Coffs Harbour City Council

Hydrocarbon Impacted Groundwater, Coramba, NSW
Groundwater Management Plan

February 2017

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1. Introduction

GHD Pty Ltd (GHD) has been engaged by Coffs Harbour City Council (CHCC) to develop and implement a Groundwater Management Plan (GMP) for the future management and monitoring of hydrocarbon impacted groundwater in Coramba, NSW (see Figure 1, Appendix A).

1.1 Background

In 2002, hydrocarbon contaminated groundwater was discovered seeping into a backwater adjacent to the Orara River, Coramba, NSW. The source of the hydrocarbon contaminated groundwater was identified as an unleaded petrol leak from an underground storage tank (UST) at a service station located at 33 Gale Street Coramba, approximately 150 m up gradient of the Orara River (see Figure 2, Appendix A). The leaking tank and contaminated soil were reported to have been removed and managed in accordance with guidelines and legislative requirements that were relevant at the time.

Assessment of the hydrocarbon impacted groundwater included the installation and sampling of four groundwater monitoring wells in 2004 by Golder Associates (Golder) and an additional 20 groundwater monitoring wells in 2006 by WSP Environmental Pty Ltd (WSP). Ongoing groundwater monitoring of the 24 wells has been undertaken approximately every 12 months from 2006 to 2015. Surface water sampling in the Orara River has also been undertaken monthly at four locations from January 2007 until June 2015.

Further management of the contamination at the site was undertaken in 2011 with the installation of a soil vapour extraction system and air sparging treatment system. This infrastructure operated sporadically from 2011 and then continuously for over 18 months from July 2013 to reduce the hydrocarbon impact in the groundwater. The system was shut down on 3 March 2015, and while it is no longer in operation, it is still in situ.

A groundwater monitoring event was undertaken in March 2015 to document groundwater conditions at the time of treatment system shut down, and a further monitoring event was undertaken in June 2015, to assess whether rebound had occurred since the shut-down.

The Service Station is reported to be monitored in accordance with the requirements of the Underground Petroleum Storage Systems (UPSS) Regulations and guidelines (NSW EPA 2014).

Groundwater monitoring results from 2008 to 2015 indicate that the overall groundwater contamination appears to be decreasing or stabilising, however some monitoring wells still contain Benzene, Toluene, Ethylbenzene, Xylene (BTEX) and Total Recoverable Hydrocarbon (TRH) concentrations above the adopted groundwater assessment criteria. Recent monitoring data indicates that contaminant concentrations may fluctuate with rainfall.

In June 2010, CHCC entered in a Voluntary Management Proposal (VMP) with the NSW Environmental Protection Authority (EPA), however recent groundwater monitoring results may lead to the land declaration issued under the Contaminated Land Management Act 1997 (CLM Act) being lifted and the GMP forming the basis of a s28 Maintenance Order under the CLM Act.

The VMP (Approval No. 20101716) is for up to 3 years operation of the groundwater treatment system, and calls for a validation report within 60 days of cessation of operations, and a Site Audit Report within 60 days of the validation report. However GHD understands from discussions with Council that the EPA in their capacity as regulator is likely to transition the VMP to the Maintenance Order (as noted above) on the basis of current monitoring reports and the GMP, without the involvement of a site auditor.

1.2 Objectives

The objectives of the GMP were to develop a groundwater management plan for the future management and monitoring of the hydrocarbon impacted groundwater at the site, including:

- Groundwater sampling of existing groundwater monitoring wells and river water sampling from the Orara River.
- Odour management – Identification of odour management measures in the event that odour complaints or issues are identified at the site.
- Rebound assessment – Determining the trigger points to recommence the use of the existing air sparge system.
- Exit strategy – Developing an exit strategy for the monitoring program based on a stabilised or decreasing trend in hydrocarbon impact at the site.

1.3 Scope of works

The agreed scope of work proposed by GHD and agreed to by CHCC and the EPA included developing a GMP that describes the scope of monitoring, including:

- Annual sampling of appropriate wells following high rainfall events to determine the link between groundwater and hydrocarbon levels, including analysis of all samples for TRH, BTEX and standard field parameters and analysis of selected wells for monitored natural attenuation (MNA) factors. A factual monitoring report would be provided following each monitoring event.
- Sampling of Orara River in conjunction with groundwater sampling from select locations and analysis for TRH and BTEX using appropriate assessment criteria.
- Developing an odour management plan with contingencies, further assessment and actions should odour complaints or issues arise (Appendix C.)
- Incorporating a contingency provision for the revision of the management plan and response actions should sampling indicate an increasing trend in hydrocarbon impacts.
- Developing an exit strategy subject to a stabilisation and decreasing trend in hydrocarbon concentrations across the site, based on key indicators and results from previous monitoring data.
- Preparing a conceptual site model (CSM) based on the updated monitoring program.

2. Site information

2.1 Location details

The site is located in Coramba, approximately 12 km north-west of Coffs Harbour on the Mid North Coast of NSW as shown on Figure 1 Appendix A. The service station where the leak occurred is located at 33 Gale Street on Lot 2, DP 264343 and the river bank where the hydrocarbon leak was first observed is located on Lot 122 DP 876790 (Council owned reserve at the end of Martin Street) as shown on Figure 2, Appendix A. The contaminated groundwater extends beneath multiple properties between these two points, including Martin St Road Reserve. Twenty-four previously installed groundwater monitoring wells are located in this area down gradient of the Service Station to the Orara River. The locations of these monitoring wells are presented in Figure 2, Appendix A. The air sparge treatment system is located on Martin Street on Lot 121 DP 876790. The 'site' refers to the area impacted or formerly impacted by the hydrocarbon contamination from the service station to the Orara River, including all 24 previously installed monitoring wells and the air sparge unit.

The site location and further site details are provided in Table 2-1.

Table 2-1 Site identification

Local Government Area	Coffs Harbour City Council (Council)
Current Land Use	Residential and Recreational along the Orara River
Proposed future land use	Residential and Recreational
Local Land Use Zoning based on Coffs Harbour Local Environmental Plan (LEP) 2013 (NSW Legislation, 2014)	Zone R2 – Low Density Residential
Objectives of Zone	• *To provide for the housing needs of the community within a low density residential environment.* • *To enable other land uses that provide facilities or services to meet the day to day needs of residents.*

2.2 Environmental setting

Table 2-2 provides an overview of the environmental setting of the site obtained from a desktop review of publically available information, including previous site reports and the following information sources:

- 1:250,000 scale Regional Geology Sheet for the Coffs Harbour area.
- NSW Land & Property Information, *SIX Maps* (http://maps.six.nsw.gov.au/), accessed 14 October 2016.
- Department of Primary Industries Office of Water database (http://allwaterdata.water.nsw.gov.au/water.stm), accessed 14 October 2016.

Table 2-2 Summary of site conditions

Section	Summary
Geology and soils	The site is underlain primarily by the Carboniferous aged Coramba beds, comprising siliceous argillite. Granodiorite forms the bedrock in a small portion of the northern part of the site. Soils at the site consist of alluvial sediments comprising gravelly river sediments close to the Orara River and sandy silty sediments further up the bank.
Topography	The site slopes down to the Orara River with an elevation ranging from approximately 80 metres Australia Height Datum (AHD) at the Orara River to 120 m AHD at Gale Street, where the service station is located.
Hydrology	The nearest surface water receptor (ecological) is the Orara River, which forms the north eastern boundary of the investigations to date. The Orara River is a tributary of the Clarence River. Runoff from the site would flow in a north westerly direction towards the Orara River.
Hydrogeology	There are 24 groundwater monitoring wells located at the site, for the purposes of assessing the impact of the contaminated groundwater, which is the focus of this report. An off-site well is located approximately 300 m north west of the site and is used for domestic purposes.

2.3 Surrounding land use

Current land uses immediately surrounding the site are detailed in Table 2-3, listed in order of proximity to the site and shown in Figure 2, Appendix A.

Table 2-3 Surrounding land use

Direction	Land use
North	The Orara River is located immediately north of the Site, beyond which a railway and rural residential properties are located.
East	Martin Street is located on the eastern portion of the site, followed by residential properties and the Orara River.
South	Residential properties off Gale Street are located to the south of the site, beyond which rural land is located.
West	Residential properties and commercial businesses are located to the west of the site.

2.4 Surrounding sensitive receptors

A CSM is provided in Section 5. The following potentially sensitive receptors were identified in the vicinity of the site:

- Ecological receptors and recreational users of the Orara River.
- Groundwater beneath the Site and users of groundwater in the surrounding area.
- Residences (on-site and off-site).
- Workers (on-site and off-site), including those working on nearby underground services and utilities and intrusive maintenance workers.
- Visitors to the Site.

3. Legislative requirements

3.1 Legislation and guidelines

The following legislation and guidelines have been referred to in the preparation of this GMP:

- Contaminated Land Management Act (CLM Act) 1997.
- Protection of the Environment Operations (POEO) Act 1997.
- Water Act 1912.
- Water Management Act 2000.
- ANZECC/ARMCANZ (2000). National Water Quality Management Strategy, Paper No. 4, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, October 2000, Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).
- NEPC (2013). National Environment Protection (Assessment of Site Contamination) Measure (NEPM) 1999 as amended by the National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1).
- NHMRC & NRMMC (2011). Australian Drinking Water Guidelines Paper 6 National Water Quality Management Strategy. National Health and Medical Research Council, National Resource Management Ministerial Council, Commonwealth of Australia, Canberra, 2011.
- NSW DEC (2007). Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination, 2007.
- CRC CARE (2010). CRC CARE technical report no. 15 A technical guide for demonstrating monitored natural attenuation of petroleum hydrocarbons in groundwater.

3.2 Director-General's requirements

On 28 August 2009, approval was granted for the 'Coramba Groundwater Remediation Project', specifically the construction of the air sparge treatment system, subject to certain conditions of consent (07_0085). These conditions were required to:

- Prevent, minimise, and/or offset adverse environmental impacts.
- Set standards and performance measures for acceptable environmental performance.
- Require regular monitoring and reporting.
- Provide for the ongoing environmental management of the project.

Ongoing monitoring at the site was to be undertaken in accordance with these conditions to ensure that environmental harm and human health risks are minimised.

3.3 Community engagement and risk communications

A consultation program is already in place, which will be continued to keep affected stakeholders informed of activities and provide them with an opportunity for input.

The implementation of the consultation program is captured in CHCC's Communication and Consultation Strategy (CHCC 2011) which is included in Appendix C.

The objectives of the current strategy are to keep the community informed about what CHCC is doing, what the community can expect and the progress of the remediation works as well as informing those involved with any work at the site about any community concerns or questions so that feedback can be provided.

The strategy includes:

- Key performance indicators.
- Guiding principles.
- Key messages.
- Roles and responsibilities.
- Communication and consultation – process, stakeholders and approach.
- Timeframe and project milestones.
- Monitoring and evaluation.
- Implementation plan.

4. Previous site investigations

A number of investigations have been undertaken at the site since the discovery of the hydrocarbon contamination, including annual groundwater monitoring reports since 2011. The findings of these previous investigations and other reports relevant to the site are summarised in the following subsections. The locations of the existing groundwater monitoring wells are shown in Figure 2, Appendix A.

4.1 Control Testing Laboratories (CTL) 2002 – preliminary investigation

This report was referred to in other reports, however has not been made available to GHD. It is understood that investigations reported no petroleum hydrocarbon contamination at or around the service station.

4.2 CTL and E.J. Armstrong & Associates 2002 – Coramba Service Station – Reported Unleaded Fuel Loss

This report was referred to in other reports, however has not been made available to GHD. It is understood that investigations reported no petroleum hydrocarbon contamination at or around the service station.

4.3 Robert Carr & Associates Pty Ltd 2002 – Contamination Assessment and Remedial Works

This report was referred to in other reports, however has not been made available to GHD. It is understood that soil investigations undertaken following removal of the UST reported TPH C6-C9 and benzene concentrations greater than the assessment criteria used at the time.

4.4 Golder Associates 2004 – Remediation Action Plan

This report was referred to in other reports, however has not been made available to GHD. It is understood that four monitoring wells (MW1, MW2, MW3 and MW4B) were installed during these investigations and soil and groundwater samples exceeded the adopted assessment criteria for TPH C6-C9 and BTEX.

4.5 WSP 2006a – Pre-remediation Environmental Assessment

WSP completed a soil and groundwater investigation at the site to determine the extent of hydrocarbon contamination on and around 5 Martin Street, Coramba, as a result of a leaking underground storage tank from the fuel station on Gale Street. The investigation involved installation and sampling of 20 monitoring wells as well as sampling four wells previously installed by Golder Associates in 2004. It was concluded that:

- Siliceous argillite forms the bedrock beneath most of the investigation area with granodiorite forming the bedrock in a small area in the northern portion of the investigation area.
- Alluvial sediments exist in two terraces, a lower terrace consisting of gravelly river sediments and an upper terrace containing sandy silty sediments.
- Groundwater was discovered beneath the investigation area, which was determined to be in direct connection with the river.

- A dissolved benzene plume was found to be larger than anticipated with a strong easterly flow towards the Orara River (it is understood that the plume is depicted in the report, however GHD does not have access to the report. GHD's interpretation of the plume, based on the available data, is shown in Figure 3, Appendix A).

This report was referred to in other reports, however has not been made available to GHD. The above interpretation was taken from other reports made available to GHD.

4.6 WSP 2006b – Remedial Action Plan

A remedial action plan (RAP) was developed for the site, which assessed the suitability of a number of soil and groundwater remedial technologies. It was recommended to undertake a staged approach. Stage 1 was designed to remove the significant risk of harm and included remedial works consisting of:

- Source removal using a soil vapour extraction system along Gale Street, accompanied by groundwater depression which was to expose the previously saturated bedrock to active vapour extraction.
- Control of benzene and other petroleum hydrocarbons migrating to the Orara River by using an air sparging barrier installed on the lower alluvial terrace parallel to the river.
- An interception trench at the eastern end of Martin Lane to ensure no further migration of hydrocarbons to down gradient sections of the 5 Martin St property. This trench was to be approximately 10 m deep.
- The impacted soils from the lower terrace would be removed, replaced by clean fill and transported to Coffs Harbour Landfill. Any impacted soils encountered during the trench excavation would also be disposed to Coffs Harbour Landfill.

Following consultation with relevant government agencies and community representatives the installation of an air sparge system with soil vapour extraction (SVE) and treatment was undertaken, which was intended to intercept the contaminated groundwater before it could enter the river.

4.7 HLA Envirosciences Pty Ltd 2006 – Site Audit Report

This report was referred to in other reports, however has not been made available to GHD.

4.8 CHCC 2007 – Preliminary Environmental Assessment

In 2007 CHCC prepared a project application and preliminary environmental assessment to be submitted to the Minister for Planning and the Director-General of Planning for the proposed Stage 1 Remedial Works at the site. The environmental issues that were addressed included water, soil, noise, air, biodiversity, traffic/access, waste, services, hazards, health and consultation. It was determined that a detailed environmental assessment would be required for the project to focus on key environmental issues. A number of requirements were outlined for the detailed environmental assessment.

4.9 NSW Health 2007 – Health Risk Assessment

In 2007 a health risk assessment was undertaken by the North Coast Area Health Service's Public Health Unit to determine the likelihood of adverse health effects resulting from drinking hydrocarbon contamination water from the Orara River, which was used as the Coramba drinking water supply. A water sampling program commenced in 2002 after the discovery of the leaking UST, with the results compared against the Australian guideline levels for recreational and drinking water applicable at the time. It was concluded in that report that there were no significant risks to human health from drinking water or using river water from the Orara River at that time as exposure to the contamination was limited. This limited exposure was attributed to Council's prompt provision of an alternative safe drinking water supply.

4.10 WSP 2008a – Groundwater Monitoring Report

A groundwater monitoring event was undertaken in January 2008 to monitor the extent and level of hydrocarbons in groundwater, particularly benzene. Groundwater results in this report were compared against the freshwater criteria from the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000) and the *Australian Drinking Water Guidelines* (NHMRC 2011). The hydrocarbon concentrations detected during this monitoring round were similar to those detected in 2006, with some decreasing concentrations noted in the wells adjacent to the river. No phase separated hydrocarbons (PSH) were detected and there was evidence of natural attenuation occurring. It was noted that this monitoring round was undertaken following heavy rainfall.

4.11 WSP 2008b – Air Sparge Trial Report

In 2008 an air sparge and SVE trial was undertaken to aid the design of the proposed sparge curtain and SVE system for the Orara River. The aim of the trial was to determine whether air sparging was suitable to protect the Orara River from contaminated groundwater and to provide operating parameters and performance specifications for the installation of the system. The trial involved installing three SVE and sparge test points, installing a number of monitoring wells, conducting the testing and documenting the results.

4.12 GHD 2009a – Environmental Assessment

In 2009, GHD prepared an environmental assessment report (EAR) to address potential environmental, social and economic impacts associated with the construction and operational phases of the proposed remediation works, consisting of the air sparging and SVE system. The EAR focussed on addressing the environmental assessment requirements outlined by the Director General, including soil and water, air quality, noise, traffic, waste management and flora and fauna. The main benefits of the project were in relation to reducing the environmental and human health risks associated with the contaminated groundwater. Potential adverse effects of the project were identified as air quality impacts, noise impacts, flora impacts and short term construction related impacts.

4.13 GHD 2009b – Response to Submissions Report

The EAR was placed on public exhibition for one month, with a number of submissions received, including five written submissions from government bodies and six written submissions from the public. The Submissions Report (GHD 2009b) provided a response to those submissions. The primary issues raised by government bodies were in relation to air quality, noise, water quality, biodiversity, community liaison and ongoing monitoring. The primary issues raised by the community were in relation to noise, odour, aesthetics/access (the location of the treatment system) and the effectiveness of the treatment system. A response to each submission was given and a statement of commitments provided to effectively manage any risks associated with the treatment system.

4.14 NSW DoP 2009 – Director General's Environmental Assessment Report

Following the exhibition of the EAR and the submissions from government agencies and the public, the NSW Department of Planning (DoP) prepared an environmental assessment report to assess the benefits of the remediation project considering relevant legislative requirements and the concerns from the public. It was concluded that the Department was satisfied that the negative impacts of the remediation project were relatively minor and could be sufficiently managed to minimise negative environmental effects. The main benefits of the project were identified to be reducing the risk to human health and the environment by reducing exposure to contaminated groundwater and improving the health of the Orara River. Further identified, positive effects of the project included increasing the biodiversity of the riparian corridor and habitat for fauna species. The overall conclusion was that the project was in the public interest and should be approved, subject to conditions.

4.15 WSP 2011 – Groundwater Monitoring Report

Groundwater monitoring was undertaken in March 2011 of the 24 wells onsite. Results showed that the extent of the benzene plume had changed little since the previous monitoring in 2006 and 2008. Overall, hydrocarbon concentrations detected in this round were lower than 2008, particularly in wells on Gale Street (closest to the service station) and those adjacent to the river. No PSH was detected. Although the hydrocarbon concentrations were reported to be decreasing, they were still well above the adopted assessment criteria.

The air sparge and SVE treatment operated sporadically from 2011.

4.16 WSP 2013 – Groundwater Monitoring Report

The air sparge and SVE treatment operated continuously from July 2013 to March 2015.

The groundwater monitoring event undertaken in 2013 had an additional objective of providing baseline data for evaluation of the success of the air sparge and SVE treatment system. Only 21 wells were sampled during this event, as MW1, MW11 and MW19 could not be located. The results of this monitoring round showed that:

- The plume area appeared to have reduced in extent with concentrations of hydrocarbons below the adopted assessment criteria in MW2, MW3, MW17 and MW21 (which had previously exceeded).
- Hydrocarbon concentrations in eight wells (MW4B, MW6, MW12, MW13, MW14, MW16, MW18 and MW23) still exceeded the adopted groundwater assessment criteria.
- Hydrocarbon concentrations in the eight wells that exceeded the adopted assessment criteria had increased compared to 2011, with the exception of MW16. However an overall decrease was noted when compared against the 2008 data.

4.17 WSP 2014 – Groundwater Monitoring Report

During the 2014 groundwater monitoring event, three wells were not accessed as they were located on private property or lost (MW1, MW2 and MW9). The following conclusions were made:

- BTEX concentrations above the adopted assessment criteria were recorded in MW6, MW11 and MW14.
- TRH concentrations above the adopted assessment criteria were recorded in MW4B, MW6, MW11 and MW14.

- With the exception of MW14, there appeared to be an overall decrease in BTEX concentrations across the site when compared to 2013 data.
- Based on the decreasing concentrations, it was concluded that degradation of hydrocarbons had occurred in the vicinity of the remediation system.
- It was considered that monitored natural attenuation was occurring within the monitoring wells affected by the plume, but the rate of degradation was limited by a lack of available electron donors.

4.18 WSP 2015a – Groundwater Monitoring Report

A groundwater monitoring event was undertaken in March 2015 to provide a baseline assessment of hydrocarbon concentrations at the time the remediation system was switched off. The following conclusions were made:

- BTEX concentrations above the adopted assessment criteria were recorded in MW4B, MW6, MW12, MW14, MW16 and MW23.
- TRH concentrations above the adopted assessment criteria were recorded in MW6, MW11, MW12, MW14, MW16, MW17, MW18 and MW23.
- With the exception of MW4B, MW6 and MW17, there appeared to be an overall decrease in BTEX and/or TRH concentrations across the site when compared to 2013 and 2014 data.
- Monitored natural attenuation was considered to be occurring within the monitoring wells affected by the plume, but the rate of degradation was limited by a lack of available electron donors.

4.19 WSP 2015b – Groundwater Monitoring Report

A groundwater monitoring event was undertaken in June 2015 to assess whether hydrocarbon contaminated groundwater at the site had rebounded since turning off the treatment system in March 2015. Figure 4, Appendix A shows the groundwater exceedances reported during this GME. The following conclusions were made:

- BTEX concentrations above the adopted assessment criteria were recorded in MW4B, MW6, MW12, MW14, MW16 and MW23. BTEX concentrations were either stable or decreasing since 2013.
- TRH concentrations above the adopted assessment criteria were recorded in MW4B, MW6, MW12, MW13, MW14, MW16, MW17 and MW24. The fluctuation in TRH concentrations since 2013 was considered a potential effect of seasonal variations and highly variable rainfall.
- The reported concentrations at MW14, MW16 and MW23 were considered indicative of PSH, smearing or high dissolved phase impact.
- Based on a comparison of these results with the March 2015 results, WSP concluded that a rebound had not occurred at the site as a result of turning off the treatment system.
- Monitored natural attenuation was considered to be occurring within the monitoring wells affected by the plume, but the rate of degradation was limited by a lack of available electron donors.

4.20 Orara River Water Monitoring

Water monitoring was undertaken at four locations in the Orara River almost monthly from January 2007 to June 2015. Samples were analysed for BTEX and TRH C6-C9 and compared against the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000) and the *Australian Drinking Water Guidelines*.

The first location (location A, shown as 'River 2' on Figure 2, Appendix A) was upstream of the footbridge at the end of Martin Street. Results have reported BTEX and TRH concentrations below the laboratory limit of reporting (LOR) over all monitoring rounds, except in March 2008, when TRH C6-C9 concentrations were reported at 120 µg/L.

The second location (location B, shown as 'River 1 on Figure 2, Appendix A) was outside the bund in the backwater of Orara River where the hydrocarbon impact was first observed, downstream of location A. BTEX and TRH concentrations were detected above the LOR periodically from April 2007 to June 2011, then again in May 2012 and March 2013, with benzene and ethylbenzene concentrations exceeding drinking water criteria on a number of occasions. BTEX concentrations have been below the LOR since March 2013.

The third location (location C) was located downstream of locations A and B adjacent to the former intake location for the Coramba water supply. Benzene, xylene and TRH concentrations marginally exceeded the LOR on three occasions from April 2007 to March 2008. Since March 2008 contaminant concentrations have been below the LOR.

The forth location (location D) was located 150 to 200 m downstream of location C and had no BTEX or TRH concentrations above the LOR over the duration of sampling, except in March 2008 where TRH concentrations were reported at 69 µg/L.

4.21 Summary of historic groundwater data

Historic groundwater data is tabulated in Appendix B. Much of this data was extracted by GHD from historic reports, without seeing the laboratory reports. The data has not been verified by GHD. Data has been compared with assessment criteria discussed in Section 6.4.

4.21.1 Extent of hydrocarbon impact

The interpreted hydrocarbon plume based on the highest recorded concentrations from 2006 to 2014 is shown on Figure 3, Appendix A.

The most recent data (WSP 2015b) is shown on Figure 4, Appendix A and indicates:

- BTEX concentrations exceeding the adopted drinking water assessment criteria were recorded in MW4B, MW6, MW11, MW12, MW13, MW14, MW16, MW17, MW18, MW20, MW22 and MW23.
- BTEX concentrations exceeding the adopted recreational assessment criteria (for direct contact) were recorded in MW4B, MW6, MW11, MW12, MW13, MW14, MW16, MW17, MW18, MW22 and MW23.
- Benzene concentrations exceeding the adopted health screening levels for vapour intrusion were recorded in MW12, MW14, MW16 and MW23.
- BTEX concentrations exceeding the adopted ecological assessment criteria were recorded in MW4B, MW6, MW12, MW14, MW16 and MW23.
- TRH concentrations exceeding the adopted assessment criteria were recorded in MW4B, MW6, MW11, MW12, MW13, MW14, MW16, MW17 and MW24.

A comparison of the historic data indicates a significant decrease in the extent and concentrations of hydrocarbons since the fuel leak.

4.21.2 Monitored natural attenuation parameters

Natural attenuation (NA) processes are evaluated through three key lines of evidence:

- Primary evidence – shrinkage of plume extent and attenuation of contaminant concentrations.
- Secondary evidence – trends in chemical indicator parameters which support the presence of active biological degradation processes.
- Tertiary evidence – demonstrated presence of bacterial fauna which are known to degrade the identified contaminants.

The shrinking of the plume is evident as discussed in Section 4.21.1.

WSP (2015a and 2015b) analysed natural attenuation factors (ammonia, major cations, major anions, ferrous iron and free carbon dioxide) in MW2, MW6, MW11 and MW14. WSP reported there are indications that biodegradation is occurring within the plume, based on:

- Increased iron concentrations within the plume which indicates a reduction of insoluble iron to soluble iron by oxidation.
- Higher oxidation reduction potential within the plume which is indicative of oxidation of contamination occurring with the plume.
- Higher bicarbonate levels with the plume.

No assessment of bacterial fauna has been carried out.

4.21.3 Seasonal water level variance

GHD prepared a hydrograph from available monitoring data from 2006 to 2015 and utilising available rainfall data[1] to assess the relationship between rainfall and groundwater levels at the dates of historical monitoring. Since two historical monitoring events were undertaken in March, the standing water levels (SWL) for these two events were averaged. The hydrograph is presented Figure 4-1. Results show that the highest rainfall for the area typically occurs in March, which corresponds to the highest groundwater level, based on limited historical groundwater monitoring events. This indicates that groundwater levels generally correspond to rainfall with minimal lag time.

[1] Bureau of Meteorology- weather station Coramba (Glenfiddich) #59009 http://www.bom.gov.au/jsp/ncc/cdio/weatherData/av?p_nccObsCode=139&p_display_type=dataFile&p_startYear=&p_c=&p_stn_num=059009 accessed 14 November 2016.

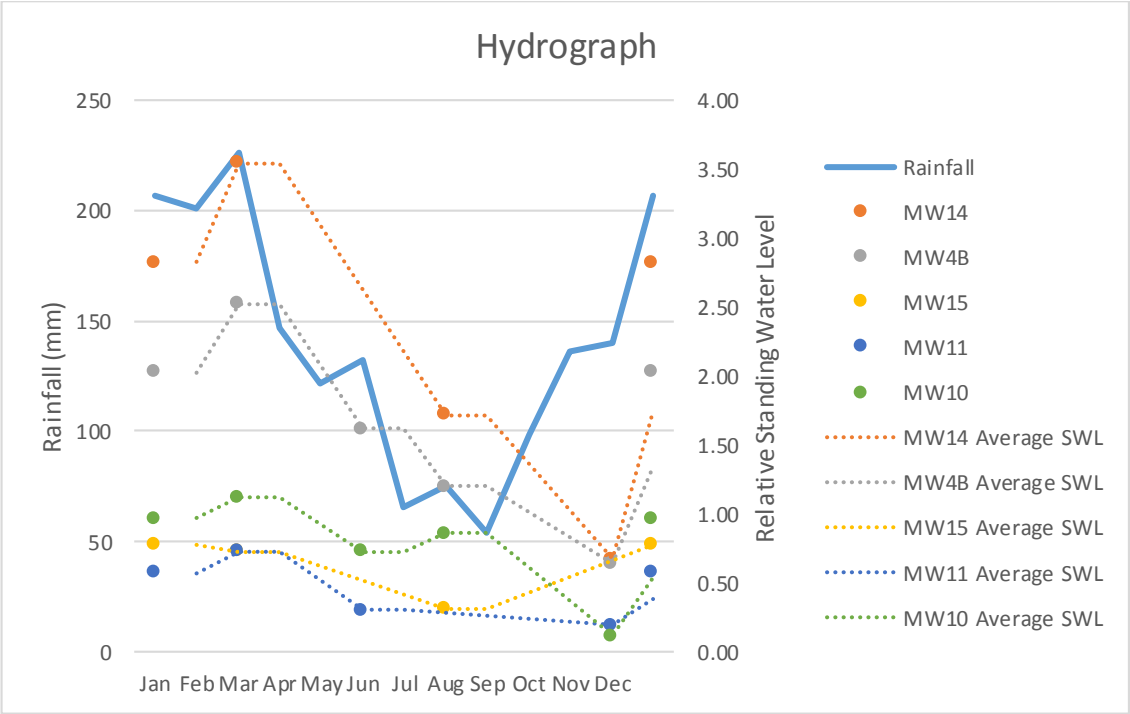


Figure 4-1 Hydrograph showing relative standing water levels in each monitoring well (using available data from 2006-2015) and average monthly rainfall data (1981-2016)

5. Conceptual site model

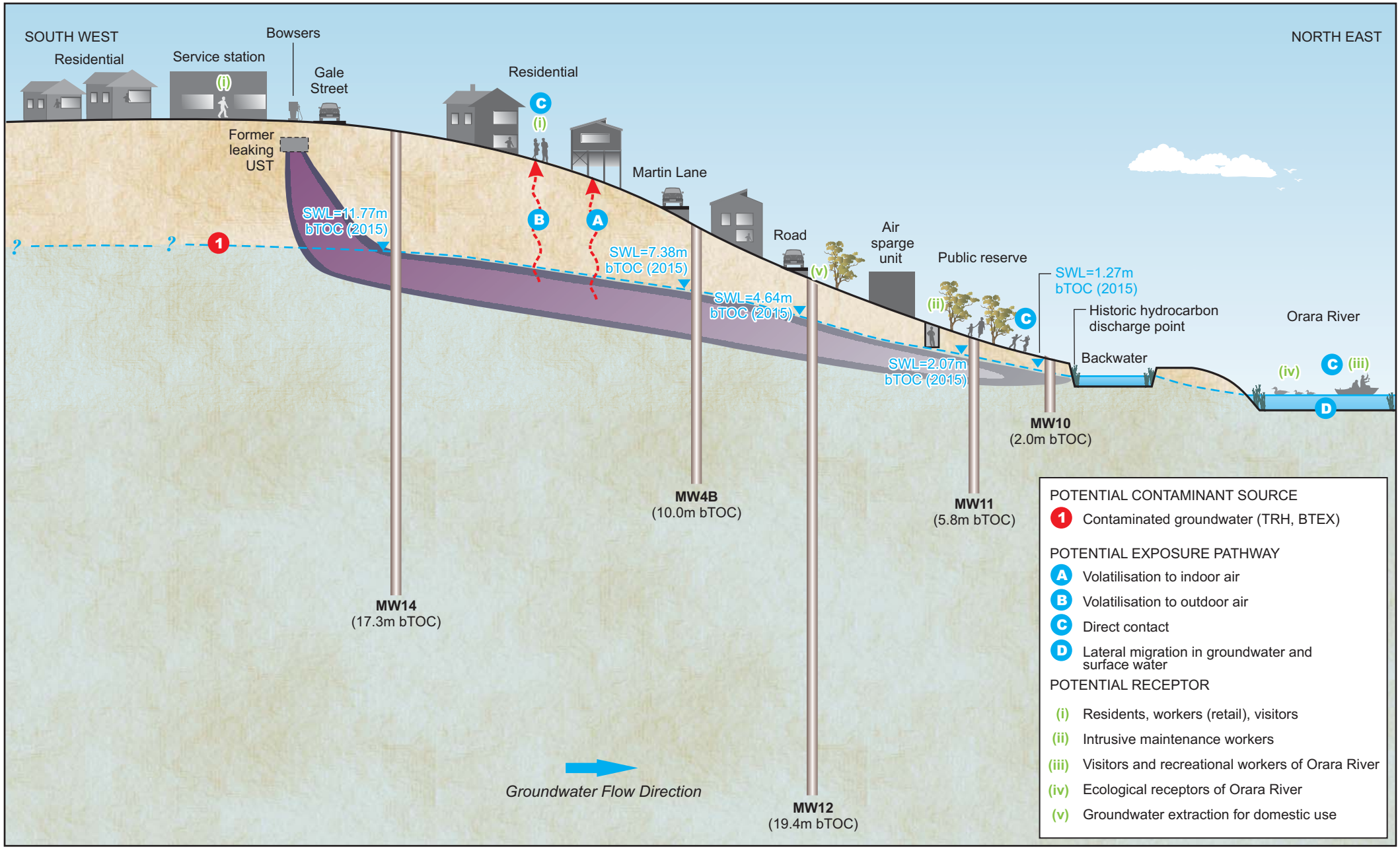
Based on the results of previous investigations, the contaminants of potential concern (CoPC) in groundwater beneath the site are considered to comprise:

- TRH
- BTEX

The presence of TRH and BTEX concentrations historically exceeding guideline levels in a number of wells throughout the site is due to a historical leak in a UST from the up gradient service station. Since the removal of this UST contaminant concentrations have generally been decreasing, however source-pathway-receptor linkages are still present. The CSM is presented in Table 5-1 and Figure 5-1 and refers to impacted groundwater only.

Table 5-1 Conceptual Site Model

Potential Source	Potential Pathway	Potential Receptor	Potential for completeness
TRH and BTEX in groundwater beneath the site and lateral migration off site	Volatilisation to indoor air (shops along Gale street and residences) and subsequent inhalation	Residents Visitors Retail workers	Possible due to benzene concentrations exceeding health screening levels (HSL) for vapour intrusion in monitoring wells adjacent to residential properties.
	Volatilisation to outdoor air and subsequent inhalation	Retail workers Intrusive maintenance workers Residents Visitors	Unlikely except for intrusive maintenance workers as any volatilisation (of benzene exceeding HSLs) would disperse in outdoor air. (HSLs for HSL C – outdoor areas – are not limiting).
	Direct contact (accidental ingestion)	Intrusive maintenance workers exposed to groundwater. Recreational users of Orara River	Possible for intrusive maintenance workers given exceedances of direct contact (recreational) assessment criteria in several monitoring wells. Unlikely for recreational users of the Orara River given lack of surface water concentrations exceeding assessment criteria.
	Lateral migration in groundwater and surface water (Orara River)	Ecological and recreational receptors to Orara River and adjacent riparian zone	Possible in the riparian zone to the south of the river given benzene and TRH concentrations exceeding assessment criteria in MW11 (adjacent to the Orara River). Unlikely in the Orara River given lack of surface water concentrations exceeding assessment criteria.
		Groundwater extraction for domestic use	Unlikely given restrictions on groundwater extraction for domestic use and the nearest registered domestic well being located 300 m north west of the site (outside of the plume).



Conceptual diagram only - not to scale

N

LEGEND

Inferred dissolved hydrocarbon plume ~2006

Inferred dissolved hydrocarbon plume ~2015

Groundwater level

Coffs Harbour City Council
Coramba Groundwater Monitoring

Conceptual Site Model

Job Number	22-18605
Revision	A
Date	18 Nov 2016

Figure 5.1

N:\AU\Launceston\Projects\22\18605\2218605_LTN_01.cdr

Level 3, GHD Tower, 24 Honeysuckle Drive Newcastle NSW 2300 T 61 2 4979 9999 F 61 2 4979 9988 E ntlmail@ghd.com W www.ghd.com

6. Groundwater Monitoring Plan

6.1 Roles and Responsibilities

Key personnel and environmental management responsibilities are outlined in Table 6-1.

Table 6-1 Roles & responsibilities

Role	Responsibilities
CHCC	CHCC is responsible for the overall implementation of the GMP and associated management requirements at the site. Key responsibilities include: • Reviewing and endorsing the GMP where required • Maintaining compliance with relevant legislation and requirements • Recording any public complaints • Responding to public complaints • Implementing a contingency plan if required • Overseeing groundwater monitoring works to ensure compliance with relevant standards and statutory requirements • Liaising with and reporting to EPA where required • Liaising with stakeholder agencies and community groups where required • Approving any reports prior to submission to relevant authorities
EPA	EPA is responsible for advising CHCC of the regulatory requirements involved for the appropriate management of the site. Key responsibilities include: • Reviewing and endorsing the GMP where required • Being kept informed of any issues relating to groundwater monitoring results and potential odour issues • Overseeing the groundwater reporting • Providing advice on management measures required to meet statutory requirements
Environmental Consultant	The Environmental Consultant is to be a suitably qualified and experienced person who will undertake the monitoring and reporting required by the GMP and respond to requests from CHCC, which may include: • Providing technical advice on best management practice and recommending measures or actions to deal with issues as they arise • Undertaking additional groundwater sampling where required • Undertaking odour sampling where required • Reviewing the adequacy of the groundwater management plan and compliance with statutory requirements

6.2 Groundwater Management Goals

6.2.1 Short term goals

The short term groundwater management goal is to:

- Confirm a lack of rebound in contaminant concentrations following turning off the air sparge system.
- Minimise potential impacts on human health and the environment.

6.2.2 Medium term goals

Medium term goals are to:

- Confirm a continuing decrease in TRH and BTEX concentrations in future groundwater monitoring events and demonstrate MNA by at least two lines of evidence.
- Confirm there are no unacceptable impacts on human health and the environment.

6.2.3 Long term goals

The long term goal is ultimately restoration of the aquifer to pre-contamination conditions with all TRH and BTEX concentrations below the adopted assessment criteria and, as far as practicable, restored to natural background conditions.

Monitored natural attenuation (MNA) is typically used as a long term management strategy to restore water quality to its natural background state, however this is only appropriate where contamination does not pose a risk to existing uses of groundwater, surface water and land, and where the groundwater resource can be restored within a reasonable time frame.

6.3 Data quality objectives

6.3.1 Overview

The Data Quality Objective (DQO) process to be applied to the groundwater monitoring is described below, to ensure that data collection activities are appropriate and achieve the stated objectives.

The DQO process involves seven steps as follows:

- Step 1: State the problem.
- Step 2: Identify the decision.
- Step 3: Identify inputs to the decision.
- Step 4: Define the study boundaries.
- Step 5: Develop a decision rule.
- Step 6: Specify limits on decision errors.
- Step 7: Optimise the design for obtaining data.

The DQO steps defined above have been addressed as follows.

6.3.2 Step 1: The "Problem"

The 'problem' as it stands is that residual groundwater contamination associated with a fuel leak from a UST exceeds appropriate guidelines in a number of wells across the site, and has the potential to adversely impact upon human and environmental receptors.

6.3.3 Step 2: Identification of the decision(s)

The primary decisions are as follows:

- Has groundwater in the area been remediated to sufficient extent that it does not pose any unacceptable risks for ongoing commercial, residential and recreational land use or to recreational use or ecosystems in the Orara River?
- Are contaminant concentrations in groundwater and surface water stable or declining?
- Are natural attenuation processes further reducing the contamination to ultimately restore groundwater quality to its natural background condition?
- Do contaminant concentrations or trends trigger recommencement of the operation of the air sparge system?

6.3.4 Step 3: Inputs to the decision

In order to address the above decisions, data input is required to assess:

- The extent of contaminant concentrations exceeding the relevant assessment criteria.
- Trends in groundwater contamination concentrations and extent of plume.
- Trends in chemical indicator parameters which support the presence of active biological degradation processes.

Inputs required to address the above points include:

- Information gained via the review of site history assessment, previous investigations and preliminary site inspection.
- Quantitative data gained via groundwater sampling and analytical works as described in Section 6.5.
- Adopted assessment criteria as discussed in Section 6.4.

The sampling program was designed to provide sufficient information to allow a sound scientific and statistical evaluation of the questions set out in Section 6.3.3. This was to be achieved by:

- Collection of groundwater and surface water samples to provide sufficient site coverage and statistically valid data sets upon which to base subsequent decisions.
- Comparing the analytical data to applicable guidelines and comparing the results against previous monitoring rounds.

6.3.5 Step 4: Boundaries of the study

With respect to physical boundaries, the lateral boundaries of the investigation area are defined as the 'site' as discussed in Section 2.1 and shown on Figure 1 and 2, Appendix A.

The vertical boundary will be the depth of existing groundwater monitoring wells.

6.3.6 Step 5: Site decision rule

In order to decide whether the data obtained was sufficiently precise, accurate, reliable and reproducible for the site at the time of the investigation, field and laboratory quality assurance/quality control (QA/QC) procedures are to be utilised throughout the sampling programmes and all sampling work are to be carried out in accordance with appropriate Standard Field Operating Procedures, which are based on relevant guidelines and current industry practices. QA/QC results are to be compared to nominal acceptance limits (as outlined in Section 6.3.7).

Project analytical data are to be compared to relevant guidelines made or endorsed by the NSW EPA. The nominated assessment criteria are presented in Section 6.4. This data will be used to assess the decisions identified in Section 6.3.3.

6.3.7 Step 6: Specify limits on decision errors

Two types of decision errors are possible:

- The groundwater is considered 'uncontaminated' when in fact it is contaminated.
- The groundwater is considered 'contaminated' when in fact it is not contaminated.

The implications of the first decision error are considered less acceptable than the second, as the first error could involve unacceptable risk to health and/or the environment, and potentially future costs including possible litigation if the site is found to be unsuitable in the future. The risks associated with the second error are primarily limited to unwarranted remediation costs.

The limits on the first decision error are therefore addressed by use of conservative investigation criteria (which incorporate a factor of safety) and by further assessing any data exceeding these criteria.

The risk of the second decision error occurring is to be minimised by reducing the potential for unrepresentative data which could arise from the following causes:

- Sampling errors which occur when the sampling program does not adequately detect the variability of a contaminant from point to point across the Site, (i.e. the samples collected are not representative of the Site conditions).
- Measurement errors which occur during sample collection, handling preparation, analysis and data reduction.

To minimise the potential for unrepresentative data, the following Data Quality Indicators (DQIs) will be evaluated – completeness, comparability, representativeness, precision and accuracy.

The DQIs for sampling techniques and laboratory analysis of collected samples are based on those listed in Appendix V of the NSW EPA Auditor Guidelines (DEC 2006). Step 5 and Step 6 of the data quality objectives are assessed by reference to data quality indicators as follows:

- **Data representativeness** - expresses the degree which sample data accurately and precisely represents a characteristic of a population or an environmental condition. Representativeness is achieved by collecting samples in an appropriate pattern across the Site, and by using an adequate number of sample locations to characterise the Site. Consistent and repeatable sampling techniques and methods are utilised throughout the sampling.
- **Completeness** - defined as the percentage of measurements made which are judged to be valid measurements. The completeness goal is set at there being sufficient valid data generated during the study. If there is insufficient valid data, then additional data are required to be collected.
- **Comparability** - is a qualitative parameter expressing the confidence with which one data set can be compared with another. This is achieved through maintaining a level of consistency in techniques used to collect samples and ensuring analysing laboratories use consistent analysis techniques and reporting methods.
- **Precision** - measures the reproducibility of measurements under a given set of conditions. The precision of the data is assessed by calculating the Relative Percent Difference (RPD) between duplicate sample pairs.

$$RPD(\%) = \frac{|C_o - C_d|}{C_o + C_d} \times 200$$

Where Co = Analyte concentration of the original sample

Cd = Analyte concentration of the duplicate sample

Adopted acceptance criteria are 30% RPD for inorganics and 50% RPD for organics; however, it is noted that this will not always be achieved, particularly in heterogeneous soil or fill materials, or at low analyte concentrations (concentrations less than 10 times the laboratory LOR will not be assessed against the acceptance criteria).

- **Accuracy** - measures the bias in a measurement system. Accuracy can be undermined by such factors as field contamination of samples, poor preservation of samples, poor sample preparation techniques and poor selection of analysis techniques by the analysing laboratory. Accuracy is assessed by reference to the analytical results of laboratory control samples, laboratory spikes, laboratory blanks and analyses against reference standards. The nominal "acceptance limits" on laboratory control samples are defined as follows:

  – Laboratory spikes – 70-130 % for metals/inorganics, 60-140 % for organics.

  – Laboratory duplicates - <30 % for metals/inorganics, <50 % for organics.

  – Laboratory blanks - <practical quantitation limit.

  The individual testing laboratories will conduct an assessment of the laboratory QC program, internally; however, the results shall also be independently reviewed and assessed by the Environmental Consultant.

6.3.8 Step 7: Optimising the design for obtaining data

6.3.8.1 Overview

The sampling program was designed to provide sufficient information to allow a sound scientific and statistical evaluation of the questions set out in Step 2. This will be achieved by conducting targeted groundwater and surface water sampling across the site to assess contaminant concentrations and trends in groundwater across the site.

Works are to be completed in accordance with NSW EPA guidelines and accepted industry standards. To optimise the design of the investigations a sampling and analytical program was prepared to specifically target information required to meet the project objectives.

6.3.8.2 Field program

All fieldwork shall be conducted in general accordance with Standard Field Operating Procedures, which are aimed at collecting environmental samples using uniform and systematic methods. Key requirements of these procedures are as follows:

- Experienced field staff – all field investigations are to be conducted by staff with sufficient and appropriate training and experience to assess and document field conditions and undertake the groundwater monitoring in accordance with relevant procedures.
- Field documentation is to include depth of groundwater tables, discolouration, odours and other indications of contamination.

- Decontamination procedures to prevent cross contamination between samples are to include use of dedicated sampling equipment or decontamination of the sampling equipment between each sampling location (using DECON Neutracon) and the use of dedicated sampling containers provided by the laboratory. To prevent cross contamination between sampling locations, field samplers are to wear new disposable nitrile gloves.
- Sample identification procedures - collected samples are to be immediately transferred to sample containers of appropriate composition and preservation for the required laboratory analysis. All sample containers are to be clearly labelled with a sample number, sample location and sample date, with corresponding information documented in day logs or registers. The sample containers are to be transferred to a chilled cooler for sample preservation prior to and during shipment to the testing laboratory.
- Chain of custody information requirements - a chain-of-custody form, for each batch of samples, is to be completed and forwarded to the testing laboratory.

Field quality control procedures are to be used during the project include the collection and analysis of the following:

- **Intra laboratory (blind) duplicates:** Comprise a single sample divided into two separate sampling containers. Both samples are sent anonymously to the project laboratory. Blind duplicates provide an indication of the analytical precision of the laboratory, but are inherently influenced by other factors such as sampling techniques and sample media heterogeneity. Blind duplicate samples shall be analysed at a rate of at least 5%.
- **Inter laboratory (split) duplicates:** Identical to a blind duplicate, except that the primary sample is sent to the primary project laboratory and the duplicate is sent to a secondary (check) laboratory. Split duplicate samples shall be analysed at a rate of at least 5%.
- **Rinsate blanks:** One rinsate blank sample will be collected each day of monitoring. Rinsate blank samples are used to estimate the amount of contamination introduced during the re-use of sampling equipment. Rinsate blank samples are to be obtained by pouring laboratory supplied deionised water over decontaminated sampling equipment into laboratory supplied bottles.
- **Trip blanks:** One trip blank will be prepared by the laboratory for the investigations. Trip blanks provide an indication of contamination introduced during sample transport and handling, and also ensure that the testing laboratory is not reporting “false positives”. Trip blanks should not indicate concentrations of the CoPC above the laboratory detection limit.
- **Trip spikes:** One trip spike will be prepared by the laboratory for the investigations. Trip spike samples are used to estimate the percentage of volatile contamination lost or introduced during the transport and storage of samples from the time of sampling to the time of analysis. Transport spike samples are to be provided by the laboratory prefilled with deionised water and spiked with a known concentration of volatile analytes (TRH and BTEXN). Transport spikes are to be transferred to a chilled esky for sample preservation prior to and during shipment to the laboratory.

6.3.8.3 Laboratory program

The project laboratories use their internal procedures and National Association of Testing Authorities (NATA) accredited methods in accordance with their QA system. The Environmental Consultant is to check that the laboratory analytical methods and limits of reporting are acceptable for analysis required. Laboratory quality control procedures to be used during the project include:

- **Laboratory duplicate samples:** Duplicate sub samples collected by the laboratory from one sample submitted for analytical testing 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 test result.
- **Spiked samples:** An authentic field sample is spiked by adding an aliquot of known concentration of the target analyte(s) prior to sample extraction and analysis. A spike documents the effect of the sample matrix on the extraction and analytical techniques. Spiked samples were analysed for each batch where samples were analysed for organic chemicals of concern.
- **Certified reference standards:** A reference standard of known (certified) concentration is analysed along with a batch of samples. The Certified Reference Standard (CRS) or Laboratory Control Spike provides an indication of the analytical accuracy and the precision of the test method and is used for inorganic analyses.
- **Surrogate standard/spikes:** These are organic compounds which are similar to the analyte of interest in terms of chemical composition, extractability, and chromatographic conditions (retention time), but which are not normally found in environmental samples. These surrogate compounds are spiked into blanks, standards and samples submitted for organic analyses by gas-chromatographic techniques prior to sample extraction. Surrogate Standard/Spikes provide a means of checking that no gross errors have occurred during any stage of the test method leading to significant analyte loss.
- **Laboratory blank:** Usually an organic or aqueous solution that is as free as possible of analytes of interest to which is added all the reagents, in the same volume, as used in the preparation and subsequent analysis of the samples. The reagent blank is carried through the complete sample preparation procedure and contains the same reagent concentrations in the final solution as in the sample solution used for analysis. The reagent blank is used to correct for possible contamination resulting from the preparation or processing of the sample.

The individual testing laboratories are to conduct an assessment of the laboratory QC program, internally however; the results are also to be independently reviewed and assessed by the Environmental Consultant.

Laboratory duplicate samples should return RPDs within the NEPM acceptance criteria of ±30%. Percent recovery is used to assess spiked samples and surrogate standards. Percent recovery; although dependent on the type of analyte tested, concentrations of analytes and sample matrix; should normally range from about 70-130%. Method (laboratory) blanks should return analyte concentrations as ‘not detected’.

6.4 Assessment criteria

The overarching reference to be used in this assessment is 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, and the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC 2000). The NEPM and the ANZECC guidelines contain investigation and screening levels suitable for the assessment of CoPC in groundwater and surface water at the site.

For the purpose of the ongoing monitoring and assessment, groundwater and surface water analytical results will be compared against investigation levels appropriate for a residential and a recreational land use setting as the impacted groundwater is located beneath residential properties and in a public reserve. Although restrictions have been placed on the use of groundwater for domestic purposes at the site, potential contact may result from groundwater used in sprinklers, wading pools etc. The criteria may be used to assess whether restrictions may be lifted at the completion of the monitoring program.

NEPM TRH HSLs are based on specific assumptions, and similarly aquatic toxicity for TRH would be based on the constituents, therefore while TRH criteria have been nominated for initial comparative purposes in this assessment, if they are exceeded analysis of constituent parameters may be required, and specific assessment against criteria for those parameters.

Groundwater investigation levels (GILs) and the corresponding ANZECC (2000) trigger values for freshwater were deemed applicable due to the Orara River adjoining the site.

Criteria from the *Ministry of Housing (Netherlands), Spatial Planning and the Environment* (2000) was used for the assessment of TRH C10-C36 given the lack of other criteria.

The Orara River is used for recreation including swimming. The Australian Drinking Water Guidelines (NHMRC 2011, version 3.1, as updated March 2015) refers to NHMRC (2008) *Guidelines for Managing Risks in Recreational Water*. These guidelines were developed to protect human health during recreational activities such as swimming and boating, and to preserve the aesthetic appeal of water bodies. The criteria in NHMRC (2008) are based on a simple screening approach in which a substance occurring in recreational water at a concentration of 10 times that stipulated in the drinking water guidelines may merit further consideration.

6.4.1 Human health

The NEPM (and related CRC CARE documents referenced in the NEPM) includes groundwater HSLs for residential and recreational landuse and GILs for drinking water as presented in Table 6-2.

Table 6-2 Groundwater health screening and investigation levels referenced

Title	Level	Abbr.	Reference	Use
Groundwater HSLs for vapour intrusion	Residential Recreational/ open space	HSL A/B HSL C	NEPM Schedule B1 Table 1A(4)	Assessment of petroleum hydrocarbon concentrations in on-site groundwater. Sand criteria used due to on-site soil conditions. Conservative depth of 2m to <4m used.
Groundwater GILs (Groundwater investigation levels)	Drinking water	Drinking water GIL	NEPM Schedule B1 Table 1C	For comparison purpose only, in the case of groundwater extraction for potential potable use. Assessment of petroleum hydrocarbons in groundwater.
NHMRC Australian Drinking Water Guidelines	Drinking Water	NHMRC Drinking Water	ADWG 2011 Table 10.5	For comparison purpose only, in the case of groundwater extraction for potential potable use. Assessment of petroleum hydrocarbons in groundwater
NHMRC Australian Drinking Water Guidelines	Recreational Water	NHMRC Recreational Water		Assessment of BTEX in regard to recreational use of the Orara River.
*Ministry of Housing (**Netherlands**), Spatial Planning and the Environment* (2000)				Initial screening / comparative assessment of TRH C10-C36 given the lack of other criteria

6.4.2 Ecological

GILs are provided in the NEPM for assessing ecological risk from direct contact with groundwater. The nearest receiving water ecosystem is the Orara River which forms the northern boundary of the site. The Orara River is considered to be a slightly-moderately disturbed system (to which the GILs apply) and is expected to be fresh water. The ANZECC guidelines provide 95% protection levels for freshwater species.

The NEPM and ANZECC (2000) include GILs and 95% freshwater guidelines for ecological protection as referenced in Table 6-3.

Table 6-3 Ecological groundwater investigation levels referenced

Title	Level	Abbr.	Reference	Use
Groundwater GILs (Groundwater investigation levels)	Fresh Waters	Fresh Waters GIL	NEPM Schedule B1 Table 1C	Assessment of petroleum hydrocarbons in groundwater, for potential receiving environment of the Orara River.
ANZECC 95% protection levels for freshwater	Fresh Waters	95% FW	ANZECC Table 3.4.1, Table 8.3.14 (Low reliability guidelines for TEX)	Assessment of petroleum hydrocarbons in groundwater, for potential receiving environment of the Orara River.

6.4.3 Adopted groundwater assessment criteria

The groundwater assessment criteria adopted for this project are summarised in Table 6-4.

6.4.4 Trigger levels for recommencement of air sparge system

Trigger levels for recommencement of operation of the air sparge system are discussed in Section 7.

Table 6-4 Adopted groundwater assessment criteria

Parameter	NEPM Groundwater HSL A/B (µg/L)[1]	NEPM Groundwater HSL C (µg/L)[1]	NEPM GILs Drinking Water[2] (µg/L)	NHMRC Australian Drinking Water Guidelines 2011 (µg/L)	NHMRC Recreational Water Guidelines 2008 (µg/L)	NEPM GILs Freshwater and ANZECC 95% FW[3] (µg/L)	Netherlands (2000)[4] (µg/L)
Benzene	800	NL	1	1	10	950	-
Toluene	NL	NL	800	800	8000	180[5]	-
Ethylbenzene	NL	NL	300	300	3000	80[5]	-
Xylene (o)	-	-	-	-	-	350	-
Xylene (m)	-	-	-	-	-	75[5]	-
Xylene (p)	-	-	-	-	-	200	-
Total Xylene	NL	NL	600	600	6000	-	-
TRH F1	1000	NL	-	-	-	-	-
TRH F2	1000	NL	-	-	-	-	-
TRH C_{10}-C_{36}	-	-	-	-	-	-	600

[1] National Environmental Protection (Assessment of Site Contamination) Measure (1999) Schedule B(1) *Groundwater Health Screening Levels, residential and recreational* – sand criteria at depth 2 m to <4 m, based on groundwater depth across the residential areas of the site.
[2] National Environmental Protection (Assessment of Site Contamination) Measure (1999) Schedule B(1) *Groundwater Investigation Levels* for drinking water are taken from the health values of the Australian Drinking Water Guidelines (NHMRC 2011).
[3] ANZECC (2000) Australian and New Zealand Guidelines for Freshwater Quality (95% Protection Levels), the National Environmental Protection (Assessment of Site Contamination) Measure (1999) Schedule B(1) *Groundwater Investigation Levels, Aquatic Ecosystems, Freshwaters*.
[4] Ministry of Housing (Netherlands), Spatial Planning and the Environment (2000) *Environment Quality Objectives in the Netherlands for petroleum hydrocarbons in groundwater (screening levels only)*.
[5] Low reliability guidelines from ANZECC 2000 table 8 3 14
NL = Not limiting
- denotes no applicable criteria

6.5 Monitoring program

6.5.1 Overview of groundwater monitoring

The air sparging remediation system was turned off in March 2015, with groundwater monitoring events undertaken just before it was turned off and 3 months after it had been turned off. Results of the June 2015 monitoring showed that no rebound of CoPC concentrations had occurred since turning off the air sparge. No groundwater monitoring events have been undertaken since June 2015. A total of 24 groundwater wells (including two which could not be located) comprise the existing monitoring network. Figure 2, Appendix A shows the location of all groundwater monitoring wells at the site.

Based on the results of the historical groundwater monitoring events and the CSM, a refined sampling analysis and quality plan (SAQP) was developed for this groundwater monitoring plan that aims to target wells within the hydrocarbon plume and those down gradient of the treatment system.

6.5.2 Methodology

Groundwater elevation gauging

Immediately upon opening each monitoring well, a photo-ionisation detector (PID) shall be used to assess for the presence of volatile organic compounds (VOC) in the air contained within the well.

The depth of the standing water level shall be measured at each of the monitoring wells using an interface probe, along with the total well depth and presence (including thickness) or absence of PSH. All measurements are to be recorded from the top of casing (TOC). If any PSH is detected, the presence shall be confirmed with a clear bailer.

Groundwater sampling

Groundwater samples are to be collected using a low flow micropurge sampler and groundwater field parameters (pH, electrical conductivity, temperature, dissolved oxygen and redox) are to be measured continuously during purging using a flow cell attached to the pump to ensure representative samples are collected. The intake of the pump is to be set at the mid-level of the screen, or at least 0.3 below the standing water table if this is below the mid-level of the screen. Samples are to be collected once field parameters have stabilised (within 10% of each other). Visual or olfactory observations are to be recorded, in particular the absence or presence of a hydrocarbon sheen or odour.

River samples will be collected with a clean unpreserved container and extension pole.

Collected groundwater and river water samples are to be immediately transferred to sample containers of appropriate composition, which are pre-treated in a manner appropriate for the laboratory analysis. Sample bottles are to be filled directly from the pump or dedicated bailer with a minimal amount of air contact and vials for volatile organic analysis are filled to be free from headspace. All sample containers are to be clearly labelled with a sample number, sample location and sample date with waterproof indelible ink. The sample containers are to be transferred to a cooler chilled with ice for sample preservation prior to and during shipment to the testing laboratory. A chain-of-custody form is to be completed, and forwarded with the samples to the testing laboratory within holding times appropriate to the analysis required. Dedicated sampling equipment (i.e. tubing, bailers, filters etc.) is to be disposed of after each well is sampled, with other sampling equipment (i.e. the micropurge head) decontaminated using a mixture of Decon nutricon solution and potable water and then rinsed with potable tap water between each well location.

All samples are to be analysed at National Association of Testing Authorities (NATA) registered laboratories.

6.5.3 SAQP

Based on the groundwater information available to date, the remediation goals and the objective of assessing whether groundwater treatment should continue, monitoring locations have been selected as shown in Table 6-5 (with SAQP and rationale) and Figure 5, Appendix A. Further details on the basis of selection of these monitoring locations are presented in Appendix C.

GHD considers the MNA monitoring undertaken to date was not entirely consistent with best practice, as described in CRC CARE technical report no. 15 *A technical guide for demonstrating monitored natural attenuation of petroleum hydrocarbons in groundwater*. GHD proposes to include MW9 or MW8 as a background well, but drop MW2 after the first round, as it is considered less useful than the other wells down the plume centreline. Also, the previous analytical parameters are not considered appropriate, as they do not include primary MNA parameters manganese or methane. Sulfate has been included but not discussed in previous reports.

The basis for historic analysis of ammonia and carbon dioxide is not clear, as nitrate and not ammonia is an electron receptor; and methane offers a more direct metabolic by-product measurement than carbon dioxide (which can be assessed by alkalinity and carbonate).

Additional monitoring may be triggered by the provisions of the GMP if there are any exceedances in river water, or increases in groundwater concentrations at locations adjoining the river. Notification to CHCC and EPA would also be required in this case, as discussed in Section 7.

Table 6-5 Groundwater Monitoring Program

Location	Round 1	Round 2	Round 3 (optional)	Basis of Monitoring
MW14	F/T/M	F/T/M	F/T/M	Source zone monitoring well
MW18	F/T	F/T	F/T	Mid zone, edge of plume. Consider sampling MW22 and MW24 as a contingency if MW18 shows a consistent increase
MW6	F/T/M	F/T/M	F/T/M	Mid zone, plume centre
MW4B	F/T	F/T	F/T	Mid zone, plume centre
MW12	F/T	F/T	F/T	Lower zone bedrock well, fluctuating and still fairly high concentrations
MW15	F/T	F/T	F/T	Close proximity to treatment system and still fluctuating
MW2	F/T/M			Dry June 2015. One round to confirm decrease and compare MNA with MW9, reinstate if MW15 increases.
MW9	F/T/M	F/T/M	F/T/M	New MNA well – best 'background' location available
MW11	F/T/M	F/T/M	F/T/M	Discharge zone alluvial well with highest impact, continued MNA monitoring point
MW20	F/T			Proximity to treatment system. Do one last round in wet weather, cease if concentrations still low (discharge zone covered by MW10 and MW11). Reinstate if there is an increase in upgradient wells (MW15, MW4B)
MW10	F/T	F/T	F/T	Discharge zone alluvial well.
River 1	F/T			Site A – upstream of footbridge – up gradient so if there is impact, it can be determined whether it was due to plume.
River 2	F/T			Site B – outside bund (sample site in backwater of river adjacent to problem area) – point of most likely impact to receptor(s). (Due diligence point).
Intra lab duplicates	T	T	T	To be analysed for the same analytes as their primary sample. Collected at a rate of 5%.
Inter lab duplicates	T	T	T	To be analysed for the same analytes as their primary sample. Collected at a rate of 5%.
Rinsates	T	T	T	One per day of sampling.
Trip blanks	T	T	T	One per monitoring program.
Trip spikes	T	T	T	One per monitoring program.

F is field parameters (SWL, well depth, PSH thickness, temp, DO, Redox, pH, EC)
T is TRH/BTEXN
M is the MNA suite (Natural attenuation indicators - nitrate, sulfate, ferrous iron, methane; major anions and cations, with hardness and alkalinity, ion balance; and manganese)

6.5.4 Schedule

Groundwater sampling is to be undertaken annually. In order to determine when the sampling events should be undertaken, GHD prepared a hydrograph, which is presented in Section 4.21. Based on the hydrograph, it is recommended to undertake the monitoring in March (commencing in 2017) to capture a representative wet weather (high groundwater level) monitoring round. Historic data indicates March as the time when the highest SWLs are generally recorded and is likely to represent the highest groundwater CoPC concentrations.

6.5.5 Monitoring Reports

The results from the monitoring events are to be presented in a report that enables a comparison of the previous and current sampling results including both tabular and graphical representations.

The reports are to include the following:

- Introduction – including a summary of background information, objectives and scope of work.
- Site description – outlining the location and details of the Site.
- Assessment criteria – outlining the relevant guidelines and assessment criteria used, including the guidelines used in the previous groundwater monitoring assessments and other applicable/relevant guidelines.
- Methodology – including groundwater and river water sampling methodology and analytical procedure.
- QA/QC procedures and sampling frequency.
- Results – including field observations and analytical results.
- Data quality assessment.
- Discussion – including a discussion of trends noted in the current results and trends compared to previous monitoring results.
- Conclusions – summarising the overall results and trends in relation to Site contamination.
- Appendices – including site figures, photographs, summary results tables, laboratory documentation, field notes and CSM.

7. Groundwater trigger levels for further assessment and revision of the GMP

This version of the GMP (which may be revised as ongoing monitoring proceeds) is based on an overall minimum two-year timeframe with an optional third year if required. Groundwater concentrations are to be assessed against remediation goals presented in Section 6.2.

Trigger values have been set for notification, further monitoring and assessment and revision of the GMP, which may include recommencement of groundwater treatment. The trigger values and rationale are presented in Table 7-1.

Review of the GMP may include consideration and review of the nature and frequency of site monitoring and locations, and shall be undertaken on completion of each monitoring round to ensure that the monitoring program remains representative. The review shall be undertaken by CHCC (or its technical representative) in conjunction with the NSW EPA. At this time, a period shall be set for further monitoring, review or additional investigations if required, or agreement that no further monitoring is necessary. The review should involve consultation with relevant interested parties, such as adjoining landowners, CHCC and other government agencies as required.

Table 7-1 Groundwater trigger levels for further assessment

Groundwater /surface water parameter	Trigger for further monitoring	Management Actions	Trigger for revision of the GMP
TRH (C6-C9), BTEX, PAH, phenol	>50% increase from previous event, if above assessment criteria. 20% increase over two annual sampling rounds, if above assessment criteria	Notification to CHCC and EPA. Re-sampling (with CHCC approval) and assessment. Assess if plume is expanding overall or in localised areas.	If re-sampling confirms rising concentrations.
PSH	Appearance of PSH in well (greater than 2 mm thick). PSH noted at discharge point near Orara River.	Notification to CHCC and EPA. Re-sampling (with CHCC approval) and assessment. Removal of PSH (bailer and other extraction as practical given recoverability). Council and EPA Notification required.	If PSH is identified in 2 consecutive monitoring events within the same well.
MNA	Evidence that biodegradation has ceased or is occurring at a notably reduced rate.	Notification to CHCC and EPA. Re-sampling (with CHCC approval) and assessment.	If biodegradation has ceased or is occurring at a notably reduced rate in two consecutive monitoring events.
Surface water (river) sample parameters	Exceedance of assessment criteria.	Notification to CHCC and EPA and additional monitoring, reassessment/ resampling and investigation.	If re-sampling confirms rising concentrations.
Non-sampling parameters	NA	NA	Changes to consent or licence conditions Any significant incident at the site.

8. Exit strategy

(CRC CARE 2010) '*A technical guide for demonstrating monitored natural attenuation of petroleum hydrocarbons in groundwater'* describes how MNA can be applied as a remediation and/or management strategy for addressing potential environmental and human health risks associated with petroleum hydrocarbon contamination in groundwater. The approach may be applicable to sites where the contaminant plumes are stable or shrinking in size. There is no generally accepted time frame for MNA to achieve results, and this is also a matter for regulatory agencies taking into account the particular circumstances. Consideration of the principle of intergenerational equity (Environmental Planning and Assessment Act 1979) suggests that contaminated groundwater should be remediated within a single generation.

8.1 Staged approach

The technical guide (CRC Care 2010) suggests a staged approach to implementation of MNA to optimise efficiency and economics of the process:

- Stage 1: Preliminary assessment, feasibility and acceptability, which considers issues such as sustainability, timeframe, legal and liability issues for applying an MNA strategy.
- Stage 2: Initial evaluation of natural attenuation, which considers the source characterisation and assessment of technical indicators of natural attenuation (NA).
- Stage 3: Detailed characterisation through demonstration of primary, secondary and tertiary lines of evidence for NA processes.
- Stage 4: Verifying performance of NA, which includes a comprehensive monitoring plan.
- Stage 5: Achieving closure, which includes documentary requirements to demonstrate that goals have been achieved.

The stages are addressed in the following subsections.

8.1.1 Stage 1: Preliminary assessment, feasibility and acceptability

MNA is considered an acceptable method of remediation at the site given:

- The source of the contamination (the leaking USTs) have been eliminated.
- MNA requires the least disruption to the site and disturbance of ecological receptors (in terms of other remedial options) and least cost.
- MNA can be monitored and assessed using the existing groundwater monitoring network and data.
- The air sparge and SVE system could be reinstated if MNA was found to be unsuitable in the future.

8.1.2 Stage 2: Initial evaluation

As the primary contaminants of concern are hydrocarbons, MNA will likely continue. The main contaminants identified in the groundwater (hydrocarbons (C_6-C_{14}) and BTEX are suitable analytes for MNA due to their solubility, volatility and biodegradability.

Groundwater monitoring data has been collected from 2006 to 2015, as discussed in Section 4. As discussed in Section 4.21.2, there is evidence of MNA occurring.

8.1.3 Stage 3: Detailed characterisation and demonstration

Contaminant concentrations have been assessed during multiple assessments spanning over a decade as discussed in Section 4, and the decrease in concentrations and extent of impact supports the primary line of evidence for MNA occurring. This will be further assessed by the monitoring program described in Section 6.5, as will the secondary line of evidence based on the proposed MNA monitoring program.

Tertiary evidence (microbial and isotope data) is not proposed at this time.

8.1.4 Stage 4: Verifying performance

Verifying performance of MNA is possible by utilising the existing monitoring well network and historical data, based on the monitoring program described in Section 6.5. Indicators of performance verification include demonstration that:

- The plume continues to be stable or is shrinking.
- Attenuation is continuing over time.

Data sets of more than five years are required for reliable information about trends. Utilising historical data and data from the two additional rounds should provide sufficient data for trend analysis.

8.1.5 Stage 5: Achieving closure

Given the long timeframe over which MNA usually takes place, full remediation may not occur for up to several decades. However, once it can be established that the plume continues to be stable or is shrinking and attenuation is continuing over time, then the monitoring program can cease, subject to the agreement with the EPA.

8.2 Closure goal

The closure goal is to reduce hydrocarbon contamination concentrations in the groundwater to a level that is unlikely to pose a significant risk to human health or the environment. This will be established initially by comparison with the adopted assessment criteria, potentially with specific assessment of the potential for exposure to the relevant receptors if any of these criteria are still exceeded at completion of the proposed monitoring period.

8.3 Ongoing consultation

Ongoing consultation is to be carried out in accordance with the consultation strategy presented in Appendix D.

9. Odour management

A number of complaints have been received by CHCC regarding odour issues at the site since the incident occurred. Management of the contamination at the site was undertaken from 2011 to 2015 with the installation of a soil vapour extraction system and air sparging treatment system. It is reported that odour issues were minimal during the operation of the treatment system. The treatment system was turned off in March 2015 and while no increase in odour has been reported, odour management measures are required in the event that odour complaints are received at the site in the future.

An odour management plan is presented in Appendix C that outlines contingencies in the event that odour complaints or issues arise as a result of the hydrocarbon contamination in the groundwater at the site.

10. References

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11. Limitations

This 'Hydrocarbon Impacted Groundwater, Coramba, NSW, Groundwater Management Plan', NSW (the "Report"):

- Has been prepared by GHD Pty Ltd ("GHD") for Coffs Harbour City Council (CHCC).
- May be used and relied on by CHCC.
- May be used by and provided to the NSW EPA and the relevant planning authority for the purpose of meeting statutory obligations in accordance with the relevant sections of the CLM Act 1997 or the Environment Planning and Assessment (EP&A) Act 1979.
- Must not be copied to, used by, or relied on by any parties other than those listed above without the prior written consent of GHD and subject always to the next paragraph.
- May only be used for the purpose as stated in Section 1 of the Report (and must not be used for any other purpose).

GHD and its servants, employees and officers otherwise expressly disclaim responsibility to any person other than CHCC arising from or in connection with this Report.

To the maximum extent permitted by law, all implied warranties and conditions in relation to the services provided by GHD and the Report are excluded unless they are expressly stated to apply in this Report.

The services undertaken by GHD in connection with preparing this Report:

- Were limited to those specifically detailed in Section 1 of this Report
- Were undertaken in accordance with current professional practice and by reference to relevant environmental regulatory authority and industry standards, guidelines and assessment criteria in existence as at the date of this Report.

The opinions, conclusions and any recommendations in this Report are based on assumptions made by GHD when undertaking the services mentioned above and preparing the Report ("Assumptions"), as specified throughout this Report.

GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with any of the Assumptions being incorrect.

Subject to the paragraphs in this section of the Report, the opinions, conclusions and any recommendations in this Report are based on information reviewed at the time of preparation of this Report and are relevant until such times as the site conditions or relevant legislations changes, at which time, GHD expressly disclaims responsibility for any error in, or omission from, this Report arising from or in connection with those opinions, conclusions and any recommendations.

GHD has prepared this Report on the basis of information provided by CHCC and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked ("Unverified Information") beyond the agreed scope of work. Many of the historic reports from which data was provided were not available to GHD.

GHD expressly disclaims responsibility in connection with the Unverified Information, including (but not limited to) errors in, or omissions from, the Report, which were caused or contributed to by errors in, or omissions from, the Unverified 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 sampling points and may not fully represent the conditions that may be encountered across the site at other than these locations. Site conditions at other parts of the site may be different from the site conditions found at the specific sampling points.

Investigations undertaken in respect of this Report were 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.

GHD has considered and/or tested for only those chemicals specifically referred to in this Report and makes no statement or representation as to the existence (or otherwise) of any other chemicals.

Site conditions (including any the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD expressly disclaims responsibility:

- Arising from, or in connection with, any change to the site conditions.
- To update this Report if the site conditions change.

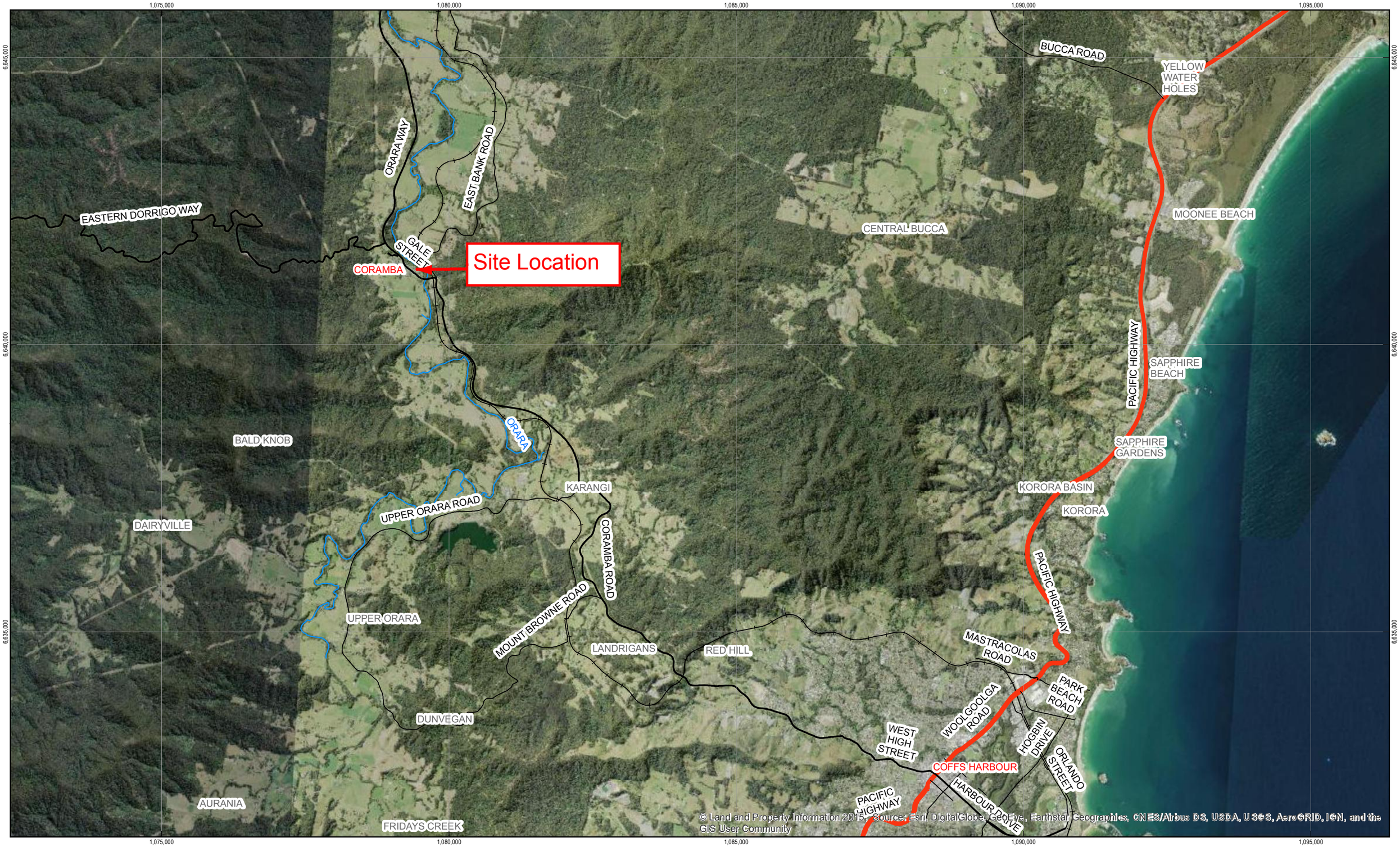
Subsurface conditions can vary across a particular site and cannot be exhaustively defined by the investigations carried out prior to this Report. As a result, it is unlikely that the results and estimations expressed or used to compile this Report will represent conditions at any location other than the specific points of sampling. A site that appears to be unaffected by contamination at the time of the Report may later, due to natural causes or human intervention, become contaminated.

Except as otherwise expressly stated in this Report, GHD makes no warranty, statement or representation of any kind concerning the suitability of the site for any purpose or the permissibility of any use, development or re-development of the site.

These Disclaimers should be read in conjunction with the entire Report and no excerpts are taken to be representative of the findings of this Report.

Appendices

Appendix A – Figures



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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Highway
- Major Road
- Arterial Road
- Railway
- Rivers

Coffs Harbour City Council
Coramba Groundwater Monitoring

Job Number	22-18605
Revision	A
Date	17 Nov 2016

Site Location

Figure 1

N:\AU\Coffs Harbour\Projects\22\18605\GIS\Maps\Deliverables\22_18605_Fig_01_SiteLocation_Rev_A.mxd

230 Harbour Drive Coffs Harbour NSW 2450 Australia T 61 2 6650 5600 F 61 2 6650 5601 E cfsmail@ghd.com W www.ghd.com

Data source: NSW LPI, DCDB (2012) / Aerial Imagery (2015). Created by:slmartin

Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

LEGEND

- River Sampling Locations
- Groundwater MW Locations
- Site Features
- Railway
- Rivers

Coffs Harbour City Council
Coramba Groundwater Monitoring

Job Number	22-18605
Revision	B
Date	01 Dec 2016

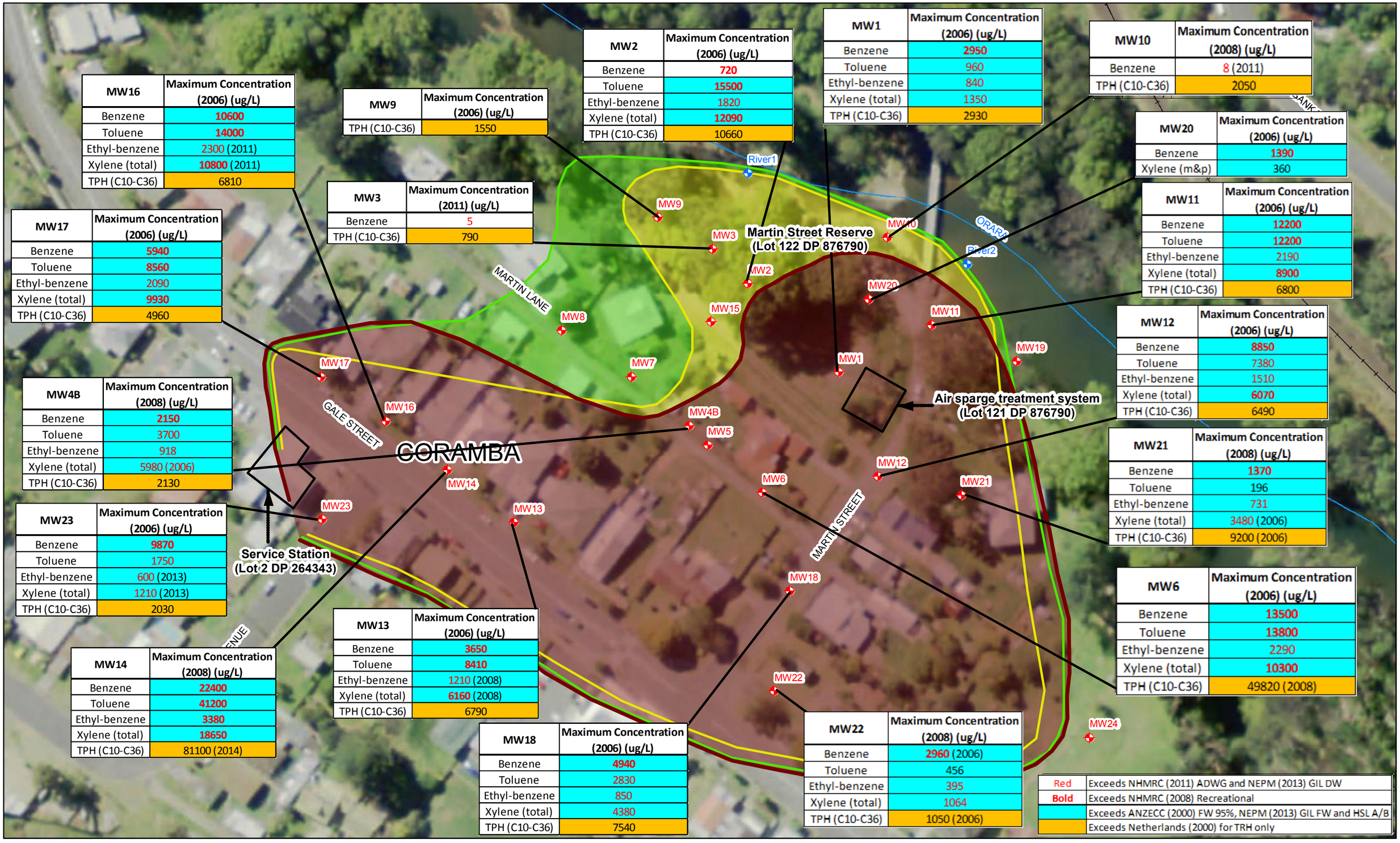
Site Features and Groundwater Monitoring Well Locations

Figure 2

G:\22\18605\GIS\Maps\Deliverables\22_18605_Fig_02_GWLocations_Rev_B.mxd

Data source: NSW LPI, DCDB (2012) / Aerial Imagery (2015). Created by:slmartin

230 Harbour Drive Coffs Harbour NSW 2450 Australia T 61 2 6650 5600 F 61 2 6650 5601 E cfsmail@ghd.com W www.ghd.com



MW1	Maximum Concentration (2006) (ug/L)
Benzene	**2950**
Toluene	960
Ethyl-benzene	840
Xylene (total)	1350
TPH (C10-C36)	2930

MW2	Maximum Concentration (2006) (ug/L)
Benzene	**720**
Toluene	**15500**
Ethyl-benzene	1820
Xylene (total)	**12090**
TPH (C10-C36)	10660

MW3	Maximum Concentration (2011) (ug/L)
Benzene	5
TPH (C10-C36)	790

MW4B	Maximum Concentration (2008) (ug/L)
Benzene	**2150**
Toluene	3700
Ethyl-benzene	918
Xylene (total)	5980 (2006)
TPH (C10-C36)	2130

MW6	Maximum Concentration (2006) (ug/L)
Benzene	**13500**
Toluene	**13800**
Ethyl-benzene	2290
Xylene (total)	**10300**
TPH (C10-C36)	49820 (2008)

MW9	Maximum Concentration (2006) (ug/L)
TPH (C10-C36)	1550

MW10	Maximum Concentration (2008) (ug/L)
Benzene	8 (2011)
TPH (C10-C36)	2050

MW11	Maximum Concentration (2006) (ug/L)
Benzene	**12200**
Toluene	**12200**
Ethyl-benzene	2190
Xylene (total)	**8900**
TPH (C10-C36)	6800

MW12	Maximum Concentration (2006) (ug/L)
Benzene	**8850**
Toluene	7380
Ethyl-benzene	1510
Xylene (total)	**6070**
TPH (C10-C36)	6490

MW13	Maximum Concentration (2006) (ug/L)
Benzene	**3650**
Toluene	**8410**
Ethyl-benzene	1210 (2008)
Xylene (total)	**6160** (2008)
TPH (C10-C36)	6790

MW14	Maximum Concentration (2008) (ug/L)
Benzene	**22400**
Toluene	**41200**
Ethyl-benzene	**3380**
Xylene (total)	**18650**
TPH (C10-C36)	81100 (2014)

MW16	Maximum Concentration (2006) (ug/L)
Benzene	**10600**
Toluene	**14000**
Ethyl-benzene	2300 (2011)
Xylene (total)	**10800** (2011)
TPH (C10-C36)	6810

MW17	Maximum Concentration (2006) (ug/L)
Benzene	**5940**
Toluene	**8560**
Ethyl-benzene	2090
Xylene (total)	**9930**
TPH (C10-C36)	4960

MW18	Maximum Concentration (2006) (ug/L)
Benzene	**4940**
Toluene	2830
Ethyl-benzene	850
Xylene (total)	4380
TPH (C10-C36)	7540

MW20	Maximum Concentration (2006) (ug/L)
Benzene	**1390**
Xylene (m&p)	360

MW21	Maximum Concentration (2008) (ug/L)
Benzene	**1370**
Toluene	196
Ethyl-benzene	731
Xylene (total)	3480 (2006)
TPH (C10-C36)	9200 (2006)

MW22	Maximum Concentration (2008) (ug/L)
Benzene	2960 (2006)
Toluene	456
Ethyl-benzene	395
Xylene (total)	1064
TPH (C10-C36)	1050 (2006)

Red	Exceeds NHMRC (2011) ADWG and NEPM (2013) GIL DW
Bold	Exceeds NHMRC (2008) Recreational
	Exceeds ANZECC (2000) FW 95%, NEPM (2013) GIL FW and HSL A/B
	Exceeds Netherlands (2000) for TRH only

Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- SiteFeatures
- River Sampling Locations
- Groundwater MW Locations
- Benzene Plume June 2006 (> FW 95% and HSL A/B)
- TRH and/or BTEX >LOR 2006-2014
- TRH and/or BTEX exceeded criteria 2006-2014
- Railway
- Rivers

Coffs Harbour City Council
Coramba Groundwater Monitoring

Job Number	22-18605
Revision	B
Date	01 Dec 2016

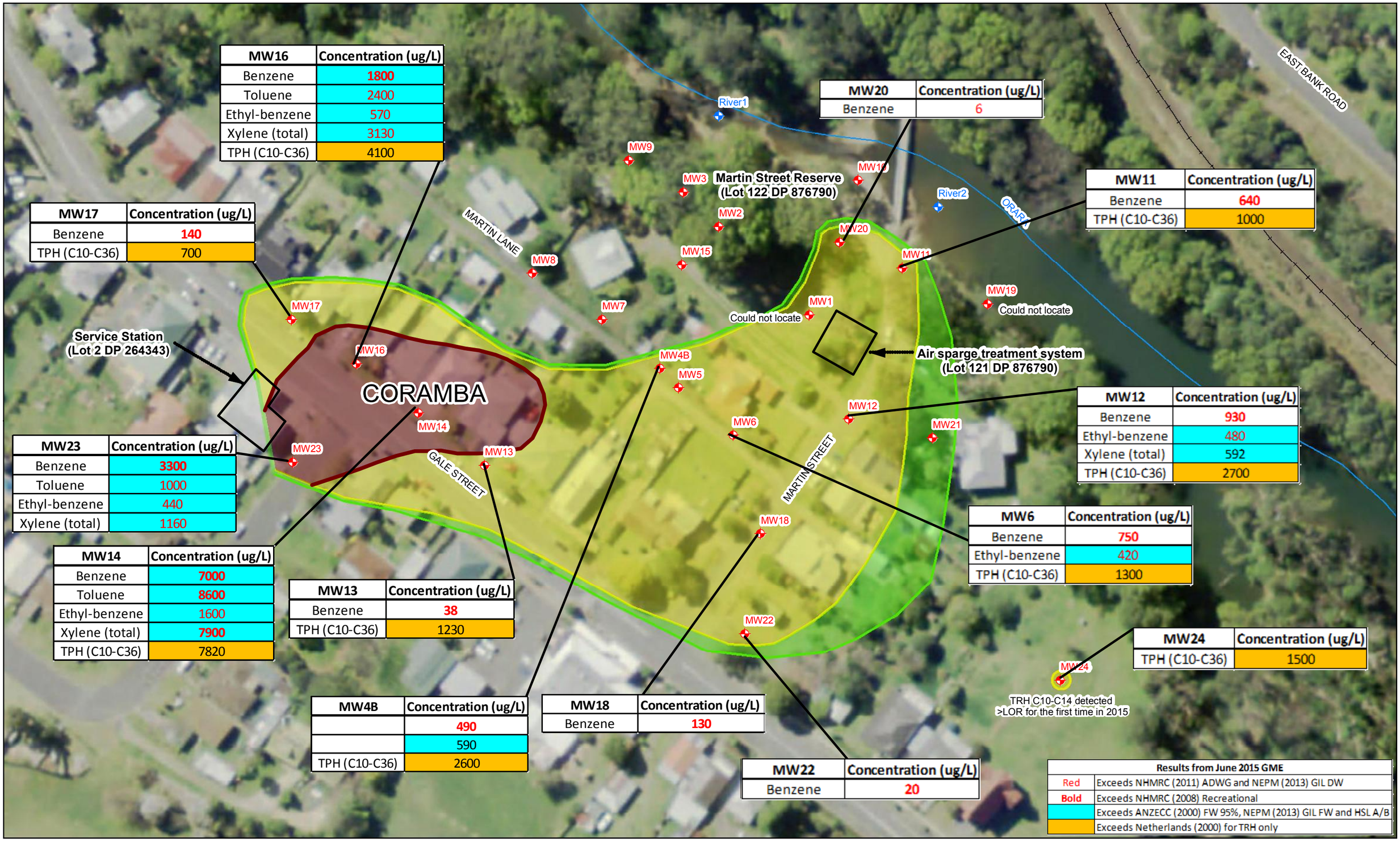
Maximum interpreted extent of impact 2006-2014

Figure 3

N:\AU\Coffs Harbour\Projects\22\18605\GIS\Maps\Deliverables\22_18605_Fig_03_Maximumextent_Rev_B.mxd

230 Harbour Drive Coffs Harbour NSW 2450 Australia T 61 2 6650 5600 F 61 2 6650 5601 E cfsmail@ghd.com W www.ghd.com

Data source: NSW LPI, DCDB (2012) / Aerial Imagery (2015). Created by:slmartin



MW16	Concentration (ug/L)
Benzene	**1800**
Toluene	2400
Ethyl-benzene	570
Xylene (total)	3130
TPH (C10-C36)	4100

MW20	Concentration (ug/L)
Benzene	6

MW11	Concentration (ug/L)
Benzene	**640**
TPH (C10-C36)	1000

MW17	Concentration (ug/L)
Benzene	**140**
TPH (C10-C36)	700

MW12	Concentration (ug/L)
Benzene	**930**
Ethyl-benzene	480
Xylene (total)	592
TPH (C10-C36)	2700

MW23	Concentration (ug/L)
Benzene	**3300**
Toluene	1000
Ethyl-benzene	440
Xylene (total)	1160

MW6	Concentration (ug/L)
Benzene	**750**
Ethyl-benzene	420
TPH (C10-C36)	1300

MW14	Concentration (ug/L)
Benzene	**7000**
Toluene	**8600**
Ethyl-benzene	1600
Xylene (total)	**7900**
TPH (C10-C36)	7820

MW13	Concentration (ug/L)
Benzene	**38**
TPH (C10-C36)	1230

MW24	Concentration (ug/L)
TPH (C10-C36)	1500

MW4B	Concentration (ug/L)
	490
	590
TPH (C10-C36)	2600

MW18	Concentration (ug/L)
Benzene	**130**

MW22	Concentration (ug/L)
Benzene	**20**

Results from June 2015 GME	
Red	Exceeds NHMRC (2011) ADWG and NEPM (2013) GIL DW
Bold	Exceeds NHMRC (2008) Recreational
	Exceeds ANZECC (2000) FW 95%, NEPM (2013) GIL FW and HSL A/B
	Exceeds Netherlands (2000) for TRH only

Paper Size A3

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- SiteFeatures
- River Sampling Locations
- Groundwater MW Locations
- Benzene Plume June 2015 (> FW 95% and HSL A/B)
- TRH and/or BTEX >LOR 2015
- TRH and/or BTEX exceeded assessment criteria 2015
- Railway
- Rivers

GHD

Coffs Harbour City Council
Coramba Groundwater Monitoring

Job Number	22-18605
Revision	B
Date	01 Dec 2016

Interpreted extent of impact 2015

Figure 4

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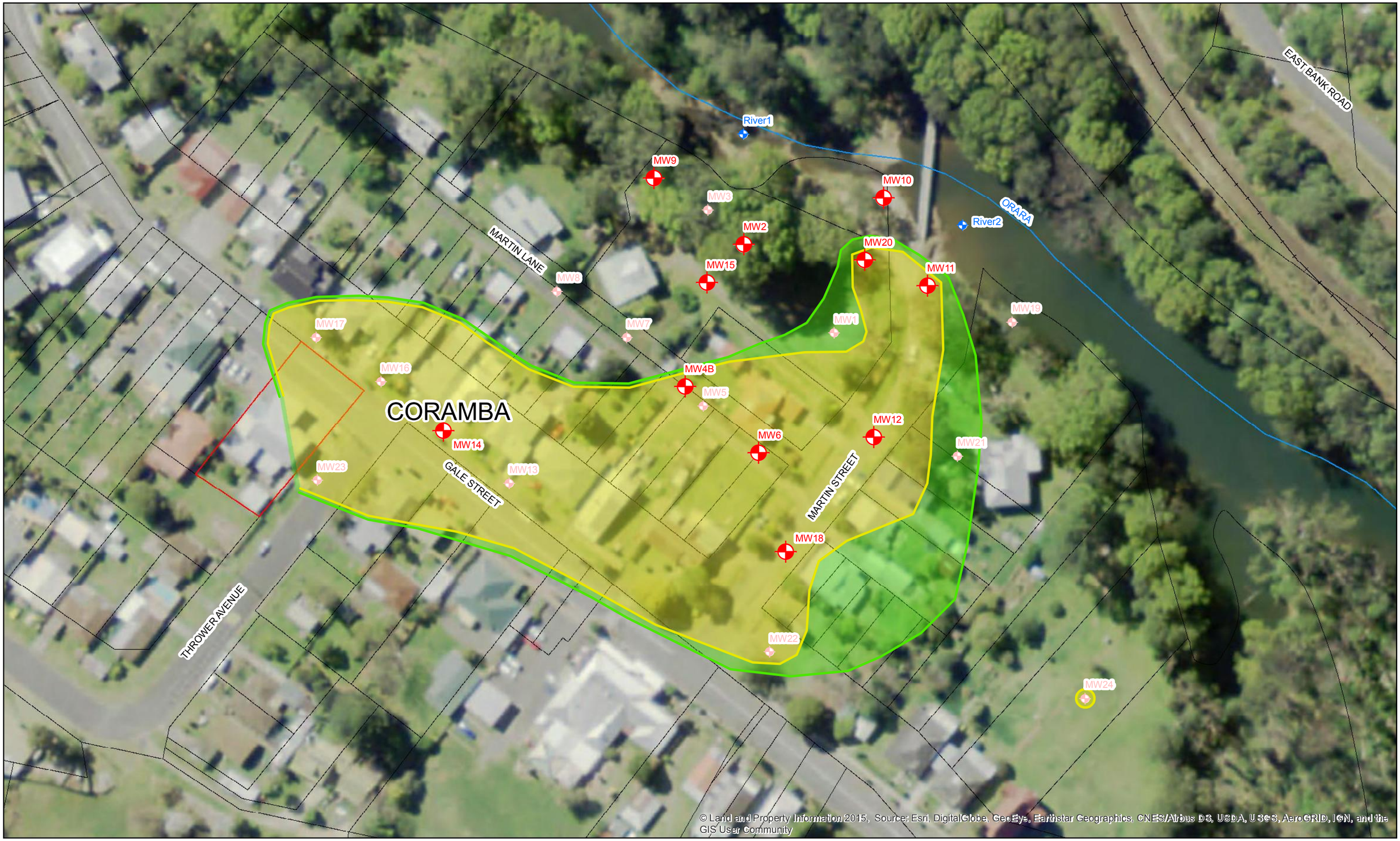
Data source: NSW LPI, DCDB (2012) / Aerial Imagery (2015). Created by:slmartin



Paper Size A3

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- Cadastre
- Service Station
- Railway
- Rivers
- TRH/BTEX >LOR
- TRH/BTEX > assessment criteria
- River Sampling Locations

GHD Groundwater Sampling Locations

- No
- Yes

Coffs Harbour City Council
Coramba Groundwater Monitoring

Job Number	22-18605
Revision	B
Date	28 Nov 2016

Proposed GHD Sampling Locations

Figure 05

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230 Harbour Drive Coffs Harbour NSW 2450 Australia T 61 2 6650 5600 F 61 2 6650 5601 E cfsmail@ghd.com W www.ghd.com

Data source: NSW LPI, DCDB (2012) / Aerial Imagery (2015). Created by:slmartin

Appendix B – Historic Groundwater Data

Appendix B
Table B1
Historic Groundwater Data

		Field Parameters									BTEX						TRH - NEPM 1999					
		SWL	Total well depth	PID	Purge volume	pH	EC	Temp	DO	RP	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	C6 - C 9 Fraction	C10 - C14 Fraction	C15 - C28 Fraction	C29 - C36 Fraction	C10 - C36 (Sum of Total)	Observations
		mbTOC	mbTOC	ppm	L	pH units	uS/cm	°C	mg/L	mV	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	-
LOR		-	-	-	-	-	-	-	-	-	1	1	1	1-2	1-2	3	10-20	50	100	100	100	-
NHMRC ADW 2011		-	-	-	-	-	-	-	-	-	1	800	300	-	-	600	-	-	-	-	-	
NEPM 2013 GIL Drinking Water		-	-	-	-	-	-	-	-	-	1	800	300	-	-	600	-	-	-	-	-	
NHMRC Recreational 2008		-	-	-	-	-	-	-	-	-	**10**	**8000**	**3000**	-	-	**6000**	-	-	-	-	-	
NEPM 2013 Groundwater HSL A/B		-	-	-	-	-	-	-	-	-	800	-	-	-	-	-	-	-	-	-	-	
NEPM 2013 Groundwater HSL C		-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
ANZECC 2000 FW 95%		-	-	-	-	-	-	-	-	-	950	180	80	200	350	550	-	-	-	-	-	
NEPM 2013 GIL Freshwater		-	-	-	-	-	-	-	-	-	950	-	-	-	350	-	-	-	-	-	-	
Netherlands (2000)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	600	
Field_ID	**Sampled_Date**																					
MW1	1/05/2006	-	-	-	-	-	-	-	-	-	**2950**	960	840	900	450	1350	5800	2840	ND	90	2930	
	29/01/2008	4.25	-	-	20	6.35	263	23.5	0.69	144	**1020**	156	375	288	224	512	3150	1440	ND	ND	1440	Brown, turbid, no odour
	17/03/2011	4.35	-	0	10	5.92	0.315	22.55	0	1456*	**310**	<100	240	<100	<100	ND	1100	620	<100	<100	720	Slightly turbid, slight HC odour
	22/08/2013	-	-	Could not locate																		
	4/12/2014	-	-	Not sampled																		
	4/03/2015	-	-	Could not locate																		
	11/06/2015	-	-	Could not locate																		
MW2	1/05/2006	-	-	-	-	-	-	-	-	-	**720**	**15500**	1820	8800	3290	**12090**	28200	10300	300	60	10660	
	29/01/2008	4.77	-	-	40	6.5	177	19.6	0.54	236	**50**	1690	853	4750	2050	**6800**	13000	7030	ND	ND	7030	Strong HC odour and sheen
	17/03/2011	4.87	-	0	16	5.58	0.288	22.31	0.26	180.9*	4	<1	24	8	3	11	260	690	<100	<100	790	Very slight HC odour. No well cap, well sealed with tape
	21/08/2013	5.498	7.63	-	10	6.07	232.3	18.6	0.48	-135.2	<1	<1	1	<2	<1	ND	370	210	<100	<100	310	Clear, slight HC odour
	4/12/2014	-	-	Not sampled																		
	4/03/2015	4.08	4.73	-	2.5	4.25	138.2	19.5	3.32	177.5	3	2	3	2	5	7	19	<50	<100	<100	ND	Clear, no odour
	11/06/2015	dry	4.73	-	Dry																	
MW3	1/05/2006	-	-	-	-	-	-	-	-	-	<5	<5	<5	<10	<5	ND	ND	ND	ND	ND	ND	
	29/01/2008	4.575	-	-	2	5.95	187.2	20.6	1.64	279	<1	<1	<1	<2	<1	ND	ND	ND	ND	ND	ND	Purged dry
	17/03/2011	4.64	-	0	6	4.3	0.17	20.79	0.79	414.6*	5	<1	7	3	<1	3	260	690	<100	<100	790	Clear with HC odour
	21/08/2013	5.2	5.54	-	1.5	5.16	155.1	18.2	0.7	35.3	<1	<1	<1	<2	<1	ND	<10	<50	<100	<100	ND	Clear, slight HC odour
	4/12/2014	-	-	Not sampled																		
	4/03/2015	3.81	5.6	-	8	4.9	144.7	19.4	1.62	-6.8	<1	<1	<1	<1	<2	ND	<10	<50	<100	<100	ND	Clear, no odour
	10/06/2015	4.97	-	-	3	5.3	160.3	18.9	1.61	103	<1	2	<1	<1	<2	ND	<10	<50	<100	<100	ND	Dark brown, turbid
MW4B	15/06/2006	-	-	-	-	-	-	-	-	-	**1510**	1240	700	4030	1950	5980	9700	1340	ND	ND	1340	
	30/01/2008	6.97	-	-	30	6.51	328	21.4	0.9	169	**2150**	3700	918	2300	1580	3880	13000	2130	ND	ND	2130	HC odour
	17/03/2011	7.03	-	0	7	4.82	233	23	0.02	203*	**89**	110	46	60	65	125	310	570	<100	<100	670	
	19/08/2013	7.8	10	-	8.5	6.45	334.5	20.3	0.31	-159.9	**82**	39	160	64	55	119	1100	1200	<100	<100	1300	Clear HC odour
	4/12/2014	8.36	9.9	-	10	6.45	340.1	20.6	0.8	-76.4	**15**	13	60	70	17	87	900	920	320	<100	1240	Slightly cloudy, HC odour
	3/03/2015	5.93	10	-	7	6.19	268.8	20.9	0.31	-96.5	**200**	37	210	21	75	96	1200	580	<100	<100	580	Clear, HC odour
	10/06/2015	7.38	10	-	6	6.55	345.1	20.5	0.66	-109	**490**	88	590	68	470	538	4800	2600	<100	<100	2600	Clear, HC odour
MW5	1/05/2006	dry	6.6	-	Dry																	
	29/01/2008	dry	6.6	-	Dry																	Dry, HC odour
	17/03/2011	dry	6.6	337	Dry																	
	22/08/2013	dry	6.6	-	Dry																	
	4/12/2014	dry	6.6	-	Dry																	
	4/03/2015	5.36	6.6	-	4	4.6	86.7	21.2	1.41	140.7	**1**	2	1	1	3	4	96	<50	<100	<100	ND	Clear, no odour
	11/06/2015	dry	6.6	-	Dry																	
MW6	15/06/2006	-	-	-	-	-	-	-	-	-	**13500**	**13800**	2290	7170	3130	**10300**	47500	7610	ND	70	7680	
	30/01/2008	6.135	-	-	12	6.48	303	21.5	1.03	146	**7080**	**8690**	2050	5130	3180	**8310**	28400	11600	36600	1620	49820	Strong HC odour
	17/03/2011	6.26	-	330	8	4.83	188.5	24.1	0.02	45*	270	170	77	180	130	310	920	1000	<100	<100	1100	Clear with strong HC odour
	21/08/2013	6.98	8.89	-	6	6.31	289.3	19.6	0.46	-203.1	**2000**	190	1100	700	180	880	8000	2700	200	<100	2950	Clear, HC odour
	3/12/2014	7.472	8.87	-	8	6.3	259.6	20.9	1.1	-133.7	410	22	520	270	120	390	2900	2000	1200	110	3310	Turbid, HC odour
	4/03/2015	5.37	8.85	-	9	5.82	245.9	20.8	0.46	-158.8	540	380	670	350	870	1220	4400	1900	<100	<100	1900	Clear, slight HC odour
	10/06/2015	6.52	8.85	-	6	5.76	234	20.9	0.16	-124	750	37	420	35	200	235	3000	1300	<100	<100	1300	Clear, HC odour
MW7	15/06/2006	-	-	-	-	-	-	-	-	-	2	ND	ND	ND	4	4	ND	ND	ND	ND	ND	
	30/01/2008	8.185	-	-	8	7.14	584	21.2	0.04	145	<1	<1	<1	<2	<1	ND	ND	ND	ND	130	130	Slightly cloudy
	17/03/2011	9	-	352	4	4.96	468	21.5	0.19	359*	**1**	4	3	8	5	13	17	79	<100	<100	179	Clear
	19/08/2013	8.33	18	-	31	5.82	480.3	20.6	0.14	-68	<1	<1	<1	<2	<1	ND	<10	<50	<100	<100	ND	Clear, no odour
	3/12/2014	9.41	17.8	-	18	6.88	468	20.3	0.77	-116.1	<1	<1	<1	<2	<1	ND	<10	<50	190	<100	190	Slightly cloudy, no odour
	3/03/2015	7.625	18.1	-	24	4.69	184.4	20.4	1.02	168.1	<1	<1	<1	<1	<2	ND	<10	<50	<100	<100	ND	Clear, no odour
	10/06/2015	8.73	18.1	-	8	5.82	189.1	19.6	0.82	104	<1	<1	<1	<1	<2	ND	<10	<50	<100	<100	ND	Clear, no odour
MW8	15/06/2006	-	-	-	-	-	-	-	-	-	4	ND	ND	ND	4	4	ND	ND	ND	ND	ND	
	30/01/2008	9.55	-	-	32	6.44	258	21.5	0.95	244	<1	<1	<1	<2	<1	ND	ND	ND	ND	140	140	Grey, clear, no odour
	17/03/2011	9.69	-	1924	7	4.56	307	20.5	0.08	422*	<1	3	2	6	3	9	14	62	<100	<100	162	Light brown, highly turbid with HC odour
	19/08/2013	9.99	14.37	-	16	5.82	264.8	20.3	0.3	35.7	<1	<1	<1	<2	<1	ND	<10	<50	<100	<100	ND	Slightly cloudy, no odour
	4/12/2014	-	-	Not sampled																		
	3/03/2015	9	14.37	-	20	4.87	177.3	21.4	2.22	104.3	<1	<1	<1	<1	<2	ND	<10	<50	<100	<100	ND	Cleear, no odour
	11/06/2015	9.57	14.37	-	8	5.46	191.8	20.5	0.28	153.3	<1	<1	<1	<1	<2	ND	<10	<50	<100	<100	ND	Clear, no odour

Appendix B
Table B1
Historic Groundwater Data

		Field Parameters									BTEX						TRH - NEPM 1999					
		SWL	Total well depth	PID	Purge volume	pH	EC	Temp	DO	RP	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	C6 - C 9 Fraction	C10 - C14 Fraction	C15 - C28 Fraction	C29 - C36 Fraction	C10 - C36 (Sum of Total)	Observations
		mbTOC	mbTOC	ppm	L	pH units	uS/cm	°C	mg/L	mV	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	-
LOR		-	-	-	-	-	-	-	-	-	1	1	1	1-2	1-2	3	10-20	50	100	100	100	-
NHMRC ADW 2011		-	-	-	-	-	-	-	-	-	1	800	300	-	-	600	-	-	-	-	-	
NEPM 2013 GIL Drinking Water		-	-	-	-	-	-	-	-	-	1	800	300	-	-	600	-	-	-	-	-	
NHMRC Recreational 2008		-	-	-	-	-	-	-	-	-	**10**	**8000**	**3000**	-	-	**6000**	-	-	-	-	-	
NEPM 2013 Groundwater HSL A/B		-	-	-	-	-	-	-	-	-	800	-	-	-	-	-	-	-	-	-	-	
NEPM 2013 Groundwater HSL C		-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
ANZECC 2000 FW 95%		-	-	-	-	-	-	-	-	-	950	180	80	200	350	550	-	-	-	-	-	
NEPM 2013 GIL Freshwater		-	-	-	-	-	-	-	-	-	950	-	-	-	350	-	-	-	-	-	-	
Netherlands (2000)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	600	
Field_ID	**Sampled_Date**																					
MW9	15/06/2006	-	-	-	-	-	-	-	-	-	**1**	5	2	150	170	320	370	1550	ND	ND	1550	
	29/01/2008	4.98	-	-	10	5.66	175.5	19.3	0.59	301	<1	<1	<1	<2	<1	ND	ND	ND	ND	<50	ND	No sheen, no odour
	17/03/2011	5.1	-	0	6	4.04	0.135	20.07	1.31	433.6*	<1	<1	<1	<2	<1	ND	<10	<50	<100	<100	ND	Clear, becoming slightly turbid after 4L pruge. No odour.
	21/08/2013	6.11	7.88	-	8.5	5.07	84.3	19.2	1.16	-6.1	<1	<1	<1	<2	<1	ND	<10	<50	<100	<100	ND	Clear, no odour
	4/12/2014	-	-	Not sampled																		
	4/03/2015	4.33	7.87	-	9	4.69	139.6	19.3	3.85	170.2	<1	<1	<1	<1	<2	ND	<10	<50	<100	<100	ND	Clear, no odour
	10/06/2015	5.79	-	-	4	5.02	136.8	19.3	2.1	201	<1	<1	<1	<1	<2	ND	<10	<50	<100	<100	ND	Pale brown, cloudy
MW10	13/06/2006	-	-	-	-	-	-	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	29/01/2008	1.03	-	-	22	5.24	80.3	22.8	0.73	273	<1	<1	<1	<2	<1	ND	ND	190	1780	80	2050	Turbid, yellow, HC odour
	16/03/2011	0.95	-	0	12	4.35	0	23.72	0	390.3*	8	2	10	19	3	22	44	<50	<100	<100	ND	Light orange with slight turbidity. Became clear in colour after 4L purged. No odour.
	20/08/2013	1.145	2	-	5	5.46	69	15	0.4	-0.3	<1	<1	<1	<2	<1	ND	<10	<50	<100	<100	ND	Clear, no odour
	3/12/2014	1.882	2.1	-	7	6.36	84.3	25.1	0.51	-26.6	<1	<1	<1	<2	<1	ND	<10	<50	<100	<100	ND	Turbid, no odour
	3/03/2015	0.81	2	-	5	4.97	79.9	23	0.46	175.1	2	<1	<1	<1	<2	ND	12	<50	<100	<100	ND	Clear, no odour
	10/06/2015	1.27	-	-	6	6.78	81.3	15.4	0.39	-75	<1	1	<1	<1	<2	ND	<10	<50	<100	<100	ND	Brown, clear, no odour
MW11	14/06/2006	-	-	-	-	-	-	-	-	-	12200	12200	2190	5950	2950	8900	46200	6800	ND	ND	6800	
	29/01/2008	2.425	-	-	40	6.85	330	22	1.06	189	4520	5740	1810	4330	2790	7120	20600	2810	ND	ND	2810	Strong HC odour
	16/03/2011	2.36	-	0	10	5.93	0.381	20.87	0	200.8*	2500	340	1100	1500	310	1810	7900	3400	<100	<100	3500	Slightly turbid with HC odour
	22/08/2013	-	-	-	Could not locate																	
	4/12/2014	2.805	5.8	-	13	6.35	368.4	19.9	0.92	-64.9	1100	8	5	45	<1	45	2600	1200	<100	<100	1200	Turbid, HC odour
	3/03/2015	2.19	5.88	-	12	6.29	316	21.2	0.33	-130.2	340	27	17	2	160	162	1500	890	<100	<100	890	Clear, HC odour
	10/06/2015	2.7	-	-	6	6.49	339	20.5	0.33	-122	640	5	4	<1	31	31	2000	1000	<100	<100	1000	Clear, HC odour
MW12	14/06/2006	-	-	-	-	-	-	-	-	-	8850	7380	1510	3990	2080	6070	28700	6490	ND	ND	6490	
	30/01/2008	5.16	-	-	18	6.74	341	22.1	2.14	134	4620	4710	1500	3350	2200	5550	18300	2400	ND	ND	2400	Clear, colourless, HC odour
	17/03/2011	4.21	-	0	5	5	244	21.2	0.07	153*	520	130	110	250	120	370	940	810	100	<100	960	Light brown and turbid with strong HC odour. Became clear after 3L purged.
	20/08/2013	4.815	6.5	-	6.5	6.36	324.5	20.6	0.23	-142.7	1500	32	560	880	3	883	5000	2100	150	<100	2300	Clear, HC odour
	4/12/2014	-	-	Not sampled																		
	3/03/2015	3.325	6.6	-	9	6.12	308.5	22.8	0.44	-127.6	550	97	470	22	720	742	3400	2200	<100	<100	2200	Clear, HC odour
	10/06/2015	4.64	6.6	-	6	6.49	352.9	21.5	0.69	-138	930	13	480	2	590	592	4300	2700	<100	<100	2700	Clear, HC odour
MW13	14/06/2006	-	-	-	-	-	-	-	-	-	3650	8410	910	3770	1410	5180	18500	6790	ND	ND	6790	
	30/01/2008	12.76	-	-	50	6.49	317	20.7	0.1	181	1160	5020	1210	4280	1880	6160	15900	2940	ND	ND	2940	Clear, HC odour, sheen
	16/03/2011	13.8	-	0	5	4.7	216	21.3	0.07	213*	18	58	13	49	26	75	220	120	<100	<100	220	HC odour
	20/08/2013	13.78	19.2	-	16	5.49	299.1	20.6	0.41	-147.6	220	800	430	1100	480	1580	4300	1200	<100	<100	1300	Slightly cloudy, HC odour
	4/12/2014	-	-	Not sampled																		
	3/03/2015	11.435	19.4	-	22	5.22	346.4	21.4	5.24	-68.3	13	25	30	21	64	85	610	330	<100	<100	330	Clear, no odour
	11/06/2015	13.22	19.4	-	6	5.61	335	20.6	0.78	-79	38	72	61	50	120	170	1200	1100	130	<100	1230	Clear, HC odour
MW14	14/06/2006	-	-	-	-	-	-	-	-	-	17300	19000	2350	8490	3560	12050	69200	11500	250	ND	11750	
	30/01/2008	13.18	-	-	40	6.79	338	21.5	1.01	136	22400	41200	3380	12600	6050	18650	89300	7000	240	100	7340	Clear, HC odour, sheen
	16/03/2011	13.15	-	0	5	4.89	74	21.3	0.08	119*	3500	6900	980	3500	2000	5500	15000	5900	540	<100	6490	Clear with HC odour
	21/08/2013	14.28	17.206	-	13	6.44	331.9	20.6	0.5	-165.4	10000	16000	2300	8300	3700	12000	53000	5100	440	<100	5590	Clear, strong HC odour
	4/12/2014	15.325	17.3	-	10	6.46	371.6	21.3	1.81	-78.7	11000	12000	2400	9400	3800	13200	52000	76000	5100	460	81100	Slightly cloudy, strong HC odour
	2/03/2015	11.77	17.3	-	18	6.24	396.5	21.5	1.65	-142.9	9400	15000	2700	4300	9900	14200	56000	7400	290	<100	7690	Clear, strong HC odour
	11/06/2015	-	17.3	-	6	6.45	348	20.7	0.25	-141	7000	8600	1600	2400	5500	7900	38000	7400	420	<100	7820	Cloudy, HC odour
MW15	15/06/2006	-	-	-	-	-	-	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	29/01/2008	5.025	-	-	22	6.01	210	19.6	0.72	179	<1	<1	<1	<2	<1	ND	ND	ND	ND	ND	ND	No sheen, no odour
	17/03/2011	6.06	-	0	8	4.03	0.188	20.13	1.01	439*	**1**	<1	2	<2	<1	ND	<10	<50	<100	<100	ND	Clear becoming slightly turbid. No odour.
	21/08/2013	5.69	7.6	-	11	6.5	383.9	18.7	0.96	-52.9	<1	<1	<1	<2	<1	ND	<10	<50	<100	<100	ND	Clear, no odour
	4/12/2014	-	-	Not sampled																		
	3/03/2015	4.06	7.6	-	12	5.2	129.6	19.5	4.56	104.5	2	<1	2	<1	2	2	<10	<50	<100	<100	ND	Clear, no odour
	10/06/2015	-	7.6	-	6	5.53	193	17.9	1.21	132	<1	<1	<1	<1	<2	ND	<10	<50	<100	<100	ND	Brown, turbid, no odour
MW16	14/06/2006	-	-	-	-	-	-	-	-	-	10600	14000	1690	6770	2760	9530	41700	6810	ND	ND	6810	
	30/01/2008	14.01	-	-	40	6.94	385	21.1	0.8	146	7240	12900	1460	5050	2430	7480	31000	2250	ND	ND	2300	HC odour, turbid
	16/03/2011	13.99	-	0	7	4.82	257	20.6	0.01	173*	9400	11000	2300	6800	4000	10800	46000	1200	<100	<100	1300	Light brown with low turbidity and a HC odour. Becomes clear after 4L purged.
	21/08/2013	15.1	18	-	8	6.52	330.1	20.2	1.29	-178.6	3200	5600	1100	4300	1800	6100	21000	2900	110	<100	3060	Clear, HC odour
	4/12/2014	-	-	Not sampled																		
	2/03/2015	12.58	18	-	18	6.26	350.7	21.6	0.3	-120	1900	2100	420	660	1500	2160	9000	2400	<100	<100	2400	Clear, very slight odour
	11/06/2015	14.4	18	-	6	6.42	303.2	20.4	0.21	-154	1800	2400	570	930	2200	3130	12000	4000	100	<100	4100	Pale brown, cloudy, HC odour

Appendix B
Table B1
Historic Groundwater Data

		Field Parameters									BTEX						TRH - NEPM 1999					
		SWL	Total well depth	PID	Purge volume	pH	EC	Temp	DO	RP	Benzene	Toluene	Ethylbenzene	Xylene (m & p)	Xylene (o)	Xylene Total	C6 - C 9 Fraction	C10 - C14 Fraction	C15 - C28 Fraction	C29 - C36 Fraction	C10 - C36 (Sum of Total)	Observations
		mbTOC	mbTOC	ppm	L	pH units	uS/cm	°C	mg/L	mV	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	-
LOR		-	-	-	-	-	-	-	-	-	1	1	1	1-2	1-2	3	10-20	50	100	100	100	-
NHMRC ADW 2011		-	-	-	-	-	-	-	-	-	1	800	300	-	-	600	-	-	-	-	-	
NEPM 2013 GIL Drinking Water		-	-	-	-	-	-	-	-	-	1	800	300	-	-	600	-	-	-	-	-	
NHMRC Recreational 2008		-	-	-	-	-	-	-	-	-	**10**	**8000**	**3000**	-	-	**6000**	-	-	-	-	-	
NEPM 2013 Groundwater HSL A/B		-	-	-	-	-	-	-	-	-	800	-	-	-	-	-	-	-	-	-	-	
NEPM 2013 Groundwater HSL C		-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-	-	
ANZECC 2000 FW 95%		-	-	-	-	-	-	-	-	-	950	180	80	200	350	550	-	-	-	-	-	
NEPM 2013 GIL Freshwater		-	-	-	-	-	-	-	-	-	950	-	-	-	350	-	-	-	-	-	-	
Netherlands (2000)		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	600	
Field_ID	**Sampled_Date**																					
MW17	15/06/2006	-	-	-	-	-	-	-	-	-	**5940**	**8560**	2090	7130	2800	**9930**	27400	4960	ND	ND	4960	
	30/01/2008	14.575	-	-	15	6.26	1820	21.6	2.28	181	**2930**	1250	1280	2130	1510	3640	10600	2020	ND	ND	2020	Slight HC odour
	16/03/2011	14.73	-	0	8	4.74	37	23.9	0.14	173*	**96**	8	27	37	13	37	190	520	<100	<100	620	Light brown and turbid with strong HC odour
	20/08/2013	15.7	17.1	-	7.5	5.01	225.4	19.6	0.86	-122.6	**130**	2	22	10	2	12	470	400	<100	<100	500	Slightly cloudy, HC odour
	4/12/2014	-	-	Not sampled																		
	2/03/2015	13.29	17.1	-	12	5.15	213.3	21.2	0.83	-29	**150**	41	90	63	280	343	1600	890	<100	<100	890	Clear, slight odour
	11/06/2015	15.1	17.1	-	4	6.34	258.3	20	0.25	-151	**140**	5	41	3	22	25	720	700	<100	<100	700	Pale brown, turbid, HC odour
MW18	14/06/2006	-	-	-	-	-	-	-	-	-	**4940**	2830	850	3220	1160	4380	13000	7540	ND	ND	7540	
	30/01/2008	6.075	-	-	30	6.99	417	22.9	0.9	129	**905**	204	434	931	290	1221	4980	3810	ND	ND	3810	HC odour, sheen, clear
	17/03/2011	6.13	-	0	6	5.12	261	20.8	0.1	29*	**76**	5	26	32	2	34	210	520	<100	<100	620	Clear with strong HC odour
	20/08/2013	7.055	8.15	-	8	5.88	353.8	21	0.27	-122.2	**290**	6	150	110	<1	110.5	1800	970	130	<100	1150	Slightly cloudy, HC odour
	4/12/2014	-	-	Not sampled																		
	3/03/2015	5.61	8.9	-	10	6.3	346.6	21.4	0.34	-160.6	**140**	28	62	3	59	62	1000	630	<100	<100	630	Clear, slight HC odour
	11/06/2015	6.6	8.9	-	6	6.28	268.1	21.3	0.28	-74	**130**	4	59	<1	41	41	750	480	<100	<100	480	Clear, HC odour
MW19	15/06/2006	-	-	-	-	-	-	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	30/01/2008	3.58	-	-	10.5	5.56	203.7	21.3	0.94	298	<1	<1	2	3	2	5	ND	ND	ND	ND	ND	Brown, turbid, no odour or sheen
	17/03/2011	-	-	Could not locate																		
	22/08/2013	-	-	Could not locate																		
	4/12/2014	4.09	5.4	-	3.5	5.91	79.4	19.3	3.79	13.3	<1	<1	<1	<2	<1	ND	<10	<50	<100	<100	ND	Turbid, very slight odour
	4/03/2015	-	-	Could not locate																		
	11/06/2015	-	-	Could not locate																		
MW20	14/06/2006	-	-	-	-	-	-	-	-	-	**1390**	62	160	360	55	415	2080	410	ND	ND	410	
	30/01/2008	2.925	-	-	10	5.31	155.6	21.7	0.47	260	<1	<1	<1	16	8	24	50	ND	ND	ND	ND	Brown, turbid, sheen
	17/03/2011	2.81	-	0	8	4.85	187	20.71	1.34	239.4*	**21**	3	31	110	4	114	180	110	<100	<100	210	Clear with slight HC odour
	20/08/2013	3.1	5.8	-	11	5.76	208.3	18.8	0.33	-119.9	6	<1	5	31	<1	31.5	100	<50	<100	<100	ND	Clear-slightly cloudy, slight HC odour
	3/12/2014	3.425	5.8	-	8	5.99	233.1	19.2	0.72	-4.6	<1	<1	1	8	<1	8	36	71	520	<100	591	Turbid, no odour
	3/03/2015	2.62	5.8	-	9	5.07	110.9	21.2	0.43	62.5	2	<1	1	<1	5	5	17	<50	<100	<100	ND	Clear, no odour
	10/06/2015	3.15	-	-	6	5.61	122.7	19.8	0.37	-36	6	<1	10	<1	54	54	130	82	<100	<100	82	Clear, no odour
MW21	14/06/2006	-	-	-	-	-	-	-	-	-	**190**	94	490	2590	890	3480	6070	9200	ND	ND	9200	
	30/01/2008	5.325	-	-	30	5.9	125	21	0.95	309	**1370**	196	731	2020	830	2850	7040	6430	ND	ND	6430	Brown, turbid, sheen, HC odour
	17/03/2011	5.4	-	0	10	4.77	0.176	20.77	0	272.8*	**250**	<1	27	<2	<1	ND	420	690	<100	<100	790	Clear becoming turbid after 2L purged. Slight HC odour.
	20/08/2013	5.795	6.9	-	4	5.66	174	19.7	0.23	-83.9	<1	<1	3	<2	<1	ND	140	400	<100	<100	500	Clear, slight HC odour
	4/12/2014	-	-	Not sampled																		
	4/03/2015	5.08	6.9	-	7	5.35	110	21.2	0.36	59.4	**45**	<1	<1	2	<2	2	130	73	<100	<100	73	Clear, no odour
	11/06/2015	5.72	6.9	-	6	5.46	134.6	19.9	0.57	101	<1	<1	<1	<1	<2	ND	62	<50	<100	<100	ND	Clear, no odour
MW22	14/06/2006	-	-	-	-	-	-	-	-	-	**2960**	260	140	280	130	410	3910	1050	ND	ND	1050	
	30/01/2008	9.15	-	-	40	6.44	334	18.9	0.9	154	**1720**	456	395	686	378	1064	4130	780	ND	ND	780	Clear, HC odour, no sheen
	17/03/2011	9.23	-	461	6	4.99	227	21	0.05	112*	**120**	9	42	52	5	57	260	250	<100	<100	350	Light brown turbid with slight HC odour
	20/08/2013	10.27	13	-	11	5.55	208.9	20.6	0.39	-119.4	**16**	<1	14	6	<1	6.5	140	140	<100	<100	240	Clear, very slight HC odour
	4/12/2014	-	-	Not sampled																		
	3/03/2015	7.66	13	-	13	5.61	176.7	20.9	1.43	-51.9	<1	<1	<1	<1	<2	ND	35	<50	<100	<100	ND	Clear, slight HC odour
	11/06/2015	9.72	13	-	8	6.27	214.1	19.9	0.67	-93	**20**	<1	16	<1	3	3	170	160	<100	<100	160	Clear, HC odour
MW23	14/06/2006	-	-	-	-	-	-	-	-	-	**9870**	1750	190	660	350	1010	13900	2030	ND	ND	2030	
	30/01/2008	12.17	-	-	40	7	360	19	0.23	137	**7340**	570	223	202	130	332	9870	600	ND	ND	600	HC odour
	17/03/2011	12.18	-	72.4	7	5.1	284	18.5	0.09	114*	**2500**	750	180	300	180	480	3300	720	130	<100	900	Clear with black suspended solids. Strong HC odour.
	20/08/2013	13.22	17.82	-	18.5	5.34	364.5	20.1	0.75	-88.7	**4600**	1100	600	1000	210	1210	11000	1500	180	<100	1730	Slightly cloudy, strong HC odour
	4/12/2014	-	-	Not sampled																		
	2/03/2015	10.77	17.9	-	20	6.42	410.1	22	0.82	-131.3	**2000**	110	210	14	280	294	4000	690	<100	<100	690	Slightly cloudy, slight odour
	11/06/2015	12.67	17.91	-	6	6.68	353.1	20.5	0.23	-92	**3300**	1000	440	190	970	1160	8700	<50	<100	<100	ND	Brown, turbid, HC odour
MW24	15/06/2006	-	-	-	-	-	-	-	-	-	3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	
	30/01/2008	5.89	-	-	25	5.41	151.1	20.4	1.06	355	<1	<1	<1	<2	<1	ND	ND	ND	ND	ND	ND	Clear, colourless, no odour or sheen
	17/03/2011	6.04	-	0	6	3.72	157	14.5	0.07	488*	5	4	4	12	6	18	25	<50	<100	<100	<250	Light brown with low turbidity. Slight HC odour.
	20/08/2013	6.5	8.9	-	10	5.21	133.2	20.2	0.5	28.2	<1	<1	<1	<2	<1	ND	<10	<50	<100	<100	ND	Clear, no odour
	4/12/2014	-	-	Not sampled																		
	4/03/2015	5.47	8.9	-	10	5.16	138.1	20.9	1.16	50.1	<1	<1	<1	<1	<2	ND	<10	<50	<100	<100	ND	Clear, no odour
	11/06/2015	6.44	8.92	-	8	6.41	220.5	20.8	0.32	37	<1	<1	<1	<1	<2	ND	<10	1500	<100	<100	1500	Cloudy, no odour

* ORP field results converted to Standard Hydrogen Electrode (SHE) readings by adding 199 mV to each field value - TPS 90FLMV Water Quality Meter
ND = Non Detect
EC = Electrical Conductivity
RP = Redox Potential
DO = Dissolved Oxygen
mbTOC = metres below top of casing
SWL = Standing water level

		MNA indicators																		
		pH (lab derived)	EC (lab derived)	Total alkalinity	Chloride	Fluoride	Sulphate	NO2-N	NO3-N	Ammonia as N	Ferrous Iron	Calcium	Magnesium	Sodium	Potassium	Sulphide	Hydroxide	Bicarbonate as CaCO3	Carbonate as CaCO3	Free CO2
		pH units	uS/cm	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	ug/L	mg/L	mg/L	ug/L
LOR		0.1	1	5	1	0.1	1-2	0.01	0.01	0.005-0.01	0.1-0.5	0.1-0.5	0.1-0.5	0.1-0.5	0.1-0.5	0.1	5000	5	5	0-5
Field_ID	**Sampled_Date**																			
MW2	3/07/2006	6	202	36	21	-	14	0	0	0	29	3	2	23	3	-	-	-	-	-
	29/01/2008	-	-	33	21	0	10	0	0	0	1	4	2	25	3	<0.1	-	-	-	83000
	17/03/2011	-	-	100	27	-	2.6	-	-	0.2	26	4.7	4.4	22	2.1	-	-	-	-	44000
	21/08/2013	-	-	59	33	-	7	-	-	0.024	29	4.2	4.2	19	1.6	-	<5000	59	<5	150000
	4/12/2014	No access																		
	4/03/2015	-	-	<5	37	-	2	-	-	0.018	<0.05	0.7	3.3	16	1.3	-	-	-	<5	71000
	11/06/2015	Dry																		
MW6	3/07/2006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	30/01/2008	-	-	144	21	<0.1	2	<0.01	<0.01	<0.01	10	4	11	26	4	<0.1	-	-	-	58000
	17/03/2011	-	-	92	18	-	8.8	-	-	0.05	8.6	2	4.4	29	3.1	-	-	-	-	240000
	21/08/2013	-	-	130	25	-	4	-	-	0.009	10	2.7	7.9	26	3.5	-	<5000	130	<5	120000
	3/12/2014	-	-	120	23	-	1	-	-	0.033	4.4	1.9	5	37	2.8	-	<5000	120	<5	120000
	4/03/2015	-	-	82	23	-	19	-	-	0.058	9	2.3	4.4	33	2.7	-	-	-	<5	90000
	10/06/2015	-	-	76	23	-	24	-	-	0.072	6.2	1.7	3.7	36	3	-	-	-	<5	94000
MW11	3/07/2006	7	357	120	24	-	<2	<0.05	<0.05	1	7	6	12	24	4	-	-	-	-	-
	29/01/2008	-	-	152	20	0	<2	<0.01	<0.01	0	15	5	12	21	4	<0.1	-	-	-	76000
	16/03/2011	-	-	160	20	-	<1	-	-	0.3	14	4	9.4	20	4.1	-	-	-	-	11000
	22/08/2013	Could not locate																		
	4/12/2014	-	-	140	21	-	<1	-	-	0.65	31	4.3	10	18	3.2	-	<5000	140	<5	140000
	3/03/2015	-	-	120	21	-	<1	-	-	0.14	27	4	9.1	16	3.7	-	-	-	<5	86000
	10/06/2015	-	-	130	19	-	<1	-	-	2	29	3.7	8.2	17	3.6	-	-	-	<5	130000
MW14	4/07/2006	7	378	130	27	-	2	0	0	0	4	4	11	28	6	-	-	-	-	-
	30/01/2008	-	-	136	23	<0.1	2	<0.01	<0.01	<0.01	6	3	10	27	5	<0.1	-	-	-	68000
	16/03/2011	-	-	140	21	-	<1	-	-	0.03	8.7	2.7	8.2	25	6	-	-	-	-	310000
	21/08/2013	-	-	150	26	-	<1	-	-	<0.005	10	3.1	9	20	5.4	-	<5000	150	<5	970000
	4/12/2014	-	-	160	24	-	<1	-	-	<0.02	7.6	3.8	12	28	5.4	-	<5000	160	<5	90000
	2/03/2015	-	-	160	-	-	<1	-	-	0.055	0.97	3.7	11	26	6.1	-	-	-	<5	85000
	11/06/2015	-	-	160	26	-	<1	-	-	<0.005	9.9	3.1	10	25	6.5	-	-	-	<5	92000
MW15	10/06/2015	-	-	27	21	-	16	-	-	0.051	2	7.4	1.1	29	3	-	-	-	<5	310000
MW24	4/07/2006	6	247	44	27	-	7	0	3	<0.01	<0.5	13	4	30	3	-	-	-	-	-

Appendix C – SAQP Rationale

Proposed SAQP

	May-06	Jan-08	Mar-11	Aug-13	Dec-14	Previous Mar-15	Current Jun-15	General Comments (Exceedences based on surface water criteria)	Benzene trends (from WSP June 2015 graphs)
SWL						High	Low		
Groundwater									
Source zone									
~~MW23~~	×	×	×	×	×		×	Exceedance in last sampling event, history of exceedances, decreasing trend, likely cross gradient from source.	Sig decrease from 2006 to 2011, fluctuating since, relatively high
~~MW13~~	×	×	×	×		×	×	No exceedance in previous sampling event, but history of exceedance	Sig drop from 2006 to 2011, fluctuating since, but relatively low
MW14	M	M	M	M	M	M	M	Exceedance in last sampling event, history of exceedances, decreasing trend. Use this as source zone indicator.	Fluctuating, sig drop from 2006 to 2011, higher since, recent decreasing trend
~~MW16~~	×	×	×	×		×	×	Exceedance in last sampling event, history of exceedances, decreasing trend. Close to MW14 but more consistently decreasing and not as high.	Fluctuating but overall decreasing trend, still relatively high
~~MW17~~	×	×	×	×		×	×	History of exceedances, concentrations increased in last sampling event, frequent sampling	Sig decrease from 2006 to 2011, consistently low since
Mid zone, upgradient of SVE/sparge system									
~~MW22~~	×	×	×	×		×	×	Hasn't had exceedances in 4 years (benzene 20 ug/L). Upgradient of treatment system and outside plume.	Sig decrease from 2006 to 2010, minimal since 2013
MW18	×	×	×	×		×	×	Exceedance in last sampling event, history of exceedances, decreasing trend. Retain to monitor edge of plume.	Sig decrease from 2006 to 2011, relatively low since
MW6	M	M	M	M	M	M	M	History of exceedances, concentrations increased in last sampling event, frequent sampling	Sig. drop from 2006 to 2011, slight peak in 2013, low since
~~MW5~~	×			×		×	Dry	Hasn't had exceedances in 4 years (missing summary table, but indiv. results tables reported for the particular event). May be ineffective. Between MW6 and MW4B.	No graph
MW4B	×	×	×	×	×	×	×	History of exceedances, concentrations increased in last sampling event, frequent sampling	Sig. drop from 2006 to 2011, increasing trend since Dec 2014
~~MW7~~	×	X	X	×	X	×	×	Hasn't had exceedances in 4 years. Upgradient of sparge system and outside plume.	Low, fluctuating, negligible since 2013
~~MW8~~	×	X	X	×		×	×	Hasn't had exceedances in 4 years. Upgradient of sparge system and outside plume.	Low in 2006, negligible since 2008
Lower zone bedrock wells									
~~MW24~~	M	×	×	×		×	×	Hasn't had exceedances in 4 years, long distance from servo (no BTEX, but 1500 TRH), cross gradient from plume.	Fluctuating with peak in 2011, negligible since
MW12	×	×	×	×		×	×	Exceedance in last sampling event, history of exceedances, decreasing trend	Sig drop from 2006 to 2011, fluctuating since, still fairly high
MW15	×	×	×			×	×	Hasn't had exceedances in 4 years. Close proximity to treatment system, and still fluctuating.	Initially low, peak in 2011, negligible in 2013, higher in March 2015, currently negligible
MW2	M	M	M	M	No access	M	Dry	Hasn't had exceedances in 4 years, but within plume and in proximity to sparge system. One round, cease if decrease continues but reinstate if MW15 increases. Covered by MW15.	Sig. drop from 2006 to 2011, negligible since
~~MW3~~	X	X	×	X		×	×	Hasn't had exceedances in 4 years, outside plume, and cross gradient (MW2 will cover)	Negligible except for slight peak in 2011
MW9	×	X	×	X		×	×	Hasn't had exceedances in 4 years, even further outside plume than MW3. **USE AS BACKGROUND FOR MNA (either MW9 or MW8)**	Low in 2006, negligible since 2008
Lower / discharge zone alluvial wells									
~~MW21~~	×	×	×	×		×	×	Hasn't had exceedances in 4 years. Not in proximity to treatment system, covered MW12. Reinstate if MW12 increases.	Sig increase from 2006 to 2008, decrease by 2011 and minimal since
~~MW1~~	×	×	×			Not located	Not located	Has been lost since before August 2013 so assume not available	Sig. drop from 2006 to 2011
~~MW19~~			Not located	Not located	**X ?**	Not located	Not located	Assume not available.	Generally negligible when sampled
MW11	M	M	M	Not located	M	M	M	Exceedance in last sampling event, history of exceedances, decreasing trend	Sig drop from 2006 to 2011, low in last 3 rounds, slight increase in current from March 2015
MW20	×	×	×	×	×	×	×	Hasn't had exceedances in 4 years (benzene 6 ug/L). One round and stop if still low (covered by MW10 and MW11). Reinstate if there is an increase in upgradient wells (MW15, MW4B).	Sig decrease from 2006 to 2008, consistently very low since
MW10	×			×		×	×	Hasn't had exceedances in 4 years. Discharge zone. Continue until consistently negligible.	Generally neglibible, except for peak in 2011, small peak in March 2015
Surface Water									
Site A	×		×		×	×		Upstream of footbridge at end of Martin Street. Never had exceedances, generally below detect, currently sampled monthly. Continue monitoring at reduced frequency for due diligence.	
Site B	×		×		×	×		Outside bund, in backwater adjacent to problem area, downstream from site A. No exceedences of aquatic trigger levels but periodic detections. Decreasing trend, currently sampled monthly, no BTEX detections since March 2013. Continue monitoring at reduced frequency for due diligence.	
~~Site C~~	×		×		×	×		Former intake location, downstream from sites A and B. BTEX below detect since 2007, currently sampled monthly. No longer a water intake, cease monitoring. (Reinstate if Site B exceeds).	
~~Site D~~	×		×		×	×		150 - 200 m downstream of site C. No exceedances since 2007, generally below detect, currently sampled monthly. Cease monitoring.	

Start of continuous SVE/Sparge

exceedance in March 2015 report

no reported exceedances (2011-2015)

Appendix D – Consultation strategy

Coffs Harbour City Council
Coramba Remediation Works Project
Community Consultation Program

Communication and Consultation Strategy
Updated January 2017

Coramba Communication and Consultation strategy

1. Introduction

Groundwater contamination was discovered in Coramba in 2002, when fuel odours were noticed by a resident near the Orara River. Actions were taken immediately by Council and the government agencies responsible, to safeguard the village's reticulated water supply and introduce environmental monitoring.

Subsequent investigations discovered that an underground fuel tank storing unleaded petrol at the service station in Gale Street was leaking and has since been removed.

Whilst the NSW Environment Protection Authority (EPA) has overall statutory responsibility to deal with the contamination, Coffs Harbour City Council entered into a voluntary agreement with the state government to manage the remediation works utilising funding provided by the Government.

An air sparge system designed to help cut hydrocarbon contamination of the groundwater entering the Orara River at Coramba was installed in 2011 to help remove vapours from soil and groundwater below the water table. Regular ground water monitoring has indicated that the air sparge system and natural processes have been effective in reducing the contamination levels within the groundwater. The air sparge system was turned off in early 2015 with further ground water monitoring undertaken to monitor the effectiveness of the remediation measures.

The Environmental Protection Authority has recently determined that the contamination of the land is no longer significant enough to warrant regulation as currently applied with a notice to end the significantly contaminated land declaration to be issued in due course. This Notice will be replaced with a new Notice issued under Section 28 of the Contaminated Land Management Act that will be provide for the on-going management of the hydrocarbon contamination in accordance with this Groundwater Management Plan.

Monitoring results will be used to evaluate if contaminant trends continue to decline and satisfy project closure requirements.

2. Project Description – Groundwater Management Plan

GHD Pty Ltd (GHD) has been engaged by Coffs Harbour City Council (CHCC) to develop and implement a Groundwater Management Plan (GMP) for the on-going management and monitoring of hydrocarbon impacted groundwater at Coramba.

The GMP seeks to achieve the following objectives:

- Groundwater sampling of existing groundwater monitoring wells and river water sampling from the Orara River.
- Odour management – Identification of odour management measures in the event that odour complaints or issues are identified at the site.
- Rebound assessment – Determining the trigger points to recommence the use of the existing air sparge system.
- Exit strategy– Developing an exit strategy for the monitoring program based on a stabilised or decreasing trend in hydrocarbon impact at the site.

3. Communication Strategy

a. Objectives

(i) To keep the community and key stakeholders informed in respect to the current status of remediation monitoring results and further planned monitoring of the remediation area.

(ii) What the community can expect as an outcome of the project;

(iii) Expected time-frames, so the community will be kept up-to-date.

b. Key Performance Indicators

(i) The community will understand the project stages and processes being undertaken

(ii) The community will know what to expect from the outcome of the project

c. Guiding Principles

(i) Communication and consultation will be conducted in a clear, transparent manner that provides stakeholders with a realistic understanding of the process and outcomes.

(ii) The purpose of the remediation monitoring and reasonable expectations with respect to outcomes will be clearly articulated and communicated.

(iii) Communication / consultation mechanisms will allow relevant stakeholders to participate in a meaningful way, via contacts listed on printed information and website.

(iv) Information will be provided appropriately to keep people informed and to encourage feedback.

(v) Stakeholders will know how to provide feedback, and will be responded to in an appropriate and timely manner.

d. Key Messages to be conveyed in relation to the process being undertaken:

(iii) Planned remediation monitoring is being undertaken as part of continuing process aimed at protecting the human and environmental health of the locality

(ii) Planned remediation monitoring results will be used to determine if further remediation monitoring is required OR whether the remediation project can be finalised

e. The 'success factors' for the project are:

(i) Remediation monitoring results are within acceptable levels to enable the project to be finalised.

f. Stakeholders – specific stakeholders to be targeted are:

(i) Owner 5 Martin Street Coramba and surrounding property owners with monitoring well/s located on their land

(ii) The Coramba community and the remaining interested members of the Community Working Party including State and Council political representatives

4. Roles & Responsibilities for the Project

a. Compliance and Regulatory Enforcement (Technical support); SAM (Project Management); Sara Hinds (Media) GHD (Consultant undertaking remediation Monitoring)

b. Engagement with stakeholder groups will be undertaken via appropriate means relevant to stakeholders as follows:

- Council to undertake direct means including face to face; phone; email – targeting owner 5 Martin Street; owners with monitoring well on property; members of Community Working Party; political representatives
- Council to prepare and distribute information flyer to key locations including Coramba pub, Police Station, local store – Targeting Coramba Community
- GHD to consult with property owners prior to conducting remediation monitoring of wells located on private property

Information in respect to the on-going management of remediation monitoring at Coramba will also be displayed on a designated web page on the Coffs Harbour City Council web site.

5. Schedule of Remediation Monitoring

Two rounds of groundwater sampling are to be conducted, the first round in March 2017 and the second round in March 2018. Timing is based on historical data which indicates March as being a representative wet weather period (high groundwater level) and the time when the highest groundwater contaminants have generally been recorded.

Sampling results will be presented by GHD in a report that enables a comparison of the previous and current sampling results including both tabular and graphical representations and will include an analysis of the findings.

Groundwater concentrations obtained from the sampling program will be assessed against remediation goals detailed within the Groundwater Management Plan. Trigger values will be incorporated within the Plan for consideration and review by Council and the EPA on completion of each monitoring round to ensure that the monitoring program remains representative. The information will be used to determine the need to undertake further monitoring, review or additional investigations or if the project can be finalised.

6. Evaluation of Communication Plan

The Communication Plan will be evaluated after each phase of the project to determine if it is successfully meeting identified criteria within part 3 above and adjusted if required.

The Environmental Trust has provided funding (as administered by the EPA) to council for the purpose of preparation and implementation of a groundwater management plan and associated actions to finalise the project when determined appropriate.

Appendix E – Odour Management Plan

Coffs Harbour City Council

Hydrocarbon Impacted Groundwater, Coramba
Odour Management Plan

February 2017

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1. Introduction

GHD Pty Ltd (GHD) has been engaged by Coffs Harbour City Council (CHCC) to develop an Odour Management Plan (OMP) as part of the Groundwater Management Plan (GMP) for the ongoing management and monitoring of hydrocarbon impacted groundwater near the Orara River in Coramba, NSW.

1.1 Background

In 2002, hydrocarbon contaminated groundwater was discovered seeping into a backwater adjacent to the Orara River, Coramba, NSW. The source of the hydrocarbon contaminated groundwater was identified as an unleaded petrol leak from an underground storage tank (UST) at a nearby service station, located approximately 150 m up gradient of the Orara River. The leaking tank and contaminated soil were removed and managed in accordance with guidelines and legislative requirements that were relevant at the time.

Assessment of the hydrocarbon impacted groundwater included the installation and sampling of four groundwater monitoring wells in 2004 by Golder Associates and an additional 20 groundwater monitoring wells in 2006 by WSP Environmental Pty Ltd (WSP). Ongoing groundwater monitoring of the 24 wells has been undertaken approximately every 12 months from 2006 to 2015. Surface water sampling in the Orara River was also undertaken monthly at four locations from January 2007 until June 2015.

A number of complaints have been received by CHCC regarding odour issues at the site since the incident occurred. Management of the contamination at the site was undertaken from 2011 to 2015 with the installation of a soil vapour extraction system and air sparging treatment system. It is reported that odour issues were minimal during the operation of the treatment system. The treatment system was turned off in March 2015 and while no increase in odour has been reported, odour management measures are required in the event that odour complaints are received at the site in the future.

1.2 Objectives

The objectives were to develop an OMP as part of the GMP that outlines contingencies in the event that odour complaints or issues arise as a result of the hydrocarbon contamination in the groundwater at the site.

1.3 Scope of works

The scope of work included developing an OMP consisting of:

- Introduction – including a brief summary of the situation, objectives and scope of work.
- Site description and history – outlining the location and details of the site including the contamination issue at the site.
- Management and Monitoring – outlining persons responsible for odour management and complaints monitoring.
- Contingency measures – outlining actions to take in the event of odour issues.
- Incident response and complaints procedure – including correct recording, management and follow up of complaints.

2. Site description and history

2.1 Location and surrounding land use

The area impacted or formerly impacted by the hydrocarbon contamination (the site) is located in Coramba, approximately 12 km north-west of Coffs Harbour on the Mid North Coast of NSW. The service station where the leak occurred is located at 33 Gale Street on Lot 2, DP 264343 and the river bank where the hydrocarbon leak was first observed is located on Lot 122 DP 876790 (Council owned reserve at the end of Martin Street). The contaminated groundwater is spread across the properties between these two points, including Martin St Road Reserve. Twenty-four previously installed groundwater monitoring wells are located in this area down gradient of the Service Station to the Orara River. The air sparge treatment system is located on Martin Street on Lot 121 DP 876790.

The surrounding land uses include:

- North – The Orara River followed by the railway and rural residential properties.
- East – Martin Street followed by residential properties and the Orara River.
- South – Residential properties off Gale Street followed by rural land.
- West – The remaining township of Coramba including residential properties and shops.

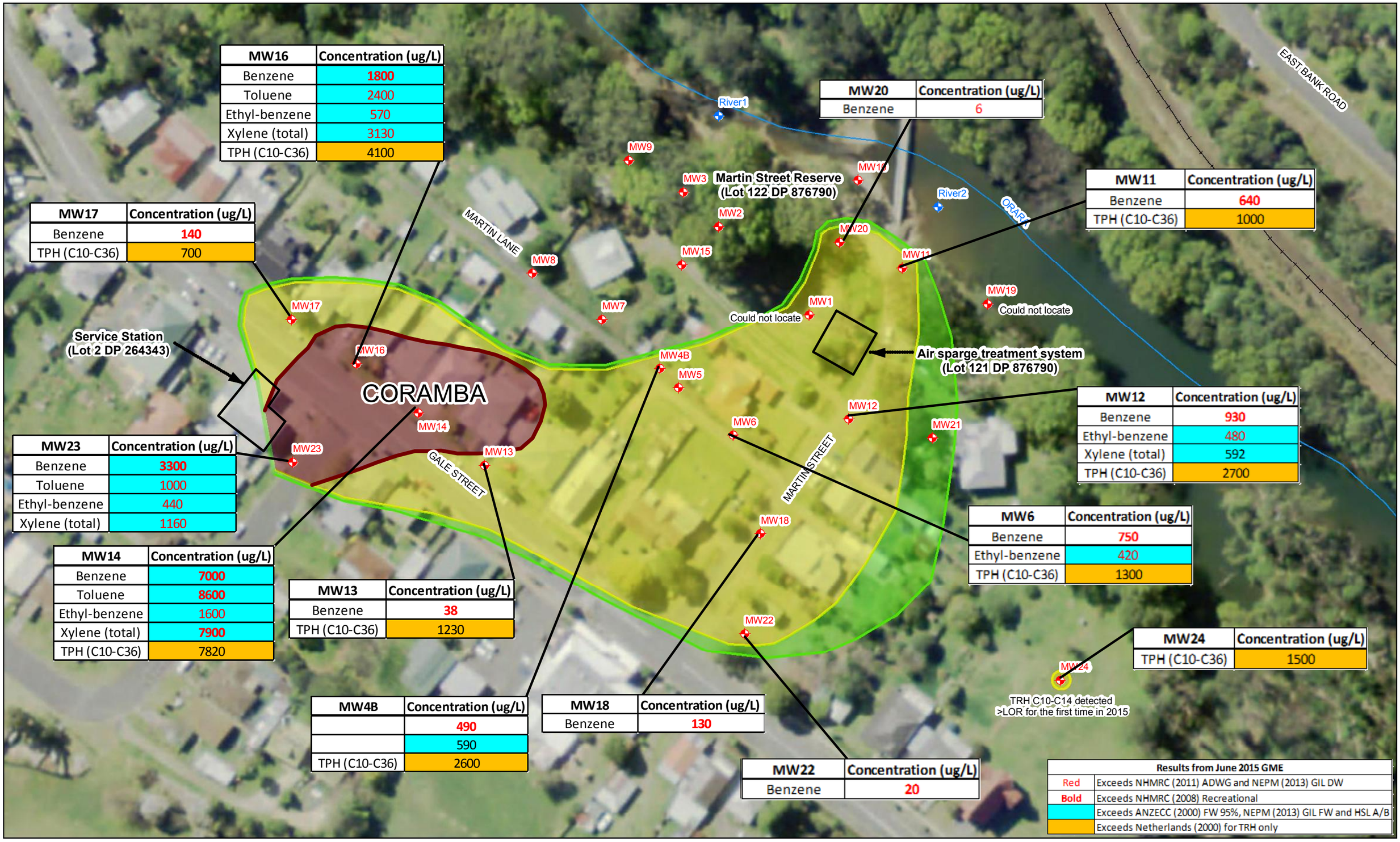
2.2 Site history

Following the discovery of the leaking fuel tank in 2002 the leaking tank and contaminated soil were removed and managed in accordance with guidelines and legislative requirements that were relevant at the time. A number of investigations have been undertaken at the site, including an environmental assessment and subsequent remedial action plan, which were undertaken by WSP in 2006. The preferred remedial approach was identified as the soil vapour extraction and air sparge system, which was installed in 2011 and operated sporadically from 2011 and then continuously for over 18 months from July 2013 to reduce the hydrocarbon impact. The system was shut down on 3 March 2015, and while it is no longer in operation, it is still in situ. A baseline groundwater monitoring event was undertaken in March 2015 to document groundwater conditions at the time of treatment system shut down, and a further monitoring event was undertaken in June 2015 to assess whether a groundwater contamination rebound has occurred since the shut-down.

In June 2011, Council entered in a Voluntary Management Proposal (VMP) with the NSW Environmental Protection Authority (EPA), however recent groundwater monitoring results may lead to the land declaration issued under the Contaminated Land Management Act 1997 (CLM Act) being lifted and the GMP forming the basis of a s28 Maintenance Order under the CLM Act.

2.3 Contamination extent

Groundwater monitoring of the existing wells was undertaken in 2006, 2008 and has been undertaken annually by WSP since 2011. The most recent groundwater monitoring event (GME) was undertaken in June 2015, three months after the air sparge treatment system was turned off. Results indicate that the overall groundwater contamination appears to be decreasing or stabilising, however nine wells still contain Benzene, Toluene, Ethylbenzene, Xylene (BTEX) and Total Recoverable Hydrocarbon (TRH) concentrations above the adopted groundwater assessment criteria. These impacted wells are located adjacent to the service station and extend down to the Orara River. A dissolved benzene plume has been identified in the vicinity of the service station, which is reportedly decreasing in size, however contaminant impact was still identified as far down gradient as the Orara River (see Figure 2-1).



MW16	Concentration (ug/L)
Benzene	**1800**
Toluene	2400
Ethyl-benzene	570
Xylene (total)	3130
TPH (C10-C36)	4100

MW20	Concentration (ug/L)
Benzene	6

MW11	Concentration (ug/L)
Benzene	**640**
TPH (C10-C36)	1000

MW17	Concentration (ug/L)
Benzene	**140**
TPH (C10-C36)	700

MW12	Concentration (ug/L)
Benzene	**930**
Ethyl-benzene	480
Xylene (total)	592
TPH (C10-C36)	2700

MW23	Concentration (ug/L)
Benzene	**3300**
Toluene	1000
Ethyl-benzene	440
Xylene (total)	1160

MW6	Concentration (ug/L)
Benzene	**750**
Ethyl-benzene	420
TPH (C10-C36)	1300

MW14	Concentration (ug/L)
Benzene	**7000**
Toluene	**8600**
Ethyl-benzene	1600
Xylene (total)	**7900**
TPH (C10-C36)	7820

MW13	Concentration (ug/L)
Benzene	**38**
TPH (C10-C36)	1230

MW24	Concentration (ug/L)
TPH (C10-C36)	1500

MW4B	Concentration (ug/L)
	490
	590
TPH (C10-C36)	2600

MW18	Concentration (ug/L)
Benzene	**130**

MW22	Concentration (ug/L)
Benzene	**20**

Results from June 2015 GME	
Red	Exceeds NHMRC (2011) ADWG and NEPM (2013) GIL DW
Bold	Exceeds NHMRC (2008) Recreational
	Exceeds ANZECC (2000) FW 95%, NEPM (2013) GIL FW and HSL A/B
	Exceeds Netherlands (2000) for TRH only

Paper Size A3

0 5 10 20 30 40

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 55

N

LEGEND

- SiteFeatures
- River Sampling Locations
- Groundwater MW Locations
- Benzene Plume June 2015 (> FW 95% and HSL A/B)
- TRH and/or BTEX >LOR 2015
- TRH and/or BTEX exceeded assessment criteria 2015
- Railway
- Rivers

GHD

Coffs Harbour City Council
Coramba Groundwater Monitoring

Job Number	22-18605
Revision	B
Date	01 Dec 2016

Contamination Extent

Figure 2.1

N:\AU\Coffs Harbour\Projects\22\18605\GIS\Maps\Deliverables\22_18605_Fig_04_InterpretedExtent2015_Rev_B.mxd

230 Harbour Drive Coffs Harbour NSW 2450 Australia T 61 2 6650 5600 F 61 2 6650 5601 E cfsmail@ghd.com W www.ghd.com

Data source: NSW LPI, DCDB (2012) / Aerial Imagery (2015). Created by:slmartin

3. Roles and responsibilities

Key personnel and environmental management responsibilities in the implementation of the OMP are outlined in Table 3-1.

Table 3-1 OMP Roles & responsibilities

Role	Responsibilities
CHCC	CHCC is responsible for the overall implementation of the OMP and management issues at the site. Key responsibilities include: • Reviewing and endorsing the OMP where required. • Maintaining compliance with relevant legislation and requirements. • Recording odour complaints. • Responding to odour complaints. • Implementing contingency plan if required. • Overseeing groundwater monitoring works to ensure compliance with relevant standards and statutory requirements. • Liaising with and reporting to EPA where required. • Liaising with stakeholder agencies and community groups where required. • Approving any reports prior to submission to relevant authorities.
EPA	EPA is responsible for advising CHCC of the regulatory requirements involved for the appropriate management of the site. Key responsibilities include: • Reviewing and endorsing the OMP where required. • Being kept informed of any odour issues. • Overseeing the groundwater reporting. • Providing advice on management measures required to meet statutory requirements.
Environmental Consultant	The Environmental Consultant is to be a suitably qualified and experienced person who will respond to requests from CHCC, which may include: • Providing technical advice on best management practice and recommending measures or actions to deal with issues as they arise. • Undertaking additional groundwater sampling where required. • Undertaking odour assessment where required. • Reviewing the adequacy of the odour management plan and compliance with statutory requirements.

4. Contingency measures

The following management measures are to be undertaken if an odour complaint is received:

- Conduct further discussions with complainant and conduct a site visit to investigate the complaint.
- Engage an environmental consultant to provide recommendations which may include:
  - Scheduling an additional groundwater monitoring round – in the event that odour issues are identified, it is recommended to undertake a sampling event as soon as possible to determine if contaminant concentrations have rebounded and are causing the odour issues. The results of this sampling event may trigger further action, such as recommencement of the air sparging treatment system, as outlined in the GMP.
  - Undertaking air/odour sampling – if numerous odour complaints are received it may be necessary to undertake air/odour sampling to determine where, when and for how long the odour issues are occurring and whether any potential health impacts are occurring.

5. Incident response and complaints procedure

5.1 Incident response

In the unlikely event that odour incidents occur with potential or actual human health impacts, Table 5-1 outlines the organisations that may be contacted.

Table 5-1 Emergency contact details

Agency	Contact
Police / Fire / Ambulance	000
Hospital	345 Pacific Highway, Coffs Harbour 02 6656 7000
NSW Health	1300 555 555
EPA	131 555
Coffs Harbour City Council	02 6648 4000

5.2 Complaints procedure

A legible record of all complaints in relation to odour issues arising from the site must include:

- The date and time of the complaint.
- The method by which the complaint was made.
- Any personal details of the complainant which were provided by the complainant or, if no such details were provided, a note to that effect.
- The nature of the complaint.
- The action taken in relation to the complaint, including any follow-up contact with the complainant.
- If no action was taken, the reason why no action was taken.

The record must be kept for at least 4 years after the complaint was made and be made available to any EPA authorised officer if requested.

GHD

230 Harbour Drive
Coffs Harbour
T: 61 2 6650 5600 F: 61 2 6650 5601 E: cfsmail@ghd.com

2218605-26362/https://projects.ghd.com/OC/Newcastle/chcccorambagroundwat/Delivery/Documents/2218605_REP_GHD_Coramba Odour Management Plan.docx

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
0	S.Martin	I.Gregson		I.Gregson		01/02/2017

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0	S.Martin B.Cork	I.Gregson		I.Gregson		01/02/2017

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