**13.33**	**10.00**	✓	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 Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Biochemical Oxygen Demand (BOD)	EP030	1	18	**5.56**	**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
Total Dissolved Solids (High Level)	EA015H	1	15	**6.67**	**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 Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	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
Total Kjeldahl Nitrogen as N By Discrete Analyser	EK061G	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

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*
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. 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)
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)
Biochemical Oxygen Demand (BOD)	EP030	WATER	In house: Referenced to APHA 5210 B. The 5-Day BOD test provides an empirical measure of the oxygen consumption capacity of a given water. A portion of the sample is diluted into oxygenated, nutrient rich water, and a seed added to begin biological decay. The initial dissolved oxygen content is measured, then the bottle is sealed and incubated for five days. The remaining dissolved oxygen is measured, and from the difference, the demand for oxygen, by biological decay, is determined. This method is compliant with NEPM (2013) Schedule B(3)
Heterotrophic (Total) Plate Count @ 22C and 36C	MW002	WATER	In house: Referenced to AS4276.3.1- 2007
Thermotolerant Coliforms & E.coli by Membrane Filtration	MW006	WATER	In house: Referenced to AS 4276.7 2007
Coliforms by Membrane Filtration	MW007	WATER	In house: Referenced to AS 4276.5 - 2007

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

CHAIN OF CUSTORDY RECORD AND ANALYSIS REQUEST

GHD CLIENTS|PEOPLE|PERFORMANCE

GHD House
239 Adelaide Terrace
Perth WA 6004
PO Box Y3106
Perth WA 6832
Telephone 08 6222 8222 Facsimile 08 6222 8555

Page 1 of 1

COC No.

Point Moore Groundwater Assessment	Laboratory:MPL Laboratories
	Address: 16-18 Hayden Court Myaree WA 6154
Client City of Greater Geraldton	**Job No.** 61/34772
	Laboratory Contact: Kiara Lockerbie
Laboratory Quote No.	**Turnaround Time** Standard
Job Manager (Invoice) Andrew Nagle	**Email Address (Results)** andrew.nagle@ghd.com steven. petts@ghd.com

GHD Sample ID	Laboratory Sample ID	Date	Time	Sample Matrix S-Soil/ SL-Sludge/ W-Water/ A-Air	Container: Type B-Bottle/J-Jar/V-Vial/Bag/G-Glass/P-Plastic	Container: Preservative Unpreserved/ HCl/ H2SO4/HNO3/Other	Container: No	Container: Total Volume (mL)	Analyses: Total Nitrogen, TKN, Nox, NO2, NO3, NH3, Total Phosphorus	Analyses: Biochemical Oxygen Demand	Analyses: TDS - Standard Level	Analyses: Total (Heterotrophic Plate Count at 22oC and 36oC (TPC) YEA	Analyses: Total +Faecal Coliforms & E. Coli (MF)									Hold	Remarks
1 QC02_20160922				W	BP	H2SO4	3	810	☒	☒	☒	☒	☒										

mpl Laboratories
ENVIROLAB GROUP
Job No.- 186264
Date Rec - 23/9
Time Rec - 1045
Rec By - mc
TAT Req - SAME 1 / 2 / 3 / [✓ STD].
Temp - [✓ cool] / ambient
Cooling - Ice / [✓ Ice pack] / None
Security Seal - [✓ Yes] / No

Sampled by: S. Petts	Date/Time: 22/09/2016	Relinquished by: S.Petts	Date/ Time: 22/9/2016
Received by: Meredith	.	Relinquished by:	Date/ Time:
Received by Lab: Meredith	Date/Time: 23-9-16	Courier/ Transport Company: NA	
Sample Conditions:	Remarks:		

Part of the Envirolab Group

16 - 18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC, Western Australia 6960
Tel: +61 8 9317 2505 / Fax: +61 8 9317 4163
email: laboratory@mpl.com.au
www.mpl.com.au
Envirolab Services (WA) Pty Ltd ABN 53 140 099 207

SAMPLE RECEIPT ADVICE

Client Details	
Client	GHD Services Pty Ltd
Attention	A Nagle

Sample Login Details	
Your Reference	61/34772 City of Greater Geraldton
Envirolab Reference	**186264**
Date Sample Received	23/09/2016
Date Instructions Received	23/09/2016
Date Results Expected to be Reported	**03/10/2016**

Sample Condition	
Samples received in appropriate condition for analysis	YES
No. of Samples Provided	1 Water
Turnaround Time Requested	Standard
Temperature on receipt (°C)	7
Cooling Method	Ice Pack
Sampling Date Provided	NO

Comments
Samples will be held for 1 month for water samples and 2 months for soil samples from date of receipt of samples

Please direct any queries to:

Joshua Lim	Meredith Conroy
Phone: 08 9317 2505	Phone: 08 9317 2505
Fax: 08 9317 4163	Fax: 08 9317 4163
Email: jlim@mpl.com.au	Email: mconroy@mpl.com.au

Sample and Testing Details on following page

Sample Id	***BOD***	***Total Dissolved Solids (grav)***	***Microbiological Testing***	***Nutrients in Water***
QC02_20160922	✓	✓	✓	✓

16-18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC, Western Australia 6950
tel: +61 8 9317 2505
email: lab@mpl.com.au
envirolab.com.au
Envirolab Services (WA) Pty Ltd trading as
MPL Laboratories | ABN 53 140 099 207

CERTIFICATE OF ANALYSIS 186264

Client:
GHD Services Pty Ltd
PO Box Y3106
Perth
WA 6000

Attention: A Nagle

Sample log in details:

Your Reference:	**61/34772 City of Greater Geraldton**
No. of samples:	1 Water
Date samples received:	23/09/2016
Date completed instructions received:	23/09/2016
Location:	

Analysis Details:

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last pages of this report for any comments relating to the results.

Report Details:

Date results requested by:	3/10/16
Date of Preliminary Report:	not issued
Issue Date:	30/09/16

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025 - Testing
Tests not covered by NATA are denoted with *.

Results Approved By:

Joshua Lim
Operations Manager

Jessica Miller
Micro Team Leader

Miscellaneous Inorganics		
Our Reference:	UNITS	186264-1
Your Reference	-------------	QC02_20160922
Type of sample	------------	Water
Date prepared	-	28/09/2016
Date analysed	-	28/09/2016
BOD	mg/L	<5
Total Dissolved Solids (grav)	mg/L	22,000

Microbiological Testing		
Our Reference:	UNITS	186264-1
Your Reference	-------------	QC02_20160922
Type of sample	------------	Water
Date testing started	-	23/09/2016
Date testing completed	-	28/09/2016
Heterotrophic Plate Count 21C	cfu/mL	340
Heterotrophic Plate Count 35C	cfu/mL	260
Total Coliforms	cfu/100mL	<1
Thermotolerant Coliforms	cfu/100mL	<1
E.coli	cfu/100mL	<1

Nutrients in Water		
Our Reference:	UNITS	186264-1
Your Reference	-------------	QC02_20160922
Type of sample	------------	Water
Date prepared	-	23/09/2016
Date analysed	-	23/09/2016
Total Nitrogen	mg/L	9.2
TKN by Discrete Analyser	mg/L	9.2
NOx as N	mg/L	0.009
Nitrate as N	mg/L	<0.005
Nitrite as N	mg/L	0.006
Ammonia as N	mg/L	5.0
Total Phosphorus	mg/L	0.78

Method ID	Methodology Summary
INORG-091	BOD - Analysed in accordance with APHA latest edition 5210 D.
INORG-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180±5°C
MICRO-001	Heterotrophic Plate Count: Microbial Water Analysis - in accordance with MICRO-001 (APHA-9215D-2005). Recommended maximums based on NHMRC and ARMC Australian Drinking Water Guidelines.
MICRO-001	Total Coliforms: Microbial Water Analysis - in accordance with MICRO-001 (AS4276.5-2007). Recommended maximums based on NHMRC and ARMC Australian Drinking Water Guidelines.
MICRO-001	Thermotolerant Coliforms: Microbial Water Analysis - in accordance with MICRO-001 (AS4276.7-2007). Recommended maximums based on NHMRC and ARMC Australian Drinking Water Guidelines.
MICRO-001	E. Coli: Microbial Water Analysis - in accordance with MICRO-001 (AS4276.7-2007). Recommended maximums based on NHMRC and ARMC Australian Drinking Water Guidelines.
INORG-055	Total Nitrogen by colourimetric analysis based on APHA 4500-P J, 4500-NO3 F.
INORG-062	TKN by calculation fromTotal Nitrogen and NOx using APHA methodology.
INORG-055	NOx - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	Nitrate - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	Nitrite - determined colourimetrically. Soils are analysed from a water extract.
INORG-057	Ammonia by colourimetric analysis based on APHA latest edition 4500-NH3 F.
METALS-020	Metals in soil and water by ICP-OES.

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			28/09/2016	[NT]	[NT]	LCS-1	28/09/2016
Date analysed	-			28/09/2016	[NT]	[NT]	LCS-1	28/09/2016
BOD	mg/L	5	INORG-091	<5	[NT]	[NT]	LCS-1	70%
Total Dissolved Solids (grav)	mg/L	5	INORG-018	<5	[NT]	[NT]	LCS-1	102%

QUALITY CONTROL Microbiological Testing	UNITS	PQL	METHOD	Blank
Date testing started	-			23/09/2016
Date testing completed	-			28/09/2016
Heterotrophic Plate Count 21C	cfu/mL	10	MICRO-001	<10
Heterotrophic Plate Count 35C	cfu/mL	10	MICRO-001	<10
Total Coliforms	cfu/100 mL	1	MICRO-001	<1
Thermotolerant Coliforms	cfu/100 mL	1	MICRO-001	<1
E.coli	cfu/100 mL	1	MICRO-001	<1

QUALITY CONTROL Nutrients in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base ll Duplicate ll %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			23/09/2016	[NT]	[NT]	LCS-1	23/09/2016
Date analysed	-			23/09/2016	[NT]	[NT]	LCS-1	23/09/2016
Total Nitrogen	mg/L	0.1	INORG-055	<0.1	[NT]	[NT]	LCS-1	118%
TKN by Discrete Analyser	mg/L	0.1	INORG-062	<0.1	[NT]	[NT]	[NR]	[NR]
NOx as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	LCS-1	103%
Nitrate as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	LCS-1	103%
Nitrite as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	LCS-1	106%
Ammonia as N	mg/L	0.005	INORG-057	<0.005	[NT]	[NT]	LCS-1	90%
Total Phosphorus	mg/L	0.05	METALS-020	<0.05	[NT]	[NT]	LCS-1	100%

Report Comments:

Definitions:

NT: Not tested NA: Test not required INS: Insufficient sample for this test PQL: Practical Quantitation Limit
<: Less than >: Greater than RPD: Relative Percent Difference LCS: Laboratory Control Sample
NS: Not Specified NEPM: National Environmental Protection Measure NR: Not Reported

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

CHAIN OF CUSTORDY RECORD AND ANALYSIS REQUEST

GHD CLIENTS|PEOPLE|PERFORMANCE

GHD House 239 Adelaide Terrace Perth WA 6004
PO Box Y3106 Perth WA 6832
Telephone 08 6222 8222 Facsimile 08 6222 8555

Page 1 of 1

COC No.

Point Moore Groundwater Assessment		Laboratory:ALS
Client City of Greater Geraldton	**Job No.** 61/34772	Address: 10 Hod Way, Malaga 6090
Laboratory Quote No. EP/919/16	**Turnaround Time** Standard	Laboratory Contact: Lauren Biagioni
Job Manager (Invoice) Andrew Nagle	**Email Address (Results)** andrew.nagle@ghd.com steven. petts@ghd.com	

GHD Sample ID	Laboratory Sample ID	Date	Time	**Sample Matrix** S-Soil/ SL-Sludge/ W-Water/ A-Air	Container: **Type** B-Bottle/J-Jar/V-Vial/Bag/G-Glass/P-Plastic	Container: **Preservative** Unpreserved/ HCl/ H2SO4/HNO3/Other	Container: **No**	Container: **Total Volume (mL)**	Analyses: NT-8	Analyses: EP030	Analyses: EA015H	Analyses: MW002	Analyses: M5									Hold	Remarks
MW1	1	18·10		W	BP	H2SO4	3	810	☒	☒	☒	☒	☒										
QC01_20160922	2	〃		W	BP	H2SO4	3	810	☒	☒	☒	☒	☒										
MW2	3	〃		W	BP	H2SO4	3	810	☒	☒	☒	☒	☒										
MW3	4	〃		W	BP	H2SO4	3	810	☒	☒	☒	☒	☒										
SHP8	5	〃		W	BP	H2SO4	3	810	☒	☒	☒	☒	☒										
QC03_20160922	6	〃		W	BP	H2SO4	2	560	☒	☒	☒												
QC04_20160922	7	〃		W	BP	H2SO4	2	560	☒	☒	☒												

Sampled by: S. Petts	Date/Time: 18/10/2016	Relinquished by: S.Petts	Date/ Time: 18/10/2016
Received by:	19-10-16 0925	Relinquished by:	Date/ Time:
Received by Lab:	Date/Time:	Courier/ Transport Company: NA	
Sample Conditions:	Remarks:		

Environmental Division
Perth
Work Order Reference
EP1609847

Telephone + 61-8-9209 7655

ALS Environmental

SAMPLE RECEIPT NOTIFICATION (SRN)

Work Order : **EP1609847**

Client : **GHD PTY LTD**
Contact : MR ANDREW NAGLE
Address : 999 HAY STREET
PERTH WA 6000

E-mail : andrew.nagle@ghd.com
Telephone : +61 08 6222 8222
Facsimile : +61 08 9429 6555

Project : 61/34772 Point Moore Groundwater Assessment
Order number : ----
C-O-C number : ----
Site : ----
Sampler : STEVEN PETTS

Laboratory : Environmental Division Perth
Contact : Lauren Biagioni
Address : 10 Hod Way Malaga WA Australia 6090

E-mail : Lauren.biagioni@alsglobal.com
Telephone : 08 9209 7655
Facsimile : +61-8-9209 7600

Page : 1 of 2

Quote number : EP2016GHDSER0029 (EP/919/16 V2)
QC Level : NEPM 2013 B3 & ALS QC Standard

Dates

Date Samples Received : 19-Oct-2016 9:25 AM
Client Requested Due Date : 26-Oct-2016

Issue Date : 19-Oct-2016
Scheduled Reporting Date : **26-Oct-2016**

Delivery Details

Mode of Delivery : Carrier
No. of coolers/boxes : 1
Receipt Detail :

Security Seal : Intact.
Temperature : 3.5 - Ice present
No. of samples received / analysed : 7 / 7

General Comments

- This report contains the following information:
    - Sample Container(s)/Preservation Non-Compliances
    - Summary of Sample(s) and Requested Analysis
    - Proactive Holding Time Report
    - Requested Deliverables
- Please see scanned COC for sample discrepencies: extra samples , samples not received etc.
- Please direct any queries related to sample condition / numbering / breakages to Sample Receipt (SamplesPerth@alsenviro.com)
- Analytical work for this work order will be conducted at ALS Environmental Perth.
- Please direct any turnaround / technical queries to the laboratory contact designated above.
- Sample Disposal - Aqueous (14 days), Solid (60 days) from date of completion of Work Order.
- **pH analysis should be conducted within 6 hours of sampling.**

Sample Container(s)/Preservation Non-Compliances

All comparisons are made against pretreatment/preservation AS, APHA, USEPA standards.

- **No sample container / preservation non-compliance exists.**

Summary of Sample(s) and Requested Analysis

Some items described below may be part of a laboratory process necessary for the execution of client requested tasks. Packages may contain additional analyses, such as the determination of moisture content and preparation tasks, that are included in the package.

If no sampling time is provided, the sampling time will default to 15:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory for processing purposes and will be shown bracketed without a time component.

Matrix: **WATER**

Laboratory sample ID	*Client sampling date / time*	*Client sample ID*	WATER - EA015H Total Dissolved Solids - High Level	WATER - EP030 BOD	WATER - M5 - ES/EB/FM FC, E.coli & TC by MF	WATER - MW002 (22C and 36C) Heterotrophic Colony Count (22C & 36C)	WATER - NT-08 Total Nitrogen + NO2 + NO3 + NH3 + Total P
EP1609847-001	[18-Oct-2016]	MW1	✓	✓	✓	✓	✓
EP1609847-002	[18-Oct-2016]	QC01_20160922	✓	✓	✓	✓	✓
EP1609847-003	[18-Oct-2016]	MW2	✓	✓	✓	✓	✓
EP1609847-004	[18-Oct-2016]	MW3	✓	✓	✓	✓	✓
EP1609847-005	[18-Oct-2016]	SHP8	✓	✓	✓	✓	✓
EP1609847-006	[18-Oct-2016]	QC03_20160922	✓	✓			✓
EP1609847-007	[18-Oct-2016]	QC04_20160922	✓	✓			✓

Proactive Holding Time Report

Sample(s) have been received within the recommended holding times for the requested analysis.

Requested Deliverables

ANDREW NAGLE

- *AU Certificate of Analysis - NATA (COA)	Email	andrew.nagle@ghd.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	andrew.nagle@ghd.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	andrew.nagle@ghd.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	andrew.nagle@ghd.com
- A4 - AU Tax Invoice (INV)	Email	andrew.nagle@ghd.com
- Chain of Custody (CoC) (COC)	Email	andrew.nagle@ghd.com
- EDI Format - ENMRG (ENMRG)	Email	andrew.nagle@ghd.com
- EDI Format - ESDAT (ESDAT)	Email	andrew.nagle@ghd.com
- EDI Format - XTab (XTAB)	Email	andrew.nagle@ghd.com

STEVEN PETTS

- *AU Certificate of Analysis - NATA (COA)	Email	steven.petts@ghd.com
- *AU Interpretive QC Report - DEFAULT (Anon QCI Rep) (QCI)	Email	steven.petts@ghd.com
- *AU QC Report - DEFAULT (Anon QC Rep) - NATA (QC)	Email	steven.petts@ghd.com
- A4 - AU Sample Receipt Notification - Environmental HT (SRN)	Email	steven.petts@ghd.com
- Chain of Custody (CoC) (COC)	Email	steven.petts@ghd.com
- EDI Format - ENMRG (ENMRG)	Email	steven.petts@ghd.com
- EDI Format - ESDAT (ESDAT)	Email	steven.petts@ghd.com
- EDI Format - XTab (XTAB)	Email	steven.petts@ghd.com

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EP1609847**	Page	: 1 of 4
Amendment	: **1**		
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: MR ANDREW NAGLE	Contact	: Lauren Biagioni
Address	: 999 HAY STREET PERTH WA 6000	Address	: 10 Hod Way Malaga WA Australia 6090
Telephone	: +61 08 6222 8222	Telephone	: 08 9209 7655
Project	: 61/34772 Point Moore Groundwater Assessment	Date Samples Received	: 19-Oct-2016 09:25
Order number	: ----	Date Analysis Commenced	: 19-Oct-2016
C-O-C number	: ----	Issue Date	: 02-Nov-2016 11:53
Sampler	: STEVEN PETTS		
Site	: ----		
Quote number	: ----		
No. of samples received	: 7		
No. of samples analysed	: 7		

NATA

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QA/QC Compliance Assessment to assist with Quality Review and Sample Receipt Notification.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Jeremy Truong	Laboratory Manager	Perth Inorganics, Malaga, WA
Tyrone Cole	Inorganics Preparation Supervisor	Perth Inorganics, Malaga, WA
Vinitha Kesavan	Analyst	Perth Microbiology, Malaga, WA

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.

Where a result is required to meet compliance limits the associated uncertainty must be considered. Refer to the ALS Contact for details.

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.
~ = Indicates an estimated value.

- CFU = colony forming unit
- MF = membrane filtration
- This report has been amended to update the sample ID's for the QC samples, as per the client's request. There are no changes to the results.
- MW007 and MW006: estimate (~) is reported where there are many non-target colonies; the typical colonies may be masked by overgrowth of non-target organisms. It may be informative to record this fact.
- MW002 is ALS's internal code and is equivalent to AS4276.3.1.
- MW006 is ALS's internal code and is equivalent to AS4276.7.
- MW007 is ALS's internal code and is equivalent to AS4276.5.

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**MW1**	**QC01_20161018**	**MW2**	**MW3**	**SHP8**
			Client sampling date / time	[18-Oct-2016]	[18-Oct-2016]	[18-Oct-2016]	[18-Oct-2016]	[18-Oct-2016]
Compound	*CAS Number*	*LOR*	*Unit*	**EP1609847-001**	**EP1609847-002**	**EP1609847-003**	**EP1609847-004**	**EP1609847-005**
				Result	Result	Result	Result	Result
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**13100**	**13100**	**1360**	**1340**	**2290**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**3.95**	**4.00**	**1.48**	**0.32**	**0.46**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	**0.27**	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.46**	**0.46**	**6.06**	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.46**	**0.46**	**6.33**	<0.01	<0.01
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	**4.2**	**4.1**	**2.6**	**0.6**	**1.2**
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	**4.7**	**4.6**	**8.9**	**0.6**	**1.2**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.47**	**0.46**	**0.18**	**0.08**	**0.28**
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	**33**	**27**	**3**	**3**	**57**
MW002: Heterotrophic Plate Count								
Heterotrophic Plate Count (22°C)	----	1	CFU/mL	**4200**	**4400**	**4500**	**14000**	**2000**
Heterotrophic Plate Count (36°C)	----	1	CFU/mL	**4400**	**3600**	**7400**	**5500**	**980**
MW006: Faecal Coliforms & E.coli by MF								
Faecal Coliforms	----	1	CFU/100mL	**~<1**	**~<1**	**~<1**	**~<1**	**~<1**
Escherichia coli	----	1	CFU/100mL	**~<1**	**~<1**	**~<1**	**~<1**	**~<1**
MW007: Coliforms by MF								
Coliforms	----	1	CFU/100mL	**~<1**	**~<1**	**~<1**	**~<1**	**~<1**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)			*Client sample ID*	**QC03_20161018**	**QC04_20161018**	**----**	**----**	**----**
			Client sampling date / time	[18-Oct-2016]	[18-Oct-2016]	----	----	----
Compound	*CAS Number*	*LOR*	*Unit*	**EP1609847-006**	**EP1609847-007**	**--------**	**--------**	**--------**
				Result	Result	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**14**	**16**	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.06**	**0.06**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	**0.01**	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	**0.01**	----	----	----
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser								
Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	<0.1	----	----	----
EK062G: Total Nitrogen as N (TKN + NOx) by Discrete Analyser								
^ **Total Nitrogen as N**	----	0.1	mg/L	<0.1	<0.1	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	<0.01	<0.01	----	----	----
EP030: Biochemical Oxygen Demand (BOD)								
Biochemical Oxygen Demand	----	2	mg/L	<2	<2	----	----	----
MW002: Heterotrophic Plate Count								
Heterotrophic Plate Count (22°C)	----	1	CFU/mL	----	----	----	----	----
Heterotrophic Plate Count (36°C)	----	1	CFU/mL	----	----	----	----	----
MW006: Faecal Coliforms & E.coli by MF								
Faecal Coliforms	----	1	CFU/100mL	----	----	----	----	----
Escherichia coli	----	1	CFU/100mL	----	----	----	----	----
MW007: Coliforms by MF								
Coliforms	----	1	CFU/100mL	----	----	----	----	----

ALS Environmental

QUALITY CONTROL REPORT

Work Order	: **EP1609847**	Page	: 1 of 4
Amendment	: **1**		
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: MR ANDREW NAGLE	Contact	: Lauren Biagioni
Address	: 999 HAY STREET PERTH WA 6000	Address	: 10 Hod Way Malaga WA Australia 6090
Telephone	: +61 08 6222 8222	Telephone	: 08 9209 7655
Project	: 61/34772 Point Moore Groundwater Assessment	Date Samples Received	: 19-Oct-2016
Order number	: ----	Date Analysis Commenced	: 19-Oct-2016
C-O-C number	: ----	Issue Date	: 02-Nov-2016
Sampler	: STEVEN PETTS		
Site	: ----		
Quote number	: ----		
No. of samples received	: 7		
No. of samples analysed	: 7		

ilac-MRA NATA

Accreditation No. 825
Accredited for compliance with
ISO/IEC 17025 - Testing

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Jeremy Truong	Laboratory Manager	Perth Inorganics, Malaga, WA
Tyrone Cole	Inorganics Preparation Supervisor	Perth Inorganics, Malaga, WA
Vinitha Kesavan	Analyst	Perth Microbiology, Malaga, WA

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 (%)*
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QC Lot: 627327)									
EP1609847-001	MW1	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	13100	12800	2.00	0% - 20%
EP1609866-001	Anonymous	EA015H: Total Dissolved Solids @180°C	----	10	mg/L	644	684	6.01	0% - 20%
EK055G: Ammonia as N by Discrete Analyser (QC Lot: 623447)									
EP1609847-001	MW1	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	3.95	3.93	0.520	0% - 20%
EP1609870-001	Anonymous	EK055G: Ammonia as N	7664-41-7	0.01	mg/L	0.03	0.03	0.00	No Limit
EK057G: Nitrite as N by Discrete Analyser (QC Lot: 623435)									
EP1609882-001	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	0.02	0.02	0.00	No Limit
EP1609888-010	Anonymous	EK057G: Nitrite as N	14797-65-0	0.01	mg/L	0.15	0.14	0.00	0% - 50%
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QC Lot: 623448)									
EP1609847-001	MW1	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	0.46	0.46	0.00	0% - 20%
EP1609870-001	Anonymous	EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	1.56	1.50	3.98	0% - 20%
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QC Lot: 628160)									
EP1608883-001	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	1.2	1.2	0.00	0% - 50%
EP1609847-003	MW2	EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	2.6	2.6	0.00	0% - 50%
EK067G: Total Phosphorus as P by Discrete Analyser (QC Lot: 628159)									
EP1608883-001	Anonymous	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.20	0.20	0.00	0% - 20%
EP1609847-003	MW2	EK067G: Total Phosphorus as P	----	0.01	mg/L	0.18	0.17	8.86	No Limit
EP030: Biochemical Oxygen Demand (BOD) (QC Lot: 625068)									
EP1609847-006	QC03_20161018	EP030: Biochemical Oxygen Demand	----	2	mg/L	<2	<2	0.00	No Limit
EP1609931-003	Anonymous	EP030: Biochemical Oxygen Demand	----	2	mg/L	<2	<2	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 Spike (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*
EA015: Total Dissolved Solids dried at 180 ± 5 °C (QCLot: 627327)								
EA015H: Total Dissolved Solids @180°C	----	10	mg/L	<10	2000 mg/L	106	83	111
				<10	1000 mg/L	109	70	130
EK055G: Ammonia as N by Discrete Analyser (QCLot: 623447)								
EK055G: Ammonia as N	7664-41-7	0.01	mg/L	<0.01	1 mg/L	101	87	115
EK057G: Nitrite as N by Discrete Analyser (QCLot: 623435)								
EK057G: Nitrite as N	14797-65-0	0.01	mg/L	<0.01	0.5 mg/L	102	86	112
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 623448)								
EK059G: Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	0.5 mg/L	109	92	112
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 628160)								
EK061G: Total Kjeldahl Nitrogen as N	----	0.1	mg/L	<0.1	10 mg/L	87.9	82	110
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 628159)								
EK067G: Total Phosphorus as P	----	0.01	mg/L	<0.01	4.42 mg/L	91.4	70	130
EP030: Biochemical Oxygen Demand (BOD) (QCLot: 625068)								
EP030: Biochemical Oxygen Demand	----	2	mg/L	<2	198 mg/L	90.8	78	117

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*
EK055G: Ammonia as N by Discrete Analyser (QCLot: 623447)							
EP1609847-002	QC01_20161018	EK055G: Ammonia as N	7664-41-7	1 mg/L	85.1	70	130
EK057G: Nitrite as N by Discrete Analyser (QCLot: 623435)							
EP1609847-001	MW1	EK057G: Nitrite as N	14797-65-0	0.5 mg/L	88.0	70	130
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser (QCLot: 623448)							
EP1609847-002	QC01_20161018	EK059G: Nitrite + Nitrate as N	----	0.5 mg/L	105	70	130
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser (QCLot: 628160)							
EP1608883-005	Anonymous	EK061G: Total Kjeldahl Nitrogen as N	----	5 mg/L	96.2	70	130
EK067G: Total Phosphorus as P by Discrete Analyser (QCLot: 628159)							
EP1608883-005	Anonymous	EK067G: Total Phosphorus as P	----	1 mg/L	85.2	70	130

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EP1609847**	Page	: 1 of 6
Amendment	: **1**		
Client	: **GHD PTY LTD**	Laboratory	: Environmental Division Perth
Contact	: MR ANDREW NAGLE	Telephone	: 08 9209 7655
Project	: 61/34772 Point Moore Groundwater Assessment	Date Samples Received	: 19-Oct-2016
Site	: ----	Issue Date	: 02-Nov-2016
Sampler	: STEVEN PETTS	No. of samples received	: 7
Order number	: ----	No. of samples analysed	: 7

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.**
- **NO Matrix Spike outliers occur.**
- **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

- **NO Quality Control Sample Frequency Outliers exist.**

Analysis Holding Time Compliance

If samples are identified below as having been analysed or extracted outside of recommended holding times, this should be taken into consideration when interpreting results.

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*
EA015: Total Dissolved Solids dried at 180 ± 5 °C							
Clear Plastic Bottle - Natural (EA015H) MW1, QC01_20161018, MW2, MW3, SHP8, QC03_20161018, QC04_20161018	**18-Oct-2016**	**----**	----	----	**24-Oct-2016**	25-Oct-2016	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G) MW1, QC01_20161018, MW2, MW3, SHP8, QC03_20161018, QC04_20161018	**18-Oct-2016**	**----**	----	----	**19-Oct-2016**	15-Nov-2016	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G) MW1, QC01_20161018, MW2, MW3, SHP8, QC03_20161018, QC04_20161018	**18-Oct-2016**	**----**	----	----	**19-Oct-2016**	20-Oct-2016	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G) MW1, QC01_20161018, MW2, MW3, SHP8, QC03_20161018, QC04_20161018	**18-Oct-2016**	**----**	----	----	**19-Oct-2016**	15-Nov-2016	✓
EK061G: Total Kjeldahl Nitrogen By Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK061G) MW1, QC01_20161018, MW2, MW3, SHP8, QC03_20161018, QC04_20161018	**18-Oct-2016**	**26-Oct-2016**	15-Nov-2016	✓	**26-Oct-2016**	15-Nov-2016	✓

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*
EK067G: Total Phosphorus as P by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK067G) MW1, QC01_20161018, MW2, MW3, SHP8, QC03_20161018, QC04_20161018	**18-Oct-2016**	**26-Oct-2016**	15-Nov-2016	✓	**26-Oct-2016**	15-Nov-2016	✓
EP030: Biochemical Oxygen Demand (BOD)							
Clear Plastic Bottle - Natural (EP030) MW1, QC01_20161018, MW2, MW3, SHP8, QC03_20161018, QC04_20161018	**18-Oct-2016**	**----**	----	----	**20-Oct-2016**	20-Oct-2016	✓
MW002: Heterotrophic Plate Count							
Sterile Plastic Bottle - Sodium Thiosulfate (MW002) MW1, QC01_20161018, MW2, MW3, SHP8	**18-Oct-2016**	**----**	----	----	**19-Oct-2016**	19-Oct-2016	✓
MW006: Faecal Coliforms & E.coli by MF							
Sterile Plastic Bottle - Sodium Thiosulfate (MW006) MW1, QC01_20161018, MW2, MW3, SHP8	**18-Oct-2016**	**----**	----	----	**19-Oct-2016**	19-Oct-2016	✓
MW007: Coliforms by MF							
Sterile Plastic Bottle - Sodium Thiosulfate (MW007) MW1, QC01_20161018, MW2, MW3, SHP8	**18-Oct-2016**	**----**	----	----	**19-Oct-2016**	19-Oct-2016	✓

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)							
Ammonia as N by Discrete analyser	EK055G	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Biochemical Oxygen Demand (BOD)	EP030	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	18	**11.11**	**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 Phosphorus as P By Discrete Analyser	EK067G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Ammonia as N by Discrete analyser	EK055G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Biochemical Oxygen Demand (BOD)	EP030	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	18	**11.11**	**10.00**	✓	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 Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Biochemical Oxygen Demand (BOD)	EP030	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	1	18	**5.56**	**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 Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**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 Phosphorus as P By Discrete Analyser	EK067G	1	20	**5.00**	**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*
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. 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)
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)
Biochemical Oxygen Demand (BOD)	EP030	WATER	In house: Referenced to APHA 5210 B. The 5-Day BOD test provides an empirical measure of the oxygen consumption capacity of a given water. A portion of the sample is diluted into oxygenated, nutrient rich water, and a seed added to begin biological decay. The initial dissolved oxygen content is measured, then the bottle is sealed and incubated for five days. The remaining dissolved oxygen is measured, and from the difference, the demand for oxygen, by biological decay, is determined. This method is compliant with NEPM (2013) Schedule B(3)
Heterotrophic (Total) Plate Count @ 22C and 36C	MW002	WATER	In house: Referenced to AS4276.3.1- 2007
Thermotolerant Coliforms & E.coli by Membrane Filtration	MW006	WATER	In house: Referenced to AS 4276.7 2007
Coliforms by Membrane Filtration	MW007	WATER	In house: Referenced to AS 4276.5 - 2007

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*

Preparation Methods	*Method*	*Matrix*	*Method Descriptions*
TKN/TP Digestion	EK061/EK067	WATER	In house: Referenced to APHA 4500 Norg - D; APHA 4500 P - H. This method is compliant with NEPM (2013) Schedule B(3)

CHAIN OF CUSTORDY RECORD AND ANALYSIS REQUEST

GHD CLIENTS|PEOPLE|PERFORMANCE

GHD House 239 Adelaide Terrace Perth WA 6004
PO Box Y3106 Perth WA 6832
Telephone 08 6222 8222 Facsimile 08 6222 8555

Page 1 of 1

COC No.

Point Moore Groundwater Assessment	Laboratory:MPL Laboratories
Client City of Greater Geraldton	**Job No.** 61/34772
	Address: 16-18 Hayden Court Myaree WA 6154
	Laboratory Contact: Kiara Lockerbie
Laboratory Quote No.	**Turnaround Time** Standard
Job Manager (Invoice) Andrew Nagle	**Email Address (Results)** andrew.nagle@ghd.com steven. petts@ghd.com

①

GHD Sample ID	Laboratory Sample ID	Date	Time	Sample Matrix S-Soil/ SL-Sludge/ W-Water/ A-Air	Container				Analyses														Remarks
					Type B-Bottle/J-Jar/V-Vial/Bag/G-Glass/P-Plastic	Preservative Unpreserved/ HCl/ H2SO4/HNO3/Other	No	Total Volume (mL)	Total Nitrogen, TKN, Nox, NO2, NO3, NH3, Total Phosphorus	Biochemical Oxygen Demand	TDS - Standard Level	Total (Heterotrophic Plate Count at 21oC and 35oC (TPC) YEA	Total +Faecal Coliforms & E. Coli (MF)									Hold	
QC02_20160922		18/10		W	BP	H2SO4	3	810	☒	☒	☒	☒	☒										

Sampled by: S. Petts	Date/Time: 18/10/2016	Relinquished by: S.Petts	Date/ Time: 18/10/2016
Received by: Meredith	.	Relinquished by:	Date/ Time:
Received by Lab:	Date/Time:	Courier/ Transport Company: NA	
Sample Conditions:	Remarks:		

mpl Laboratories
ENVIROLAB GROUP
Job No.- 187366
Date Rec - 19-10
Time Rec - 930
Rec By - MC
TAT Req - SAME 1 / 2 / 3 / [✓ STD]
Temp - [✓ cool] / ambient
Cooling - Ice / [✓ Ice pack] / None
Security Seal - [✓ Yes] / No

mpl Laboratories
Part of the Envirolab Group
ENVIROLAB GROUP

16 - 18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC, Western Australia 6960
Tel: +61 8 9317 2505 / Fax: +61 8 9317 4163
email: laboratory@mpl.com.au
www.mpl.com.au
Envirolab Services (WA) Pty Ltd ABN 53 140 099 207

SAMPLE RECEIPT ADVICE

Client Details	
Client	GHD Services Pty Ltd
Attention	Andrew Nagle

Sample Login Details	
Your Reference	61/34772
Envirolab Reference	**187366**
Date Sample Received	19/10/2016
Date Instructions Received	19/10/2016
Date Results Expected to be Reported	**26/10/2016**

Sample Condition	
Samples received in appropriate condition for analysis	YES
No. of Samples Provided	1 Water
Turnaround Time Requested	Standard
Temperature on receipt (°C)	15
Cooling Method	Ice Pack
Sampling Date Provided	Yes

Comments
Samples will be held for 1 month for water samples and 2 months for soil samples from date of receipt of samples

Please direct any queries to:

Joshua Lim	Meredith Conroy
Phone: 08 9317 2505	Phone: 08 9317 2505
Fax: 08 9317 4163	Fax: 08 9317 4163
Email: jlim@mpl.com.au	Email: mconroy@mpl.com.au

Sample and Testing Details on following page

Sample Id	*BOD*	*Total Dissolved Solids (grav)*	*Nutrients in Water*	*Microbiological Testing*
QC02_20160922	✓	✓	✓	✓

16-18 Hayden Court, Myaree, Western Australia 6154
PO Box 4023 Myaree BC, Western Australia 6950
tel: +61 8 9317 2505

email: lab@mpl.com.au
envirolab.com.au

Envirolab Services (WA) Pty Ltd trading as
MPL Laboratories | ABN 53 140 099 207

CERTIFICATE OF ANALYSIS 187366

Client:

GHD Services Pty Ltd
PO Box Y3106
Perth
WA 6000

Attention: Andrew Nagle

Sample log in details:

Your Reference:	**61/34772**
No. of samples:	1 Water
Date samples received:	19/10/2016
Date completed instructions received:	19/10/2016
Location:	

Analysis Details:

Please refer to the following pages for results, methodology summary and quality control data.
Samples were analysed as received from the client. Results relate specifically to the samples as received.
Results are reported on a dry weight basis for solids and on an as received basis for other matrices.
Please refer to the last pages of this report for any comments relating to the results.

Report Details:

Date results requested by:	26/10/16
Date of Preliminary Report:	Not issued
Issue Date:	26/10/16

NATA accreditation number 2901. This document shall not be reproduced except in full.
Accredited for compliance with ISO/IEC 17025 - Testing
Tests not covered by NATA are denoted with *.

Results Approved By:

Joshua Lim
Operations Manager

Jessica Miller
Micro Team Leader

NATA
ACCREDITED FOR
TECHNICAL
COMPETENCE

Miscellaneous Inorganics Our Reference:	UNITS	187366-1
Your Reference	-------------	QC02_20160922
Date Sampled	------------	18/10/2016
Type of sample		Water
Date prepared	-	19/10/2016
Date analysed	-	19/10/2016
BOD	mg/L	14
Total Dissolved Solids (grav)	mg/L	14,000

Nutrients in Water		
Our Reference:	UNITS	187366-1
Your Reference	-------------	QC02_20160922
Date Sampled	------------	18/10/2016
Type of sample		Water
Date prepared	-	19/10/2016
Date analysed	-	19/10/2016
Total Nitrogen	mg/L	5.7
TKN by Discrete Analyser	mg/L	5.3
NOx as N	mg/L	0.44
Nitrite as N	mg/L	<0.005
Nitrate as N	mg/L	0.44
Ammonia as N	mg/L	3.2
Total Phosphorus	mg/L	0.57

Microbiological Testing		
Our Reference:	UNITS	187366-1
Your Reference	-------------	QC02_20160922
Date Sampled	------------	18/10/2016
Type of sample		Water
Date testing started	-	19/10/2016
Date testing completed	-	24/10/2016
Heterotrophic Plate Count 21C	cfu/mL	4,200^
Heterotrophic Plate Count 35C	cfu/mL	3,900^
Total Coliforms	cfu/100mL	3**
Thermotolerant Coliforms	cfu/100mL	<1**
E.coli	cfu/100mL	<1**

Method ID	Methodology Summary
INORG-091	BOD - Analysed in accordance with APHA latest edition 5210 D.
INORG-018	Total Dissolved Solids - determined gravimetrically. The solids are dried at 180±5°C
INORG-055	Total Nitrogen by colourimetric analysis based on APHA 4500-P J, 4500-NO3 F.
INORG-062	TKN by calculation fromTotal Nitrogen and NOx using APHA methodology.
INORG-055	NOx - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	Nitrite - determined colourimetrically. Soils are analysed from a water extract.
INORG-055	Nitrate - determined colourimetrically. Soils are analysed from a water extract.
INORG-057	Ammonia by colourimetric analysis based on APHA latest edition 4500-NH3 F.
METALS-020	Metals in soil and water by ICP-OES.
MICRO-001	Heterotrophic Plate Count: Microbial Water Analysis - in accordance with MICRO-001 (APHA-9215D-2005). Recommended maximums based on NHMRC and ARMC Australian Drinking Water Guidelines.
MICRO-001	Total Coliforms: Microbial Water Analysis - in accordance with MICRO-001 (AS4276.5-2007). Recommended maximums based on NHMRC and ARMC Australian Drinking Water Guidelines.
MICRO-001	Thermotolerant Coliforms: Microbial Water Analysis - in accordance with MICRO-001 (AS4276.7-2007). Recommended maximums based on NHMRC and ARMC Australian Drinking Water Guidelines.
MICRO-001	E. Coli: Microbial Water Analysis - in accordance with MICRO-001 (AS4276.7-2007). Recommended maximums based on NHMRC and ARMC Australian Drinking Water Guidelines.

QUALITY CONTROL Miscellaneous Inorganics	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			19/10/2016	[NT]	[NT]	LCS-1	19/10/2016
Date analysed	-			19/10/2016	[NT]	[NT]	LCS-1	19/10/2016
BOD	mg/L	5	INORG-091	<5	[NT]	[NT]	LCS-1	71%
Total Dissolved Solids (grav)	mg/L	5	INORG-018	<5	[NT]	[NT]	LCS-1	96%

QUALITY CONTROL Nutrients in Water	UNITS	PQL	METHOD	Blank	Duplicate Sm#	Duplicate results Base II Duplicate II %RPD	Spike Sm#	Spike % Recovery
Date prepared	-			19/10/2016	[NT]	[NT]	LCS-1	19/10/2016
Date analysed	-			20/10/2016	[NT]	[NT]	LCS-1	19/10/2016
Total Nitrogen	mg/L	0.1	INORG-055	<0.1	[NT]	[NT]	LCS-1	103%
TKN by Discrete Analyser	mg/L	0.1	INORG-062	<0.1	[NT]	[NT]	[NR]	[NR]
NOx as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	LCS-1	110%
Nitrite as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	LCS-1	107%
Nitrate as N	mg/L	0.005	INORG-055	<0.005	[NT]	[NT]	LCS-1	110%
Ammonia as N	mg/L	0.005	INORG-057	<0.005	[NT]	[NT]	LCS-1	108%
Total Phosphorus	mg/L	0.05	METALS-020	<0.05	[NT]	[NT]	LCS-1	113%

QUALITY CONTROL Microbiological Testing	UNITS	PQL	METHOD	Blank
Date testing started	-			19/10/2016
Date testing completed	-			24/10/2016
Heterotrophic Plate Count 21C	cfu/mL	10	MICRO-001	<10
Heterotrophic Plate Count 35C	cfu/mL	10	MICRO-001	<10
Total Coliforms	cfu/100 mL	1	MICRO-001	<1
Thermotolerant Coliforms	cfu/100 mL	1	MICRO-001	<1
E.coli	cfu/100 mL	1	MICRO-001	<1

Report Comments:

^ - Heterotrophic plate count is an estimate.
** - High background growth of non-coliform bacteria may underestimate Total Coliform Count.
** - High background growth of non-coliform bacteria may underestimate the Thermotolerant Coliform and E.coli Count.

Definitions:

NT: Not tested NA: Test not required INS: Insufficient sample for this test PQL: Practical Quantitation Limit
<: Less than >: Greater than RPD: Relative Percent Difference LCS: Laboratory Control Sample
NS: Not Specified NEPM: National Environmental Protection Measure NR: Not Reported

Australian Drinking Water Guidelines recommend that Thermotolerant Coliform, Faecal Enterococci, & E.Coli levels are less than 1cfu/100mL. The recommended maximums are taken from "Australian Drinking Water Guidelines", published by NHMRC & ARMC 2011

Quality Control Definitions

Blank: This is the component of the analytical signal which is not derived from the sample but from reagents, glassware etc, can be determined by processing solvents and reagents in exactly the same manner as for samples.

Duplicate: This is the complete duplicate analysis of a sample from the process batch. If possible, the sample selected should be one where the analyte concentration is easily measurable.

Matrix Spike : A portion of the sample is spiked with a known concentration of target analyte. The purpose of the matrix spike is to monitor the performance of the analytical method used and to determine whether matrix interferences exist.

LCS (Laboratory Control Sample) : This comprises either a standard reference material or a control matrix (such as a blank sand or water) fortified with analytes representative of the analyte class. It is simply a check sample.

Surrogate Spike: Surrogates are known additions to each sample, blank, matrix spike and LCS in a batch, of compounds which are similar to the analyte of interest, however are not expected to be found in real samples.

Laboratory Acceptance Criteria

Duplicate sample and matrix spike recoveries may not be reported on smaller jobs, however, were analysed at a frequency to meet or exceed NEPM requirements. All samples are tested in batches of 20. The duplicate sample RPD and matrix spike recoveries for the batch were within the laboratory acceptance criteria.
Filters, swabs, wipes, tubes and badges will not have duplicate data as the whole sample is generally extracted during sample extraction.
Spikes for Physical and Aggregate Tests are not applicable.
For VOCs in water samples, three vials are required for duplicate or spike analysis.

Duplicates: <5xPQL - any RPD is acceptable; >5xPQL - 0-50% RPD is acceptable.
Matrix Spikes, LCS and Surrogate recoveries: Generally 70-130% for inorganics/metals; 60-140% for organics (+/-50% surrogates) and 10-140% for labile SVOCs (including labile surrogates), ultra trace organics and speciated phenols is acceptable.

In circumstances where no duplicate and/or sample spike has been reported at 1 in 10 and/or 1 in 20 samples respectively, the sample volume submitted was insufficient in order to satisfy laboratory QA/QC protocols.

When samples are received where certain analytes are outside of recommended technical holding times (THTs), the analysis has proceeded. Where analytes are on the verge of breaching THTs, every effort will be made to analyse within the THT or as soon as practicable.

Where sampling dates are not provided, Envirolab are not in a position to comment on the validity of the analysis where recommended technical holding times may have been breached.

Measurement Uncertainty estimates are available for most tests upon request.

Appendix G – Tabulated Groundwater Analytical Results

Appendix G, Table G1
Groundwater Analytical Results

		Water Quality Guidelines				6134772 MW1 24/08/2016	6134772 MW1 23/09/2016	6134772 MW1 18/10/2016	6134772 MW2 24/08/2016	6134772 MW2 23/09/2016	6134772 MW2 18/10/2016	6134772 MW3 24/08/2016	6134772 MW3 23/09/2016
Parameter	**Unit**	**ANZECC 2000 MW 95%**	**ANZECC 2000 Marine Inshore**	**ANZECC 2000 Primary Contact Recreation**	**ANZECC 2000 Secondary Contact Recreation**								
Ammonia as N	mg/L	0.91	-	-	-	2.68	6.28	3.95	0.53	0.13	1.48	0.57	0.78
BOD	mg/L	-	-	-	-	6	31	33	7	4	3	4	5
Coliform	cfu/100 ml	-	-	-	-	250,000	<1	1	1000	10	1	3000	10
Plate Count (36°C)	CFU/mL	-	-	-	-	46,000	170	4400	11,000	12,000	7400	68,000	2100
Plate Count (22°C)	CFU/mL	-	-	-	-	49,000	72	4200	13,000	1700	4500	70,000	2400
Nitrate (as N)	mg/L	-	0.05	-	-	0.19	0.05	0.46	13.8	9.95	6.06	0.02	0.01
Nitrite + Nitrate as N	mg/L	-	-	-	-	0.19	0.05	0.46	14	11.8	6.33	0.02	0.01
Nitrite (as N)	mg/L	-	-	-	-	<0.01	<0.01	<0.01	0.2	1.85	0.27	<0.01	<0.01
Faecal Coliform	CFU/100mL	-	-	150	1000	200	<1	1	400	1	1	400	1
E. Coli	CFU/100 ml	-	-	150	1000	200	<1	1	400	1	1	400	1
Total Dissolved Solids	mg/L	-	-			8890	-	-	1480	-	-	1090	-
Total Dissolved Solids (Filtered)	mg/L	-	-	-	-	-	22,300	13,100	-	2120	1360	-	1320
Total Kjeldahl Nitrogen (as N)	mg/L	-	-	-	-	3	6.7	4.2	3.1	2	2.6	0.7	0.9
Nitrogen (Total)	mg/L	-	0.23	-	-	3.2	6.8	4.7	17.1	13.8	8.9	0.7	0.9
Phosphorus (Total)	mg/L	-	0.005	-	-	0.29	0.81	0.47	0.21	0.14	0.18	0.06	0.08

Legend

ANZECC 2000 MW 95%	Indicates a level is equal to or above the ANZECC (2000) Marine Waters 95% Species Protection Trigger Value
ANZECC 2000 Marine Inshore	Indicates a level is equal to or above the ANZECC (2000) Marine Inshore Trigger Value
ANZECC 2000 Pimary Contact Recreation	Indicates a level is equal to or above the ANZECC (2000) Water Quality Guideline for Primary Contact Recreation (e.g. swimming)
ANZECC 2000 Secondary Contact Recreation	Indicates a level is equal to or above the ANZECC (2000) Water Quality Guideline for Secondary Contact Recreation (e.g. boating, fishing)

Appendix G, Table G1
Groundwater Analytical Results

		Water Quality Guidelines				6134772 MW3 18/10/2016	6134772 SHP8 24/08/2016	6134772 SHP8 23/09/2016	6134772 SHP8 18/10/2016	Statistical Summary				
Parameter	**Unit**	**ANZECC 2000 MW 95%**	**ANZECC 2000 Marine Inshore**	**ANZECC 2000 Primary Contact Recreation**	**ANZECC 2000 Secondary Contact Recreation**					Number of Results	Minimum	Maximum	Mean	Median
Ammonia as N	mg/L	0.91	-	-	-	**0.32**	**0.36**	**2.54**	**0.46**	12	0.13	6.28	1.7	0.675
BOD	mg/L	-	-	-	-	**3**	**4**	**22**	**57**	12	3	57	15	5.5
Coliform	cfu/100 ml	-	-	-	-	**1**	**200**	<1	**1**	12	<1	250,000	21,185	5.5
Plate Count (36°C)	CFU/mL	-	-	-	-	**5500**	**110**	**17**	**980**	12	17	68,000	13,140	4,950
Plate Count (22°C)	CFU/mL	-	-	-	-	**14,000**	**910**	**12**	**2000**	12	12	70,000	13,483	3,300
Nitrate (as N)	mg/L	-	**0.05**	-	-	<0.01	**0.02**	**0.03**	<0.01	12	<0.01	**13.8**	**2.6**	0.04
Nitrite + Nitrate as N	mg/L	-	-	-	-	<0.01	**0.02**	**0.03**	<0.01	12	<0.01	14	2.7	0.04
Nitrite (as N)	mg/L	-	-	-	-	<0.01	<0.01	<0.01	<0.01	12	<0.01	1.85	0.2	0.005
Faecal Coliform	CFU/100mL	-	-	150	1000	**1**	**100**	<1	**1**	12	<1	400	92	1
E. Coli	CFU/100 ml	-	-	150	1000	**1**	**100**	<1	**1**	12	<1	400	92	1
Total Dissolved Solids	mg/L	-	-			-	**3320**	-	-	4	1,090	8,890	3,695	2,400
Total Dissolved Solids (Filtered)	mg/L	-	-	-	-	**1340**	-	**10,300**	**2290**	8	1,320	22,300	6,766	2,205
Total Kjeldahl Nitrogen (as N)	mg/L	-	-	-	-	**0.6**	**1.5**	**3.3**	**1.2**	12	0.6	6.7	2.5	2.3
Nitrogen (Total)	mg/L	-	**0.23**	-	-	**0.6**	**1.5**	**3.3**	**1.2**	12	**0.6**	**17.1**	**5.2**	**3.25**
Phosphorus (Total)	mg/L	-	**0.005**	-	-	**0.08**	**0.31**	**0.38**	**0.28**	12	**0.06**	**0.81**	**0.27**	**0.245**

Legend

ANZECC 2000 MW 95%	Indicates a level is equal to or above the ANZECC (2000) Marine Waters 95% Species Protection Trigger Value
ANZECC 2000 Marine Inshore	Indicates a level is equal to or above the ANZECC (2000) Marine Inshore Trigger Value
ANZECC 2000 Pimary Contact Recreation	Indicates a level is equal to or above the ANZECC (2000) Water Quality Guideline for Primary Contact Recreation (e.g. swimming)
ANZECC 2000 Secondary Contact Recreation	Indicates a level is equal to or above the ANZECC (2000) Water Quality Guideline for Secondary Contact Recreation (e.g. boating, fishing)

Appendix G
Table G2
Field and Rinsate Blanks

		Rinsate	Field Blank	Rinsate
		QC03_20160824	QC04_20160824	QC03_20160922
ChemName	**output unit**	24/08/2016	24/08/2016	23/09/2016
Ammonia as N	mg/L	<0.01	<0.01	<0.01
BOD	mg/L	**5**	<2	<2
Coliform	cfu/100 ml	-	-	-
Plate Count (36°C)	cfu/100 ml	-	-	-
PLATE COUNT 22C	cfu/100 ml	-	-	-
Nitrate (as N)	mg/L	<0.01	<0.01	<0.01
Nitrite + Nitrate as N	mg/L	<0.01	<0.01	<0.01
Nitrite (as N)	mg/L	<0.01	<0.01	<0.01
Faecal Coliform	cfu/100 ml	-	-	-
E. Coli	cfu/100 ml	-	-	-
Total Dissolved Solids	mg/L	<10	<10	-
Total Dissolved Solids (Filtered)	mg/L	-	-	**20**
Total Kjeldahl Nitrogen	mg/L	<0.1	<0.1	<0.1
Nitrogen (Total)	mg/L	<0.1	<0.1	<0.1
Phosphorus	mg/L	<0.01	<0.01	<0.01

Appendix G
Table G2
Field and Rinsate Blanks

Field Blank	Rinsate	Field Blank
QC04_20160922	QC03_20160922	QC04_20160922
23/09/2016	18/10/2016	18/10/2016
<0.01	**0.06**	**0.06**
<2	<2	<2
-	-	-
-	-	-
-	-	-
<0.01	<0.01	**0.01**
<0.01	<0.01	**0.01**
<0.01	<0.01	<0.01
-	-	-
-	-	-
-	-	-
<10	**14**	**16**
<0.1	<0.1	<0.1
<0.1	<0.1	<0.1
<0.01	<0.01	<0.01

Appendix G
Table G3
Blind and Split RPDs

		Well	MW1	QC01_20160824	QC02_20160824	RPD	RPD	MW1	QC01_20160922	QC02_20160922	RPD	RPD	MW1	QC01_20161018	QC02_20161018	RPD	RPD
		Date	24/08/2016	24/08/2016	24/08/2016	MW1	MW1	23/09/2016	23/09/2016	23/09/2016	MW1 and	MW1 and	18/10/2016	18/10/2016	18/10/2016	MW1 and	MW1 and
						QC01	QC02				QC01	QC02				QC01	QC02
ChemName	**output unit**	**EQL**															
Ammonia as N	mg/L	**0.01**	**2.68**	**2.86**	2.9	6	1	**6.28**	6.42	5	2	-23	**3.95**	4	3.2	1	-21
BOD	mg/L	**2**	**6**	**6**	<5	0	-18	**31**	31	<5	0	-144	**33**	27	14	-20	-81
Coliform	cfu/100 ml	**1**	**250,000**	**200**	-	200	-	<1	<1	<1	-	-	**1**	1	<1	0	0
Plate Count (36°C)	CFU/mL	**1**	**46,000**	**49,000**	-	6	-	**170**	140	340	-19	67	**4400**	4400	4200	0	-5
PLATE COUNT 22C	CFU/mL	**1**	**49,000**	**60,000**	-	20	-	**72**	73	260	1	113	**4200**	3600	3900	-15	-7
Nitrate (as N)	mg/L	**0.01**	**0.19**	**0.18**	0.17	-5	-6	**0.05**	<0.01	<0.005	-133	-164	**0.46**	0.46	0.44	0	-4
Nitrite + Nitrate as N	mg/L	**0.01**	**0.19**	**0.18**	0.17	-5	-6	**0.05**	0.46	-	161	-	**0.46**	0.46	-	0	-
Nitrite (as N)	mg/L	**0.01**	<0.01	<0.01	<0.2	-	-	<0.01	<0.01	0.006	-	-198	<0.01	<0.01	<0.005	-	-
Faecal Coliform	CFU/100mL	**1**	**200**	**1100**	-	138	-	<1	<1	<1	0	0	**1**	1	<1	0	0
E. Coli	cfu/100 ml	**1**	**200**	**1100**	-	138	-	<1	<1	<1	0	0	**1**	1	<1	0	0
Total Dissolved Solids	mg/L	**10**	**8890**	**8800**	7500	-1	-16	**22,300**	22,400	22000	0	-1	**13,100**	13,100	14000	0	7
Total Kjeldahl Nitrogen	mg/L	**0.1**	**3**	**2.9**	3.1	-3	7	**6.7**	6.7	9.2	0	31	**4.2**	4.1	5.3	-2	23
Nitrogen (Total)	mg/L	**0.1**	**3.2**	**3.1**	3.2	-3	3	**6.8**	6.7	9.2	-1	30	**4.7**	4.6	5.7	-2	19
Phosphorus	mg/L	**0.01**	**0.29**	**0.3**	0.19	3	-45	**0.81**	0.9	0.78	11	-4	**0.47**	0.46	0.57	-2	19

🟥 Indicates Exceedance of RPD criteria (50%)

Appendix H – Calibration Certificates

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RENTALS

Insitu Aqua Troll 600 Profiler Water Quality Meter

This Water Quality Meter has been performance checked / calibrated* as follows:

pH	☐ pH 6.88	☑ pH 7.00	☑ pH 4.00	☐ pH 10.00	☑ pH
Conductivity	☑ 0.0mS/cm	☑ 1413uS/cm	☑ 12.88mS/cm	☐ 58.6mS/cm	☑ mS/cm
TDS	☑ 0.0 ppk	☑ 36 ppk	☑ ppk		
Dissolved Oxygen	☑ 0.00ppm in Sodium Sulphite			☑ 100% Saturation in Air	
Redox (ORP)**	☑ Electrode operability test 240mV +/- 10%. Actual: 240 mV				
☑ Electrodes cleaned/checked		☑ Temperature			

* Calibration solution traceability information is available upon request.
**

Date: 22/8 Checked by: Aaron

Signed: AO

Please check that the following items are received and that all items are cleaned and decontaminated before return. A minimum $20 cleaning / service / repair charge may be applied to any unclean or damaged items. Items not returned will be billed for at the full replacement cost.

Sent	Received	Returned	Item
☑	☐	☐	AquaTroll 600 Unit. Ops check / Battery Voltage @ __________
☑	☐	☐	AquaTroll 600 Set to Time: Yes / No
☑	☐	☐	Aqua Troll 600 Cal Cup
☐	☐	☐	Troll Cable S/n:____________ Length:_______ m
☐	☐	☐	USB Cable Connect Comms Cable S/n: ________
☑	☐	☐	S/steel Sensor Protector Shroud
☐	☐	☐	Screw Drivers x3
☑	☐	☐	Turbidity Wiper
☑	☐	☐	PC Software version X.X
☑	☐	☐	Aqua Troll 600 Cary Case

Processors Signature/ Initials AO

Quote Reference	CP0818	Condition on return
Customer Ref		
Equipment ID	AT600	
Equipment serial no.		
Return Date	/ /	
Return Time		

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RENTALS

Equipment Certification Report – TPS 90FLMV Water Quality Meter

This Water Quality Meter has been performance checked and calibrated as follows:

Sensor	Concentration	Span 1	Span 2	Traceability Lot #	Pass?
pH	pH 7.00 / pH 4.00	7 pH	4 pH	/	☑
Conductivity	1413uS/cm	1413 mS/cm	12880 mS/cm		☑
TDS	36 ppk	0 ppk	36 ppk		☑
Dissolved Oxygen	Sodium Sulphite / Air	0 ppm in Sodium Sulphite	10 ppm Saturation in Air		☑

Check only

Redox (ORP) *	Electrode operability test	240mV +/- 10%	240 mV		☑

* This meter uses an Ag/AgCl ORP electrode. To convert readings to SHE (Standard Hydrogen Electrode), add 199mV to the mV reading.

☑ Battery Status ______________(min 7.2V)

☑ Electrical Safety Tag attached (AS/NZS 3760)

☑ Temperature 21 °C

☑ Electrodes Cleaned and checked

Tag No: ___________

Valid to: ___________

Date: 20/9

Signed: AD

Please check that the following items are received and that all items are cleaned and decontaminated before return. A minimum $30 cleaning / service / repair charge may be applied to any unclean or damaged items. Items not returned will be billed for at the full replacement cost.

Sent	Returned	Item
☑	☐	90FLMV Unit. Ops check/Battery status: ___________
☑	☐	pH sensor with wetting cap, 5m
☑	☐	Conductivity/TDS/Temperature K=10 sensor, 5m
☑	☐	Dissolved oxygen YSI5739 sensor with wetting cap, 5m
☑	☐	Redox (ORP) sensor with wetting cap, 5m
☑	☐	Power supply 240V to 12V DC 200mA
☑	☐	Instruction Manual
☐	☐	Quick Guide
☑	☐	Syringe with storage solution for pH and ORP sensors
☑	☐	Carry Case
☑	☐	Check to confirm electrical safety (tag must be valid)

Date: 20/9

Signed: AD

TFS Reference	CP0818	Return Date: / /
Customer Reference		Return Time:
Equipment ID	90FLMV WA3	Condition on return:
Equipment Serial No.		

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RENTALS

Equipment Certification Report – TPS 90FLT Water Quality Meter

This Water Quality Meter has been performance checked and calibrated as follows:

Sensor	Concentration	Span 1	Span 2	Traceability Lot #	Pass?
pH	pH 4.00/ pH 7.00	4 pH	7 pH	/	☑
Conductivity	12.88mS/cm	12.88mS/cm	1413 μS/cm		☑
TDS	36.0ppk	0 ppk	36 ppk		☑
Dissolved Oxygen	Sodium Sulphite / Air	0 ppm in Sodium Sulphite	10 ppm Saturation in Air		☑
Turbidity	1000 NTU	0 NTU	1000 NTU		☑
Redox (ORP)**240mV	☑	Electrode operability test 240mV +/- 10%. Actual: 240 mV			

☑ Battery Status ________________(min 7.2V)

☑ Electrical Safety Tag attached (AS/NZS 3760)

☑ Temperature 21 °C

☑ Electrodes Cleaned and checked

Tag No: ____________

Valid to: ____________

Date: 14/10

Signed: AD

Please check that the following items are received and that all items are cleaned and decontaminated before return. A minimum $30 cleaning / service / repair charge may be applied to any unclean or damaged items. Items not returned will be billed for at the full replacement cost.

Sent	Returned	Item
☑	☐	90FLMV Unit. Ops check/Battery status: ____________
☑	☐	pH sensor with wetting cap, 5m
☑	☐	Conductivity/TDS/Temperature K=10 sensor, 5m
☑	☐	Dissolved oxygen YSI5739 sensor with wetting cap, 5m
☑	☐	Turbidity sensor, 5m
☑	☐	Power supply 240V to 12V DC 200mA
☑	☐	Instruction Manual
☐	☐	Quick Guide
☑	☐	Syringe with storage solution for pH and ORP sensors
☑	☐	Carry Case
☑	☐	Check to confirm electrical safety (tag must be valid)

Date: 14/10

Signed: AD

TFS Reference	CP0818	Return Date: / /	
Customer Reference		Return Time:	
Equipment ID	90FLT - WA6	Condition on return:	
Equipment Serial No.			

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Appendix I – Field Works Photographs

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2217	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW1 – Soil Log 0.5 mbgl		

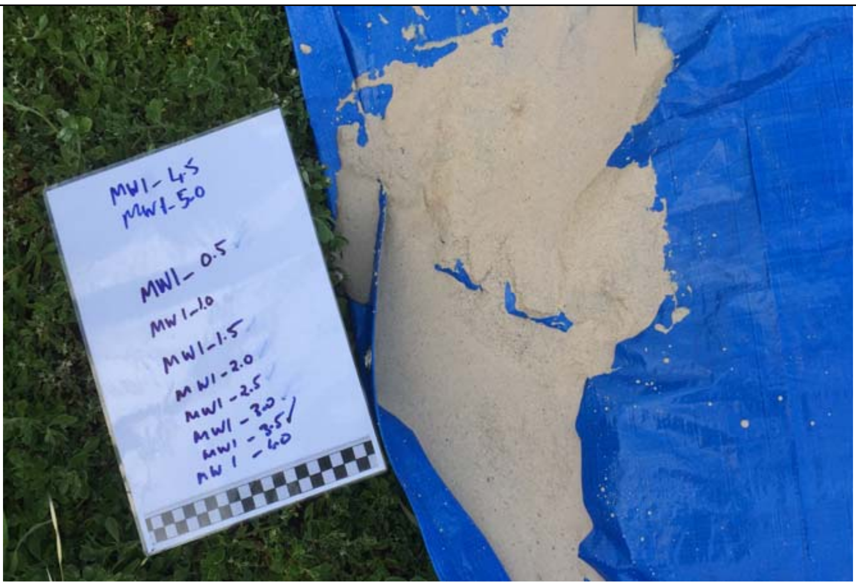
Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2218	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW1 – Soil Log 1.0 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2219	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW1 – Soil Log 1.5 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2220	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW1 – Soil Log 2.0 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2221	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW1 – Soil Log 2.5 mbgl		

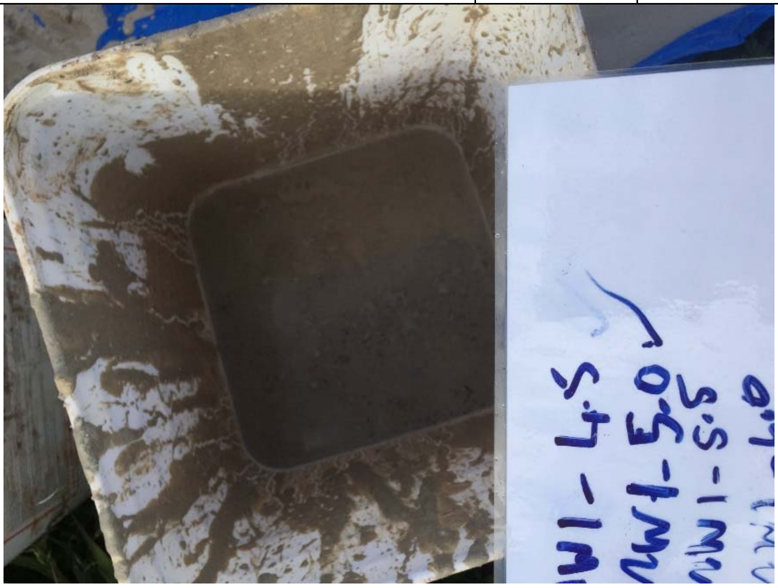
Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2222	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW1 – Soil Log 3.0 mbgl		



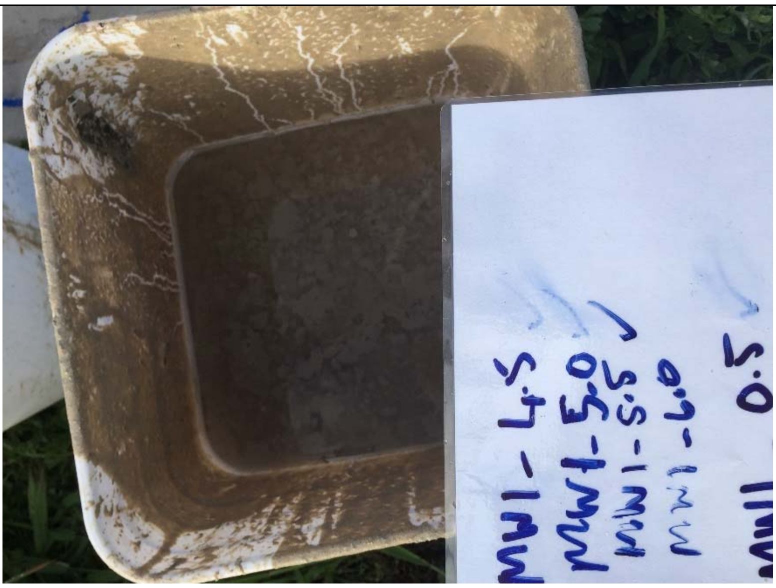
Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2223	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW1 – Soil Log 3.5 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2224	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW1 – Soil Log 4.0 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2225	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW1 – Soil Log 4.5 mbgl		



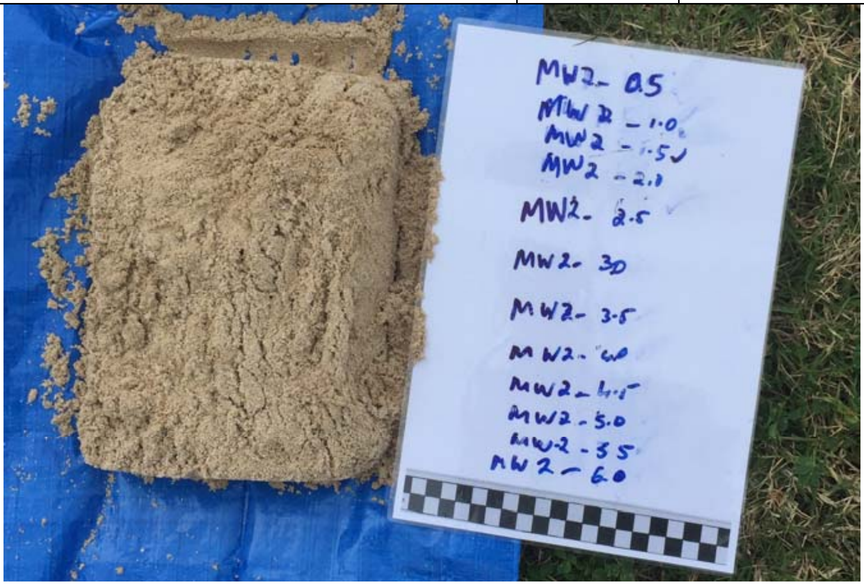
Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2226	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW1 – Soil Log 5.0 mbgl		



Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2227	**2016**	GHD
File:G:\61\34772\Technical\Photos\		
Description: MW1 – Soil Log 5.5 mbgl		

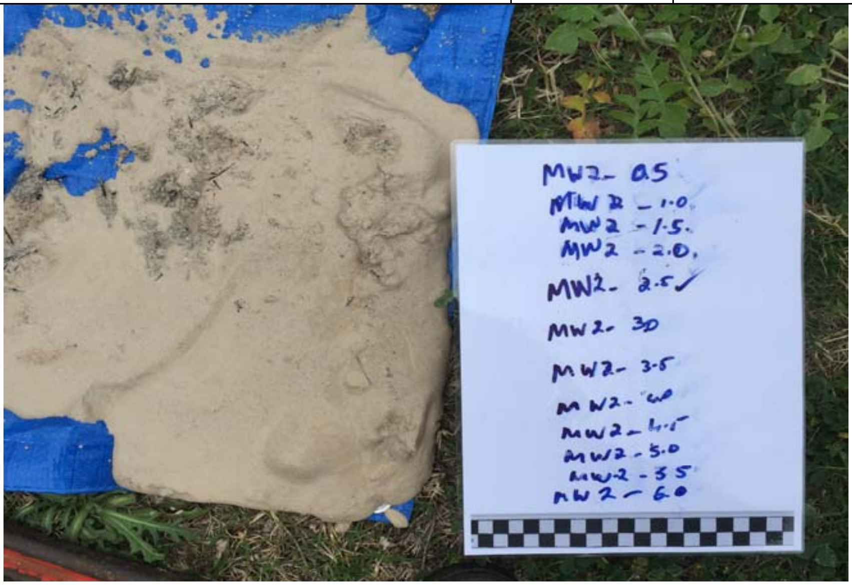
Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2229	**2016**	GHD
File:G:\61\34772\Technical\Photos\		
Description: MW2 – Soil Log 0.5 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2230	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW2 – Soil Log 1 mbgl		



Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2231	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW2 – Soil Log 1.5 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2232	**2016**	GHD
File:G:\61\34772\Technical\Photos\		
Description: MW2 – Soil Log 2.0 mbgl		



Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2233	**2016**	GHD
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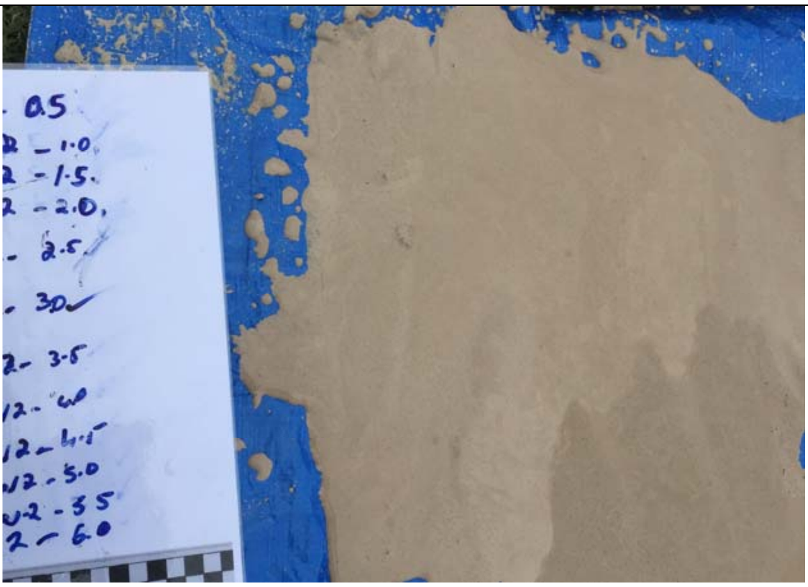
Description: MW1 – Soil Log 2.5 mbgl		



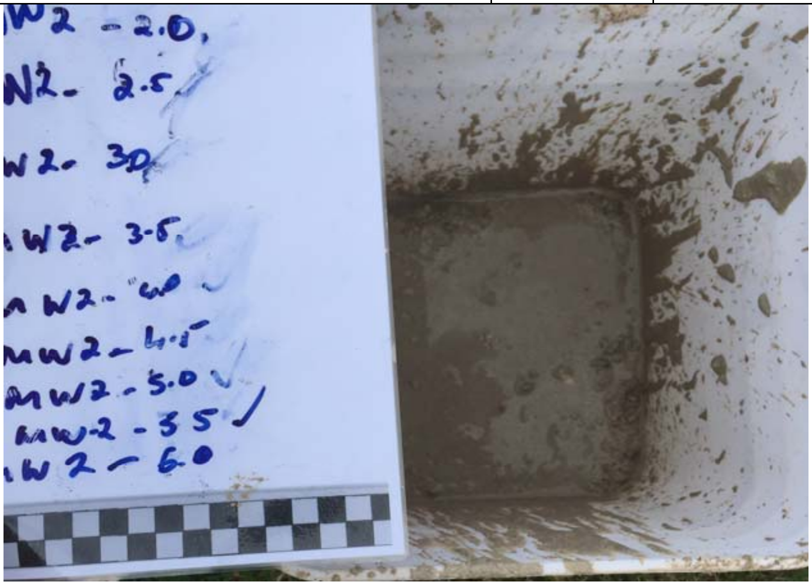
Created by: S Petts	**Date** **16/09/2016**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)		
Reference: IMG_2234	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW2 – Soil Log 3.0 mbgl		

Created by: S Petts	**Date** **16/09/2016**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)		
Reference: IMG_2235	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW2 – Soil Log 3.5 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2236	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW2 – Soil Log 4.0 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2237	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW2 – Soil Log 4.5 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2238	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW2 – Soil Log 5.0 mbgl		



Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2239	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW2 – Soil Log 5.5 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2240	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW2 – Soil Log 6.0 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2241	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW3 – Soil Log 0.5 mbgl		

Created by: S Petts Source: GHD (15/08/2016)	**Date** **16/09/2016**	**Point Moore Groundwater Assessment**
Reference: IMG_2242 File:G:\61\34772\Technical\Photos\ Description: MW3 – Soil Log 1.0 mbgl	**2016**	

Created by: S Petts Source: GHD (15/08/2016)	**Date** **16/09/2016**	**Point Moore Groundwater Assessment**
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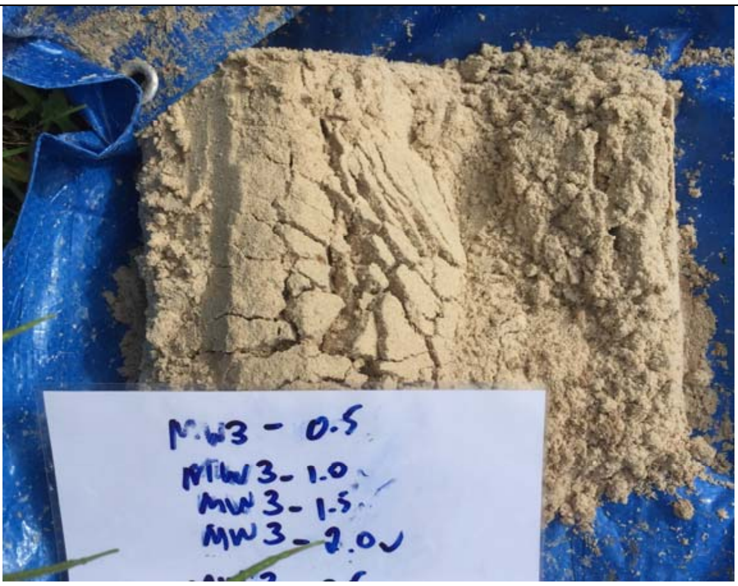

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2244	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW3 – Soil Log 2.0 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2245	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW3 – Soil Log 2.5 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2246	**2016**	GHD
File:G:\61\34772\Technical\Photos\		
Description: MW3 – Soil Log 3.0 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2247	**2016**	GHD
File:G:\61\34772\Technical\Photos\		
Description: MW3 – Soil Log 3.5 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2248	**2016**	GHD
File:G:\61\34772\Technical\Photos\		
Description: MW3 – Soil Log 4.0 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2249	**2016**	GHD
File:G:\61\34772\Technical\Photos\		
Description: MW3 – Soil Log 4.5 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2250	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW3 – Soil Log 5.0 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2251	**2016**	
File:G:\61\34772\Technical\Photos\		
Description: MW3 – Soil Log 5.5 mbgl		

Created by: S Petts	**Date**	**Point Moore Groundwater Assessment**
Source: GHD (15/08/2016)	**16/09/2016**	
Reference: IMG_2252	**2016**	GHD
File:G:\61\34772\Technical\Photos\		
Description: MW3 – Soil Log 6.0 mbgl		

GHD

Level 1, 209 Foreshore Drive WA 6530
PO BOX 164 Geraldton WA 6531
T: (08) 9920 9400   F: (08) 9920 9499   E: getmail@ghd.com.au

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	S. Petts	D. Edgar	DME	D. Edgar	DME	10/11/2016
1	S.Petts	A. Nagle D. Edgar	DME for AN DME	D. Edgar	DMEdgar	25/11/2016

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