APPENDIX 17

Perth Airport Rail Link - Sampling and Analysis Plan (GHD, 2014b)

Included as a separate hard copy report

Public Transport Authority

Perth Airport Rail Link

Sampling and Analysis Plan

February 2014

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1. Introduction

GHD Pty Ltd (GHD) was commissioned by the Public Transport Authority (PTA) to develop a sampling and analysis plan (SAP) including acid sulfate soils (ASS) sampling program for the three proposed 'Perth Airport Rail Link' alignments herein referred to as 'the alignments' (Figure 1).

GHD understands that the PTA is currently developing a Project Definition Plan for the Perth Airport Rail Link project to connect the city with the airport. The PTA has identified the requirement to commence investigations to assess the likelihood of contamination and ASS being present intersecting the alignments.

The SAP is based on the preliminary conceptual site model (CSM) developed during the preliminary site investigation (PSI) undertaken by GHD (GHD 2013). The broad CSM as presented in section 3 is based on the current understanding of the proposed development and location of the alignments and considers potential risks without identifying any incomplete linkages too early in the project. The PTA currently considers a number of different alignment and construction options which limits the development of a more specific CSM. GHD and PTA acknowledge that the CSM may require change and revision once more information becomes available about the project. Additional information may also allow more specific pathway and receptor discussions for the construction versus the operation phase. Furthermore, the PTA has advised that they may also require for this SAP to be implemented in stages.

The ASS sampling program is provided in *Perth Airport Rail Link, Acid Sulfate Soils Sampling and Analysis Plan*, report for Public Transport Authority, November 2013 (GHD 2013a).

1.1 Proposed development

Growth of aviation services into and from Perth Airport has created the need to address the transportation demands. This has been recognised by the state and federal governments and Perth Airport Pty Ltd (PAPL). Construction of a rail line connecting Perth city to the airport is an option which the state government is exploring to improve transportation links and cater for the predicted future demand.

The PTA has developed three alignment options for the western half of the Perth Airport Rail Link. All three alignments merge as they enter Perth Airport and then follow a single alignment to a terminus adjacent to Dundas Road in High Wycombe. A brief description of each option is provided below.

- Surface option 1: A combination of elevated structures, at grade and subterranean sections of rail. Features unique to this alignment option are elevated structures at both the Tonkin Highway/Guildford Road and Tonkin Highway/Great Eastern Highway intersections and a cut and cover tunnel structure along Brearley Avenue. This option will be identical to the tunnel option beyond the domestic airport;
- Surface option 2: A combination of at grade and subterranean sections of rail. Features unique to this alignment option are cut and cover tunnel structures at the intersections of Tonkin Highway/Guildford Road, Tonkin Highway/Great Eastern Highway and Tonkin Highway/Stanton Road. This option will be identical to the tunnel option beyond the domestic airport; and
- Tunnel option: This option is a bored tunnel for the entire length of the alignment.

The SAP is proceeding ahead of finalising the alignment route and work packages would be unlikely to have been prepared for each stage of the construction. A brief description of the

construction methodology associated with both bored tunnels and cut and cover tunnel structures is provided below.

1.1.1 Bored tunnel

Bored tunnels will be constructed using a tunnel boring machine (TBM). TBMs are commonly used to construct road and railway tunnels where access to the surface is not possible, such as dense urban areas, rivers, hills and mountains and airports. The TBM starts and terminates from a concrete box structure that is excavated to the required depth, nominally 15 m below ground level (bgl). The TBM will excavate and line a circular shaped tunnel 6.7 m in diameter. The top of the tunnel is approximately 7 m bgl and the base is approximately 14 m bgl. Dewatering is only required to facilitate construction of the concrete box structures used for launching and retrieving the TBM.

1.1.2 Cut and cover tunnel

Cut and cover tunnels have a rectangular box shape and are constructed from the ground surface using a 'top down' methodology. The 'top down' construction process consists of first digging deep trenches in the ground and filling them with concrete walls. After the walls are constructed, the tunnel roof slab is built from precast concrete planks laid between the walls. The soil is then excavated from below the roof slab down to the base level. This construction method requires dewatering to facilitate construction.

1.2 Purpose of the report

The aim of the SAP is to develop a sampling rationale in accordance with the Department of Environment Regulation (DER) *Contaminated Sites Management Series* guidelines which will address the Potential Areas of Environmental Concern (PAEC) identified in the PSI.

1.3 Objective

The objectives of the investigation as developed in the SAP are to

- Assess the nature and likely extent of contamination, including uncontrolled fill, fly-tipping wastes and groundwater pollution, at the alignments and which could have a material impact on the construction and operation of the development; and
- Obtain information regarding contaminant types and locations to better inform construction and waste management plans which are expected to be required for the development.

The SAP report will be subject to accredited contaminated sites Auditor review.

1.4 Scope and limitations

This report has been prepared by GHD for Public Transport Authority and may only be used and relied on by Public Transport Authority for the purpose agreed between GHD and the Public Transport Authority as set out in section 1.2 of this report.

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

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

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation

to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

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

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

The opinions, conclusions and any recommendations in this report are based on information obtained from the PSI (including the site inspection). Conditions at other parts (non-publicly or not physically accessible) of the alignments may be different from the conditions found at the publicly or physically accessible areas inspected.

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

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

2. Site definition

The alignments for the Perth Airport Rail Link are long linear features and currently the decision by PTA on a final alignment has not been made.

For the purpose of this investigation, the alignments are qualitatively defined as:

- Surface option 1: A combination of elevated structures, at grade and subterranean, sections of rail;
- Surface option 2: A combination of at grade and subterranean sections of rail; and
- Tunnel option: This option is a bored tunnel for the entire length of the alignment (Figure 1).

The vertical component of the alignments is further described (as advised by the PTA) below and outlined in Figure 1:

- The western section of the alignments follow the existing rail infrastructure and any additional construction works will be at grade with only shallow (< 1 m) disturbance.
- From the point where the alignments are parting the existing rail corridor to where the three alignments join west of the domestic terminal water table disturbance to facilitate construction of the concrete box structures, for cut and cover (i.e. dewatering) or pilling is assumed. A small section of surface option 1 to the north of Tonkin Highway located between the Guildford Road entry and exit ramps and just east of Dunstone Road will be at grade with only shallow (< 1 m) disturbance.
- All options will be constructed using a TBM from the western side of the airport to the eastern side of the freight rail line. No dewatering is required and ground disturbance will only be occurring between 7 m and 14 m bgl.
- The final section of the alignments east of the freight rail line will require dewatering to facilitate construction of the concrete box structure used for launching the TBM.

2.1 Certificate of title

The PTA supplied all current certificates of title (CoTs) intersecting with the alignments and 20 m to either side (see Figure 6 in GHD PSI 2013). The alignments intersect (from west to east) three local government areas: City of Bayswater, City of Belmont and Shire of Kalamunda and various zoning types: urban, primary regional roads, parks and recreation, public purposes, industrial, other regional roads and railways. Copies of all current CoTs and summary tables are presented in Appendix B and a table outlining the alignment coordinates in Appendix C in the GHD PSI (GHD 2013).

In summary, the review of CoT for the proposed alignment identified the following:

- None of the CoTs identified a memorial or classification under the *Contaminated Sites Act 2003*.
- The lots intersecting with the alignments comprise a mix of freehold and Crown Land and include residential, road, railway, airport, main drain and electrical sub-station land uses.
- The review of the CoTs highlighted that one lot intersected by the alignments is zoned as ‘electricity sub-station’ (Lot 10565, DP 216183). The historical aerial review confirmed this is only a proposed zoning and no substation has been located at this location in the past.

3. Preliminary conceptual site model

The *Contaminated Sites Act 2003* defines “contaminated” as “having a substance present in or on that land, water or site at above background concentrations that presents, or has the potential to present, a risk of harm to human health, the environment or any environmental value”. Therefore, for a site to be considered “contaminated” there needs to be a risk (i.e. a source, pathway and receptor) that has either materialised, or has the potential to materialise (DEC 2006).

3.1 Potentially sensitive receptors

Based on a review of surrounding land uses and activities at lots intersecting the alignments (GHD 2013), sensitive environmental and human receptors that may be affected by any potential soil and groundwater contamination include the following:

- Visitors and workers;
- Users of registered and unregistered groundwater bores in surrounding areas hydraulically down-gradient of groundwater contamination (i.e. domestic/household bores, council irrigation bores) or affected by potential dewatering;
- Environment: the Bayswater main drain, Swan River and various surface drainage features are intersecting the alignments. Various wetlands are located within 500 m to the alignments (GHD 2013); and
- Property: with respect to ASS disturbance, acidic ground conditions and groundwater seepage into tunnel post-construction.

3.2 Preliminary conceptual site model

The potential contaminants of concern, along with the potential pathways and receptors are summarised in Table 1 below. The CSM includes primary and secondary release pathway mechanisms.

The broad CSM as presented in Table 1 is based on the current understanding of the proposed development and location of the alignments and considers potential risks without identifying any incomplete linkages too early in the project. The PTA currently considers a number of different alignment and construction options which limits the development of a more specific CSM. GHD and PTA acknowledge that the CSM may require change and revision once more information becomes available about the project. Additional information may also allow more specific pathway and receptor discussions for the construction versus the operation phase.

The preliminary CSM is largely focused on shallow soils and surface workers; therefore, any risks in regards to dermal contact for tunnelling will be reconsidered where applicable at a later stage.

Table 1 Preliminary conceptual site model

Potential area of environmental concern (PAEC)	Contaminants of potential concern	Pathways	Receptors
INTERSECTING THE ALIGNMENTS			
PAEC 2: former CSBP fertilizer manufacturing plant	acidity, metals and nutrients	Dermal contact with and ingestion of dewatering water	Workers
		Lateral and vertical migration via preferential flow paths enhanced by dewatering activities and direct contact	Bore users (registered or unregistered) Environment Property damage
		Groundwater seepage into tunnel post-construction	Visitors and workers Property damage
PAEC 3: JOSF	hydrocarbons, MTBE, lead, PFOS	Dermal contact with, inhalation (vapours) and ingestion of dewatering water	Visitors and workers
		Lateral and vertical migration via preferential flow paths enhanced by dewatering activities and direct contact	Bore users (registered or unregistered) Environment
		Groundwater seepage into tunnel post-construction	Visitors and workers Property damage
PAEC 6: fuel line	Hydrocarbons, MTBE	Inhalation (vapours)	Visitors and workers
		Groundwater seepage into tunnel post-construction	Visitors and workers Property damage
PAEC 7: Access Park	TRH, MTBE, PAH, DCE, metals and nutrients	Dermal contact with, inhalation (vapours) and ingestion of dewatering water	Workers
		Lateral and vertical migration via preferential flow paths enhanced by dewatering activities and direct contact	Bore users (registered or unregistered) Environment
		Groundwater seepage into tunnel post-construction	Visitors and workers Property damage
PAEC 10: fly-tipping and stockpiles	metals, TRH, MTBE, PAH, OCP and ACM	Dermal contact, inhalation (dust and fibres) and ingestion	Visitors and workers
PAEC 11: ACM fly-tipping and fragments	ACM	Inhalation of fibres if integrity of material is compromised	Visitors and workers

Potential area of environmental concern (PAEC)	Contaminants of potential concern	Pathways	Receptors
PAEC 12: ACM fragments	ACM	Inhalation of fibres if integrity of material is compromised	Visitors and workers
PAEC 13: stockpiles	metals, TRH, MTBE, PAH, OCP and ACM	Dermal contact, inhalation (dust and fibres) and ingestion	Visitors and workers
PAEC 15: stockpiles	metals, TRH, MTBE, PAH, OCP and ACM	Dermal contact, inhalation (dust and fibres) and ingestion	Visitors and workers
PAEC 9: acid sulfate soils	metals, acidity	If disturbed by earthworks or dewatering	Visitors and workers Bore users (registered or unregistered) Environment Property damage
PAEC 8: fill	metals, TRH, MTBE, PAH, OCP and ACM	If disturbed by earthworks dermal contact, inhalation (dust and fibres) and ingestion	Workers
PAEC 16: workshops	metals, TRH, MTBE, PAH, solvents, phenols	Dermal contact with, inhalation (vapours) and ingestion of dewatering water	Visitors and workers
		Lateral and vertical migration via preferential flow paths enhanced by dewatering activities and direct contact	Bore users (registered or unregistered) Environment
		Groundwater seepage into tunnel post-construction	Visitors and workers Property damage
WITHIN 500 M OF THE ALIGNMENTS			
PAEC 1: industrial area north of alignments	metals, OCP, TRH, MTBE, PAH	Dermal contact with, inhalation (vapours) and ingestion of dewatering water	Workers
		Lateral and vertical migration via preferential flow paths enhanced by dewatering activities and direct contact	Bore users (registered or unregistered) Environment
PAEC 4: Ansett	hydrocarbons, MTBE, phenolic compounds, solvents, PFOS	Dermal contact with, inhalation (vapours) and ingestion of dewatering water	Workers
		Lateral and vertical migration via preferential flow paths enhanced by dewatering activities and direct contact	Bore users (registered or unregistered) Environment
PAEC 5: Shell	hydrocarbons, MTBE, lead, PFOS	Dermal contact with, inhalation (vapours) and ingestion of dewatering water	Workers

Potential area of environmental concern (PAEC)	Contaminants of potential concern	Pathways	Receptors
		Lateral and vertical migration via preferential flow paths enhanced by dewatering activities and direct contact	Bore users (registered or unregistered) Environment
PAEC 9: acid sulfate soils	metals, acidity	If disturbed by earthworks or dewatering	Visitors and workers Bore users (registered or unregistered) Environment Property damage
PAEC 14: hire car services area	Hydrocarbon, MTBE, lead, PFOS	Dermal contact with, inhalation (vapours) and ingestion of dewatering water	Workers
		Lateral and vertical migration via preferential flow paths enhanced by dewatering activities and direct contact	Bore users (registered or unregistered) Environment
PAEC 17: various light industrial/commercial land use	metals, TRH, MTBE, PAH and OCP	Dermal contact with, inhalation (vapours) and ingestion of dewatering water	Workers
		Lateral and vertical migration via preferential flow paths enhanced by dewatering activities and direct contact	Bore users (registered or unregistered) Environment

Note: JOSF = Joint Operations Supply Facility, perfluorooctane sulfonate (PFOS), TRH = total recoverable hydrocarbons; MTBE = methyl tert-butyl ether, PAH = polycyclic aromatic hydrocarbons, OCP = organochlorine pesticides, ACM = asbestos containing material, DCE = cis-1,2-dichloroethene

4. Guideline framework for contamination assessment

4.1 Assessment guidelines

The legislation and guidelines that outline the appropriate framework for the site investigation are presented below.

- *Contaminated Sites Act 2003* and Contaminated Sites Regulations 2006 (DEC 2006a);
- *Airports Act 1996* and Airports (Environment Protection) Regulations 1997;
- DER *Contaminated Sites Management Series* guidelines;
- DER *Landfill Waste Classification and Waste Definitions 1996 (as amended December 2009)* (DEC 2009);
- DER *Assessment Levels for Soil, Sediment and Water* (DEC 2010);
- DER *Treatment and management of soils and water in acid sulphate soil landscapes* (DEC 2011);
- DER *Identification and investigation of acid sulfate soils and acidic landscape* (DEC 2013);
- Department of Health (DoH) *Guidelines for the Assessment, Remediation and Management of Asbestos-Contaminated Sites in Western Australia* (DoH 2009); and
- National Environment Protection Council (NEPC) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 No. 1* (NEPC 1999).

4.2 Soil assessment criteria

Ecological investigation levels (EILs), ecological screening levels (ESLs), relevant health investigation levels (HILs), health screening levels (HSLs) for vapour intrusion and management levels for hydrocarbons in soil will be adopted based on *NEPM Amendment 2013 No. 1* (NEPC 1999).

As the alignments will be used as a rail corridor, the appropriate HIL for soil results intersecting with the alignments in regards to construction works and future use would be HIL D/HSL D for “commercial/industrial”.

Furthermore, asbestos materials in soil will be assessed based on *NEPM Amendment 2013 No.1* which is based on the WA DoH guideline (DoH 2009).

The soil leachate results will be compared against relevant adopted groundwater criteria, which include the domestic non-potable groundwater use (DoH 2006), fresh waters (NEPC 1999), marine waters (NEPC 1999) and long-term irrigation water (DEC 2010) to determine if soil leachate could present a risk to human health or the environment.

Soil data collected on Commonwealth Land will also be assessed against the trigger levels specified in the Airports (Environment Protection) Regulations 1997.

4.3 Groundwater assessment criteria

Potential beneficial uses of groundwater are limited to off-site human receptors and sensitive discharge locations. Groundwater is not expected to be used as a source of potable water,

agricultural, irrigation or domestic uses within the alignments. The only on-site receptor considered is the exposure to dewatering water for construction workers.

Groundwater investigation levels (GILs) for fresh and marine waters and HSLs for vapour intrusion for petroleum hydrocarbons will be adopted base on *NEPM Amendment 2013 No. 1* (NEPC 1999) where applicable. The purpose of the HSLs is assessment of chronic human health risks. With respect to the receptors under consideration, GHD has adopted HSL D (commercial/industrial) as a conservative screening assessment.

Furthermore, groundwater results will be assessed against domestic non-potable groundwater use (DoH 2006) and long-term irrigation water (DEC 2010) where applicable.

Groundwater data collected on Commonwealth Land will also be assessed against the trigger levels specified in the Airports (Environment Protection) Regulations 1997.

4.4 Waste classification

Analytical soil results will be assessed against DER *Landfill Waste Classification and Waste Definitions 1996* (as amended December 2009) where soil is excavated or stockpiles are to be removed which provide guidance and criteria to determine the classification of wastes for acceptance to landfills in Western Australia.

It is proposed that any visual observation of ACM during the soil investigation will qualitatively indicate the material is potentially Special Waste Type 1 (waste which includes asbestos and asbestos cement products). Detailed characterisation of waste type will consider the most appropriate risk based criteria for disposal to licensed landfill.

5. Data quality objectives

The data quality objectives (DQOs) for the SAP are based on guidance presented in AS 4482.1 - 2005 (Standards Australia 2005). DQOs establish a framework for contamination investigations which incorporates a seven stepped continuum that defines the problem at the alignments. A series of stages then optimises the design of the investigation. The seven steps are outlined below:

- Step 1: State the problem;
- Step 2: Identify the principal study question;
- Step 3: Inputs to the decision;
- Step 4: Boundaries of the study;
- Step 5: Decision rules;
- Step 6: Tolerable limits on decision errors;
- Step 7: Optimisation of the data collection process;

An overview of the DQOs for the SAP is presented in the following sections.

5.1 Step 1: State the problem

With respect to contamination and ASS are the alignments suitable for the proposed future land use? What impact will dewatering have on potential groundwater contamination and ASS?

5.1.1 Identify members of the investigation team

Table 2 Investigation team

Role	Organisation
Client	Public Transport Authority
Regulator	Department of Environment Regulation outside of Commonwealth Land
Auditor	Jason Clay (AECOM Australia Pty Ltd)
Consultant	GHD Pty Ltd

5.1.2 Specify available resources and constraints

Resources

PTA and PAPL provided GHD with previous environmental reports and correspondence between stakeholders which provides details to prepare the SAP.

Constraints

The choice of sampling locations is constrained by above ground and underground services and land access (especially for third party property and airport land).

The SAP is proceeding ahead of finalising the alignment route and work packages and is based on the current understanding of the proposed development. GHD and PTA acknowledge that the CSM and SAP may require change and revision once more information becomes available about the project.

5.2 Step 2: Identify the principle study question

5.2.1 Identify the principle study question

Is there an unacceptable human health or environmental risk on-site that would deem the alignments unsuitable for their future use or restrict the development options?

Is there potential groundwater contamination located off-site that could be mobilised by the proposed development and subsequently cause an unacceptable risk to human health or the environment?

5.2.2 Identify alternative actions that could result from resolving the principle study question

Following investigation of areas outlined in section 6, findings may identify there is no unacceptable risk to human health or the environment. No further action would be required.

Should contamination present pose an unacceptable risk to human health or the environment further investigation, remediation or treatment may be required.

5.2.3 Combine the principle study question and alternative actions into a decision statement

Establish where contaminant concentrations or potential ASS (PASS) exceed the investigation or risk based action levels thus requiring further assessment and where no further action is required.

5.3 Step 3: Identify the inputs to the decision

5.3.1 Identify the information that will be required to resolve the decision statement

The following information will be required:

- Soil sampling and laboratory analysis to determine that soil does not pose an unacceptable risk to human health and the receiving environment; and
- Groundwater sampling and laboratory analysis to determine that groundwater on- and off-site does not pose an unacceptable risk to human health and the receiving environment.

5.3.2 Determine the sources for each item of identified information

The following sources of information will be required:

- Previous investigations;
- Collection of soil samples at appropriate locations;
- Collection of groundwater samples at appropriate locations;
- Geological observations made during groundwater monitoring well installation; and
- Chemical data obtained through analysis of collected soil and groundwater samples.

5.3.3 Identify the information needed to establish the action level

The action levels adopted during this investigation are outlined in section 4.

5.3.4 Confirm the appropriate analytical methods exist to provide the necessary data

Laboratory analytical methodologies are accredited under the standards set by the National Association of Testing Authorities (NATA).

5.4 Step 4: Define the study boundaries

5.4.1 Specify the characteristics that define the population of interest

The population of interest can be characterised as soil and groundwater (i.e. unconfined aquifer) in the targeted areas of interest (section 6).

5.4.2 Define the spatial boundaries of the decision

The alignments are shown in Figure 1 and defined in section 2.

5.4.3 Define the temporal boundaries of the decision

The timeframe for this scope of work exists until more information becomes available about the project which may require change and revision of the CSM and SAP.

The PTA has advised that this may also require for this SAP to be implemented in stages.

5.4.4 Define the scale of decision making

The sampling rationale is discussed in section 6. The scale of the decision making is limited to the alignments and the identified receptors to date.

5.4.5 Identify any practical constraints on data collection

Constraints on data collection are as set out in section 5.1.2. All proposed targeted locations will be subject to access and stakeholder approval.

5.5 Step 5: develop a decision rule

5.5.1 Specify the statistical parameter that characterises the population of interest

Decision rules for the selection of soil and groundwater sampling locations include reference to:

- DER *Assessment Levels for Soil, Sediment and Water* (DEC 2010) and
- NEPC *NEPM Amendment 2013 No. 1* (NEPC 1999)

The proposed soil and groundwater sample locations will be based on a systematic and targeted approach.

5.6 Step 6: Specify limits on decision errors

5.6.1 Baseline decision

Concentrations in soil and groundwater as per the assessment criteria outlined in section 4.

5.6.2 Acceptable limits on decision errors

Measurement error is controlled by the application of data quality indicators in accordance with AS 4482.1 (Standards Australia 2005). Quality assurance/quality control procedures are provided in section 9 of the SAP.

5.7 Step 7: Optimise the design

The SAP has been prepared with regard to the DER *Contaminated Sites Management Series* guidelines.

To maintain the integrity and reliability of data, the following measures were adopted:

- Groundwater will be purged and sampled using low flow techniques;
- Strict adherence to QA/QC protocols; and
- Use of suitable laboratory limits of reporting.

This SAP will be provided to PTA and the contaminated sites Auditor for review and approval prior to implementation.

6. Sampling rationale

The sampling rationale presented in Table 3 is based on the preliminary CSM (section 3) developed from the PSI (GHD 2013). Proposed monitoring well locations are outlined in Figure 2.

Table 3 Sampling rationale

Potential area of environmental concern (PAEC)	Proposed investigation	Analytes	Rationale
INTERSECTING THE ALIGNMENTS			
PAEC 3: JOSF	Soil bore investigation (MW3-01 to MW3-19, Figure 2). Scope option 1: utilise existing bores (subject to gaining access to the monitoring bores and them being in a serviceable condition) or Scope option 2: All soil bore locations will be converted into groundwater monitoring wells. Installation of 19 groundwater monitoring wells across PAEC 3. Every second well to be nested (shallow and intermediate, e.g. MW3-01S/I, Figure 2).	Groundwater: Victoria Environmental Protection Authority (Vic EPA) screen, MTBE, PFOS, major anions and cations, acidity and nutrients Soil: Vic EPA screen, 10% for total iron, cation exchange capacity, total organic carbon, clay content (%) and grain size distribution	Collect data on the status of soil and groundwater quality in this area due to historical fuel storage. Sampling locations are focused near the alignments and fan out across the potentially affected area. Intermediate depth wells target the middle portion of the Superficial aquifer (i.e. screens nominally to be located between 12.5 m and 15.5 m below ground level (bgl) based on the anticipated depth of the base of the Superficial formations shown in the *Perth Groundwater Atlas* [DoW 2013]). Further information on the placement of intermediate well screens is located in section 7.2.3).
PAEC 6: fuel line	Installation of three shallow groundwater monitoring wells (MW6-01 to MW6-03, Figure 2) west of the alignments and soil sampling at capillary fringe.	Groundwater: Vic EPA screen, MTBE, PFOS, major anions and cations, acidity and nutrients Soil: Vic EPA screen	One well is located at the northern bend of the fuel line, one where the fuel line is intersecting the alignment and one south of the alignment at even spacing (approximately 50 m). Located hydraulically down-gradient from the fuel line. Development in this area will be by tunnelling where no interference with potential contaminated groundwater is assumed.
PAEC 7: Access Park	Installation of one shallow groundwater monitoring well (MW7-01, Figure 2) south of the alignments and soil sampling at capillary fringe.	Groundwater: Vic EPA screen, MTBE, major anions and cations, acidity and nutrients Soil: Vic EPA screen	Location of well hydraulically down-gradient of source at closest intersection with alignment.

Potential area of environmental concern (PAEC)	Proposed investigation	Analytes	Rationale
PAEC 10: fly-tipping and stockpiles	Stockpile sampling based on number and size of stockpiles (NEPC 1999). The stockpile sample locations are not included in Figure 2 as depended on stockpile locations and size at the time of sampling.	Metals, TRH, PAH, OCP and absence/presence for asbestos	Targeted soil samples for waste classification.
PAEC 11: ACM fly-tipping and fragments	Step 1: Undertake a site walkover and record co-ordinates of all stockpiles, fly-tipping and ACM, photographic log and description of waste type, sample ACM fragments for laboratory asbestos identification. If required based on NEPM Amendment 2013 No. 1 Step 2: Undertake a grid based sampling programme incorporating 21 sample locations (approximate 1 ha area) within the PAEC where ACM and waste stockpiles are observed (i.e. the number of samples to be based on DoH requirement and to be skewed towards visible ACM and fly tipping). The grid sampling locations are not included in Figure 2 as depended on fly-tipping observed during the site walkover.	Absence/presence for asbestos	Identification of fly-tipping, confirmatory analysis of asbestos fragments and grid soil samples to identify asbestos impact in surface soils from fly-tipping.
PAEC 12: ACM fragments	Sampling of suspect ACM for confirmatory analysis.	Absence/presence for asbestos	Confirmatory analysis.
PAEC 13: stockpiles	Stockpile sampling based on number and size of stockpiles (NEPC 1999). The stockpile sample locations are not included in Figure 2 as depended on stockpile locations and size at the time of sampling.	Metals, TRH, PAH, OCP and absence/presence for asbestos	Targeted soil samples for waste classification.

Potential area of environmental concern (PAEC)	Proposed investigation	Analytes	Rationale
PAEC 15: stockpiles	Stockpile sampling based on number and size of stockpiles (NEPC 1999). Step 1: Undertake a site walkover and record co-ordinates of all stockpiles, fly-tipping and ACM, photographic log and description of waste type, sample ACM fragments for laboratory asbestos identification. If required based on NEPM Amendment 2013 No. 1 Step 2: Undertake a grid based sampling programme incorporating 21 sample locations (approximate 1 ha area) within the PAEC where ACM and waste stockpiles are observed (i.e. the number of samples to be based on DoH requirement and to be skewed towards visible ACM and fly tipping). The stockpile and grid sampling locations are not included in Figure 2 as depended on fly-tipping and stockpiles observed during the site walkover.	Metals, TRH, PAH, OCP and absence/presence for asbestos	Targeted soil samples for waste classification. Identification of fly-tipping, confirmatory analysis of asbestos fragments and grid soil samples to identify asbestos impact in surface soils from fly-tipping.
PAEC 9: acid sulfate soils	Refer to *Perth Airport Rail Link, Acid Sulfate Soils Sampling and Analysis Plan*, report for Public Transport Authority, October 2013 (GHD 2013a)		
PAEC 8: fill (refer to note below)	Soil bore investigation at proposed locations of the Airport West Station and Airport Station, the amount of grid sample locations will be based on the area size required for the station construction (Table E1, AS 4482.1-2005). The soil bore locations are not included in Figure 2 as GHD has not been provided with a plan for the proposed construction sites of the Airport Station West and Airport Station by the PTA.	Metals, TRH, PAH, OCP and absence/presence for asbestos	Due to anecdotal evidence from PAPL Environment Manger fill containing bonded asbestos is present in the vicinity of the International Terminal. Grid sampling to identify fill at the location of the proposed stations.
	All other potential fill encountered during construction works: No investigation required	na	Site management plan for all construction activities along the alignments should include the management of unidentified contamination/fill.

Potential area of environmental concern (PAEC)	Proposed investigation	Analytes	Rationale
PAEC 16: workshops	Installation of three shallow groundwater monitoring wells (MW16-01 to MW16-03, Figure 2) west of the workshops and north and south of the alignments and soil sampling at capillary fringe.	Groundwater: Vic EPA screen, MTBE, major anions and cations, acidity and nutrients Soil: Vic EPA screen	Investigate any potential groundwater contamination from current land use. Between surface drain and workshops.
WITHIN 500 M OF THE ALIGNMENTS			
PAEC 1: industrial area north of alignments and the existing rail line	Installation of six shallow groundwater monitoring wells (MW1-01 to MW01-06, Figure 2) north and south to allow for triangulation and soil sampling at capillary fringe.	Groundwater: Vic EPA screen, MTBE, major anions and cations, acidity and nutrients Soil: Vic EPA screen	Background groundwater quality from industrial area. Between Bayswater main drain and the alignments. The well should be located as close to the alignments as possible taking site restrictions and underground services into account. Approximately 100 m spacing used for higher risk areas. Triangulation for groundwater flow calculations but staggering the groundwater monitoring wells north and south of the alignments. Within road reserve to the north of the alignment.
PAEC 2: former CSBP fertilizer manufacturing plant	Scope option 1: utilise existing CSBP bores (if permissions are obtained and wells are still intact) or Scope option 2: installation of three nested (shallow and intermediate) groundwater monitoring wells (MW2-01S/I to MW2-03S/I, Figure 2) and soil sampling at capillary fringe.	Groundwater: Vic EPA screen, major anions and cations, acidity and nutrients Soil: Vic EPA screen	Investigate current condition of the acidity and heavy metals associated with the CSBP plume. Approximate 100 m spacing. Triangulation for groundwater flow calculations. Screens for intermediate wells nominally to be located between 17 m and 20 m bgl central in superficial aquifer (depth based on *Perth Groundwater Atlas* [DoW 2013]). Further information on the placement of intermediate well screens in section 7.2.3.
PAEC 4: Ansett	Installation of two shallow groundwater monitoring wells (MW4-01 and MW4-02, Figure 2) north-west and north of the former Ansett maintenance shed and south of the alignments and soil sampling at capillary fringe.	Groundwater: Vic EPA screen, MTBE, PFOS, major anions and cations, acidity and nutrients Soil: Vic EPA screen	Investigate any potential groundwater contamination from historical land use. Located as close to the workshop as possible.

Potential area of environmental concern (PAEC)	Proposed investigation	Analytes	Rationale
PAEC 5: Shell	Installation of three shallow groundwater monitoring wells (MW5-01 to MW5-03), Figure 2) north of the alignments and soil sampling at capillary fringe. Request to PAPL to allow access and sampling of existing bores within the existing plume (nominally two).	Groundwater: Vic EPA screen, MTBE, PFOS, major anions and cations, acidity and nutrients Soil: Vic EPA screen	Collect data on the status of soil and groundwater quality in this area due to historical fuel storage. Sentry wells located between the alignments and the source area. Approximate 20 m spacing.
PAEC 9: acid sulfate soils	Refer to *Perth Airport Rail Link, Acid Sulfate Soils Sampling and Analysis Plan*, report for Public Transport Authority, October 2013 (GHD 2013a)		
PAEC 14: hire car services area	Installation of one shallow groundwater monitoring well (MW14-01, Figure 2) north of the service area and south of the alignments and soil sampling at capillary fringe.	Groundwater: Vic EPA screen, MTBE, PFOS, major anions and cations, acidity and nutrients Soil: Vic EPA screen	Investigate any potential groundwater contamination from current land use. Located as close to the tanks as possible.
PAEC 17: various light industrial/commercial land use	Installation of eight shallow groundwater monitoring wells (MW17-01 to MW17-08) north and east of the alignments and soil capillary fringe samples.	Groundwater: Vic EPA screen, MTBE, major anions and cations, acidity and nutrients Soil: Vic EPA screen	Background groundwater quality from industrial/commercial land uses. Nominal spacing of 100 m will be used in the higher risk areas (predominance of light industry) and a spacing of >200 m in the low risk areas (predominance of residential). Between the industrial land use and the alignment: map 1 of 4 located in road reserve to the north of the alignments and in map 4 of 4 in PTA land to the east of the alignment

Vic EPA screen: total recoverable hydrocarbons (TRH), polycyclic aromatic hydrocarbons (PAH), phenols, organochlorine pesticides (OCP), polycyclic biphenyls (PCB), volatile organic compounds (VOC), vinyl chloride, dissolved metals: arsenic, cadmium, speciated chromium, copper, nickel, lead, silver, tin, molybdenum, selenium and zinc, total mercury, cyanide, total fluoride and pH; JOSF = Joint Operations Supply Facility; PFOS = perfluorooctane sulfonate, MTBE = methyl tert-butyl ether, na = not applicable; ACM = asbestos containing material

Note: Uncontrolled fill is inherently heterogeneous and has a high probability of containing ACM. Where it occurs within the alignment there will be a requirement to manage it conservatively, particularly with respect to ACM. PAPL has advised that fill used within the airport precinct potentially contains ACM. Consequently the following investigation strategy is recommended.

- To better inform the construction management plans which are expected to be required for the development, the nature and extent of fly-tipping, potential ACM waste and fill needs to be assessed where practicable; however, it is recognised the management plans will need to address potential changes to the site condition and unidentified contamination.
- In the event fill (where it occurs) is intended for re-use (i.e. not destined for landfill) there will be a requirement to further characterise it (this is not included in the present SAP).

7. Methodology

7.1 Health and safety

An approved job safety and environmental assessment (JSEA) will be prepared for review prior to beginning field work. A Pre-Work Safety Assessment will be completed prior to commencing work on-site, which involves reviewing the JSEA against the condition of the work environment on the day of field work. If there are any changes required to the JSEA these will be noted on the Pre-Work Safety Assessment and the job manager will be notified if field staff believe an unacceptable risk has been identified and cannot be managed on-site.

7.2 Groundwater investigation

7.2.1 Service location

GHD will obtain Dial Before You Dig site plans to identify any potential services at the locations of the sampling locations. However, it is recognised that this process does not always identify services on private land. We will request that the PTA provide copies of any available site or services survey plans. In addition, it is proposed that GHD commissions a suitably qualified underground utilities clearance contractor to aid in avoiding underground services during intrusive (drilling) works at the locations of all proposed groundwater monitoring wells.

7.2.2 Drilling technique

Groundwater monitoring wells will be installed using rotary auger drilling techniques if no other soil sampling but capillary fringe sampling is undertaken.

For PAEC 3 additional soil sampling is required and GHD propose to utilise direct push or sonic drilling techniques.

7.2.3 Groundwater monitoring well installation

Groundwater monitoring well construction will comply with the DER *Development of Sampling and Analysis Programs* Guideline (DEP 2001). The shallow groundwater monitoring wells will be drilled to a depth of 2 m below the groundwater table.

The purpose of intermediate depth wells is to assess potential ‘diving’ plumes. The intermediate groundwater monitoring wells will nominally be installed with the screened casing located central within the superficial aquifer (halfway between the groundwater table and base of the aquifer). Placement must be based on findings during the drilling. Note: for the purpose of this contamination assessment a clay layer (>20 cm thickness) is considered to be confining.

Groundwater monitoring wells will be constructed with the following specifications:

- 50 mm polyvinyl chloride (PVC) Class 18 blank and screened casings;
- Screened casing will extend 1 m above the groundwater level and 2 m below the groundwater level for shallow wells and central in the superficial aquifer for intermediate wells (3 m screen length). Refer to Table 3 for approximate screen depths.
- Screened casing slots will be no greater than 1 mm in width;
- Solid and screened PVC casing attached using flush mounted factory-threaded joints;
- Primary filter pack material will be a chemically inert material and well rounded, with a high coefficient of uniformity and will extent at least 0.5 m above the screened PVC casing;

- Bentonite pellets will be used as annular sealant and will extend at least 0.5 m above the filter pack;
- The annulus will be backfilled with grout; and
- Monitoring wells will be finished either at ground level with lockable trafficable steel covers or with lockable steel risers (where possible) and cement.

7.2.4 Groundwater monitoring well development

Groundwater monitoring wells will be developed using a mechanical pump which will remove at least four well volumes and will continue operation until water is relatively clear when pumped from the well. Well development is required to bring the well to its maximum production capacity. Monitoring well development optimises the well efficiency, specific capacity, stabilisation of aquifer material and control of suspended solids.

The newly installed groundwater monitoring wells will be allowed to stabilise for a minimum of seven days prior to purging and sampling.

7.2.5 Groundwater monitoring well surveying

Surveying of each well location will be undertaken following well installation. This will include surveying of the well locations to northings and eastings (accuracy +/- 30 mm) and elevation (accuracy +/- 5 mm) of ground surface and top of well casing to Australian Height Datum (AHD).

7.2.6 Groundwater sampling

The groundwater monitoring wells will be sampled after a settling period of one week. Any further sampling rounds can be discussed between GHD, PTA and the contaminated site Auditor as required.

Measuring groundwater depths

Groundwater levels (and thickness of any phase separated hydrocarbons) will be measured from the groundwater wells using an electronic interface water level meter prior to sampling. Measurements will be recorded on GHD groundwater monitoring forms.

The electronic interface water level meter will be cleaned in laboratory grade detergent and triple rinsed prior to use at each well.

Groundwater monitoring well purging

Purging of groundwater monitoring wells is essential to evacuate stagnant water in the well casing prior to sampling and to provide a representative sample of *in-situ* groundwater.

Purging of groundwater monitoring wells will be based on AS/NZS 5667.11 – 1998 (Standards Australia 1998). Field groundwater quality measurements for pH, temperature, oxidation-reduction potential (ORP or Eh), dissolved oxygen (DO), and electrical conductivity (EC) will be taken following each purge well volume to assess stabilisation of the well. Groundwater monitoring wells will be purged with a low-flow pumping technique (less than 1 L/minute) until stabilisation of field parameters has occurred, over three consecutive readings. Field measurements for chemical stabilisation parameters will be achieved using a multi-parameter water quality meter. The water quality meter will be calibrated by the supplier, prior to obtaining field measurements, using the appropriate probe and calibration solution. The calibration certificate will be provided in the subsequent investigation report.

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

- pH: 0.1 unit;

- Temperature: 0.2^{o} C;
- Eh (ORP): 10%;
- DO: 10%; and
- EC: 10%.

Field monitoring forms will be completed at each well, noting the general condition of the well, any visual or olfactory signs of groundwater contamination and purging stabilisation results.

Purging of groundwater monitoring wells will be achieved using low-flow pumping techniques. New tubing and new bladders (where required) will be used for each well to eliminate issues arising from cross-contamination through the repeated use of sampling equipment. The pump will be decontaminated following sampling of each well to prevent cross-contamination between wells.

Groundwater monitoring well sampling

Sampling of groundwater monitoring wells will be based on *AS/NZS 5667.1 – 1998* (Standards Australia 1998). The wells will be sampled using low-density poly-ethylene tubing coupled to a peristaltic or micro purge ('low flow') pump system (depending on sampling depth). The low flow pump provides an appropriate method for collection of representative samples for the required analytes and is recognised as best practice for groundwater sampling.

Any phase separated hydrocarbons encountered will be sampled using a bailer and submitted for 'fingerprint' analysis.

Groundwater samples will be obtained in accordance with *AS/NZS 5667.1 – 1998 water quality sampling – guidance of sampling groundwaters* (Standards Australia 1998). The purged volume and field parameters, showing stabilisation of parameters prior sample collection, will be recorded on field sheets. Samples will be placed into laboratory prepared containers provided by the primary laboratory. Heavy metals samples will be field filtered using a 0.45 micron filter prior to being placed in sample containers. Each sample will be identified by means of a label showing sample location, date and job number. The samples will then be transferred to a chilled esky for sample preservation prior to and during shipment to the testing laboratory.

Disposable nitrile gloves will be worn during sampling and handling of the laboratory prepared containers to ensure that cross-contamination is not introduced to the groundwater samples. The disposable gloves and various field work waste (e.g. paper towels, scrap paper, plastic wrappers) will be collected and disposed to landfill. Biodegradable disposables will be used wherever possible.

Sample details will be entered on to a CoC form that will accompany the samples to the laboratory. All samples will be transported and handled following CoC procedures. A CoC form will be used for every batch of samples submitted to the laboratory. Delivery of samples to the laboratory will comply with analytical extraction holding times.

All field work will be undertaken by an Environmental Scientist trained in sampling contaminated sites. The Environmental Scientist will undertake all groundwater monitoring and record on a groundwater field forms. Field activities will be conducted in general accordance with procedures outlined in GHD Field Work Procedures, which are based on accepted industry protocols for environmental sampling.

Decontamination of sampling equipment

To ensure groundwater samples are collected without the potential presence of cross-contamination, all sampling equipment will be decontaminated in accordance with the procedure and methods described in *AS 4482.1 – 2005* (Standards Australia 2005). In addition, all

samples will be handled by field staff using disposable nitrile gloves, which will be replaced between each sampling event.

Groundwater sampling equipment will be decontaminated as follows:

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

7.2.7 Disposal of drill cuttings and water

Drill cuttings, development water, purge water and rinse water will be collected and stored until chemical compositions are known. Appropriate disposal requirements for soil cuttings will be determined based on analytical data obtained for assessment.

7.3 Soil investigation

The soil investigation will be undertaken with reference to *Development of Sampling and Analysis Programs* guideline (DEP 2001) and *AS 4482 – 2005 Guide to the Sampling and Investigation of Potentially Contaminated Soil* (Standards Australia 2005).

7.3.1 Capillary fringe soil sampling

Discrete soil samples will be collected from the capillary fringe at each groundwater monitoring well location to assess possible presence of a smear zone.

Samples will be collected from the drill cuttings (rotary drilling will be used for groundwater well installations) using new disposable gloves and placed directly into laboratory provided sample jars.

7.3.2 Stockpile sampling

Stockpile sampling will be undertaken in accordance with the *NEPM Amendment 2013 No. 1* (NEPC 1999). The number of samples will be based on the stockpile volume (NEPC 1999). Samples should be taken at various depth towards the centre of the stockpile from 300 mm (for inorganic and non-volatile components) or from 500 mm (for volatile or semi-volatile components) below the stockpile surface.

Sample point distribution should be done systematically.

Samples will be collected directly into the laboratory containers by hand using a new pair of disposable nitrile gloves for each sample. Where it is impractical or unsafe to sample by hand a clean hand auger or shovel will be used to recover the sample. Any equipment used will be decontaminated as described in section 7.2.6.

The composition of the stockpile will be documented in a field form and photographs taken.

7.3.3 Asbestos containing material sampling

For any potential ACM material observed a representative sample will be taken for confirmatory analysis. The observed ACM will be documented in a field form and photographs taken. The location will be located using a hand held GPS.

7.3.4 Test pits

Test pits will be excavated using a mini excavator (e.g. 1.5 tonne bobcat) to a depth of 0.5 m bgl. This method has the advantage of allowing detailed soil logging and a DoH complainant asbestos investigation.

GHD recommends a DoH (DoH 2009) compliant asbestos investigation of sieving a 10 L bulk soil sample using a ≤7 mm sieve. Nominally two 10 L bulk samples will be sieved per test pit (at surface and at 0.5 m bgl). For any bulk asbestos containing material encountered the bulk samples will be double bagged, individually labelled, weighted and all observations regarding the condition and size of ACM will be recorded. Soil samples will be recovered as 500 mL samples into appropriate zip lock bags for laboratory fibre analysis (asbestos absence/presence) at locations where bulk ACM material is encountered.

7.3.5 Soil bores

Soil bores will be drilled using a direct push or sonic drill rig so that an undisturbed core is obtained.

Soil sampling will be undertaken at surface (0.0 m bgl), 0.5 m bgl, 1.0 m bgl and 1 m intervals to the bottom of hole (based on well installation requirement for each location or bottom of fill). Samples will be placed into laboratory prepared bags or containers and stored in an insulated container. Nominally for all soil bore locations the following samples will be send for laboratory analysis:

- Surface sample;
- All samples within fill material;
- Samples taken at the capillary fringe;
- Samples with visually/olfactory contamination indicators (including PID readings); and
- One sample within each natural stratum intersected.

A separate sample will be collected and a photo-ionisation detector (PID) will be used to assess volatiles within the sample headspace. PID samples will be collected by placing soil into a zip lock bag and allowing the samples to rest for a period of five minutes. The headspace sample will then be analysed by piercing the bag with the PID. PID readings will be recorded in the field lithological logs. PID calibration data will be presented in the report.

Note: A separate soil sample will be taken for asbestos fibre (absence/presence) analysis in soil at the proposed station locations (PAEC 8).

7.3.6 General soil sampling methodology

All samples will be visually inspected and all field observations and subsurface conditions recorded on field lithological logs. Photographs will be taken of the test pits, stockpiles, fly-tipping and soil cores. The photographs will show the soil profile, provide a reference for determining scale and be clearly illuminated. Co-ordinates of all stockpiles, fly-tipping and ACM will be recorded using a hand held GPS.

Each sample will be identified by means of a label showing sample location, date, job number and depth. The samples will be immediately transferred to a chilled esky for sample preservation prior to and during shipment to the NATA accredited analytical laboratory.

Sample details will be entered on to a CoC form that will accompany the samples to the laboratory. All samples will be transported and handled following CoC procedures. A CoC form will be used for every batch of sampled submitted to the laboratory. Delivery of samples to the laboratory will comply with analytical extraction holding times.

8. Laboratory program

The objective of the analytical program is to gather quantitative data on potential contamination that is of high quality, which is definitive and suitable for comparison against relevant assessment guidelines.

The nominated laboratories are NATA accredited for the specific analytical procedures. Methods are in accordance with the NEPM (NEPC 1999) *Schedule B3 Guidelines for the laboratory analysis of potentially contaminated soils* and have been developed with respect to the assessment levels outlined in section 4.

The detection limits and analytical methods followed for testing the relevant soil and groundwater analytes are presented in Table 4.

Table 4 Laboratory methods and laboratory limits of reporting

Analyte	Method	Soil limits of reporting (mg/kg)	Groundwater limits of reporting (mg/L)
Metals	US EPA 6010, 6020	0.1 - 10	0.0001-0.05
Chromium (hexavalent)	APHA 3500, US EPA 3060	1	0.001
Total recoverable hydrocarbons	LTM-ORG-2010	20 - 100	0.02 - 0.1
Benzene, toluene, ethylbenzene and xylene	US EPA 8260	0.1	0.001
Methyl tert-butyl ether	US EPA 8260	0.05	0.001
Polycyclic aromatic hydrocarbons	US EPA 8270, 8310, 8100	0.5	0.001
Organochlorine pesticides	US EPA 8081, 8270	0.05	0.0001
Polycyclic biphenyls	US EPA 8082	0.1	0.001
Phenols (speciated)	US EPA 8270	1	0.01
Vinyl chloride	US EPA 8121, 8270	0.1	0.001
Volatile organic compounds	USE PA 8260		
Cyanide	APHA 4500, US EPA 9010, 9013, 9014, 9213	5	0.005
Perfluorooctane sulfonate	US EPA 537 (version 1.1)	1 µg/kg	0.005 µg/L
Total fluoride	NEPM 404 or APHA 4500	100	0.02
pH	APHA 4500	0.1 units	0.1 units
Major ions	APHA 4500, 2320	-	0.05 - 20
Nutrients	APHA 4500	-	0.01 – 0.2
Asbestos (bulk and in soil)	Stereo and polarized light microscopy	Absence/presence	-
Total organic carbon	APHA 5310	50	-

'-' = not applicable, APHA = American Public Health Association, US EPA = United States Environmental Protection Agency

9. Quality assurance/quality control program

The quality assurance/quality control (QA/QC) procedures are based on DER's *Development of Sampling and Analysis Programs* guideline (DEP 2001) and AS/NZS 5667.1 – 1998 (Standards Australia 1998), AS/NZS 5667.11 – 1998 (Standards Australia 1998a) and AS 4482.1 - 2005 (Standards Australia 2005).

QA involves all of the actions, procedures, checks and decisions, undertaken to ensure the representativeness and integrity of samples and accuracy and reliability of analytical results (NEPC 1999). QC involves protocols to monitor and measure the effectiveness of QA procedures.

9.1 Field program

9.1.1 Field quality assurance procedures

All fieldwork will be conducted with reference to the DER's *Contaminated Sites Management Series* guidelines and GHD's Standard Field Operating Procedures which ensure all samples are collected by a set of uniform and systematic methods, as required by GHD's QA system. Key requirements of these procedures are listed below:

- Field instrument calibration checks: The following field calibrations checks will be undertaken on the equipment:
  - PID: The PID is supplied by the equipment supplier calibrated with an isobutylene solution. GHD will also undertake daily field calibration comprising zeroing in ambient conditions. Filters will be replaced daily.
  - Dipper: A daily equipment check will be undertaken to ensure that the equipment works correctly when immersed in water and that it has had no unauthorised repairs.
  - Low flow pump: The low flow sampling equipment is provided by the equipment supplier in good working condition. The equipment is inspected by GHD at the start of each day to ensure that all parts of the equipment are in good working order. GHD measures the volume of water purged during purging to ensure that the volume of water purged does not exceed 1 L per minute. The equipment flow rate is adjusted accordingly and purge volumes are recorded on the groundwater sampling field sheets.
  - Water quality meter: The water quality meter is supplied by the equipment supplier calibrated with appropriate calibration standards. GHD also undertakes daily field checks to ensure that the equipment is calibrated correctly by using pH, EC and DO calibration standards. If the meter is not reading these standards correctly, the water quality meter will be field calibrated in accordance with the manufacturer's instructions.
- Decontamination procedures – including washing and rinsing of re-useable equipment, the use of new disposable gloves and sampling tubing between each sampling location and the use of sampling containers provided by the laboratory;
- Sample identification procedures - samples are immediately transferred to sample containers of appropriate composition and preservation for the required laboratory analysis. All sample containers are clearly labelled with a sample number, job number, and sample date. The sample containers are then transferred to a chilled insulated container for sample preservation prior to and during shipment to the analytical laboratory;

- Chain of custody (CoC) information requirements - a CoC form is completed and forwarded to the testing laboratory with the samples; and
- Blind and split duplicate sample frequency.

9.1.2 Soil and groundwater sampling and analysis quality control

The DER *Development of Sampling and Analysis Programs* (DEP 2001) outlines soil and groundwater QC sampling protocol. The soil and groundwater QC samples to be collected during the investigation (or for each stage of the investigation) are described below.

- Blind duplicate: Blind samples are used to identify the variation in the analyte concentration between samples from the same sampling point.
- Split duplicate: Split samples provide an indication of the repeatability of the results between laboratories.
- Field blanks: Field blanks are used to estimate contamination of a sample during the collection procedure.
  - Field blanks are collected by pouring laboratory supplied deionised water into laboratory supplied bottles on-site. Field blanks are then kept cool in insulated containers until delivery to the laboratory.
- Rinsate blanks: Rinsate blank samples are used to estimate the amount of contamination introduced during the re-use of sampling equipment.
  - Rinsate blank samples are obtained by pouring laboratory supplied deionised water over decontaminated sampling equipment (e.g. drill bit, pump, interface meter) into laboratory supplied bottles. Rinsate blanks are then kept cool in insulated containers until delivery to the laboratory.
- Transport blanks: Transport blank samples are used to estimate the amount of contamination introduced during the transport and storage of samples from the time of sampling to the time of analysis.
  - Transport blank samples are provided by the laboratory prefilled with deionised water. Transport blanks were then transferred to a chilled esky for sample preservation prior to and during shipment to the laboratory.

Table 5 Soil quality control (QC) sampling frequency (per stage of works)

Sample	Recommended sampling rate	Laboratory analysis
Blind	1/20 samples	Same as primary sample
Split	1/20 samples	Same as primary sample
Field blanks	1/day	TRH, metals, BTEX
Rinsate blanks	1/equipment/day	TRH, metals, BTEX
Transport blanks	1/esky/day	TRH C_6 to C_9, BTEX

TRH = total recoverable hydrocarbons, metals = arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc, BTEX = benzene, toluene, ethylbenze and xylene

9.1.3 Relative percentage difference calculations

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

A quantitative measure of the accuracy of the analytical results reported is made by calculating the RPDs between the primary, blind and split results in accordance with the procedure described in AS 4482.1 – 2005 (Standards Australia 2005). According to AS 4482.1 - 2005 (Standards Australia 2005) typical RPDs are expected to range between 30% and 50%;

however, this may be higher for organics and for low concentrations of analytes. GHD uses 50% as the general assessment criteria.

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

9.2 Laboratory program

9.2.1 Laboratory analytical programs

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

9.2.2 Laboratory quality control procedures

The following laboratory QC procedures will be used during the investigation.

Laboratory duplicate samples

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

The permitted ranges for the RPD of laboratory duplicates are dependent on the magnitude of the results in comparison to the level of reporting as shown in Table 6 below.

Table 6 Permitted laboratory duplicate relative percentage difference (RPD) ranges

Magnitude of result	Permitted RPD range
< 10 x limit of reporting (LOR)	No limits
10 - 20 x LOR	0% - 50%
> 20 x LOR	0% - 20%

Method blank samples

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

Laboratory control samples

Laboratory control spike analysis is the analysis of either a reference material or a control matrix fortified with analytes representative of the analyte class. The purpose of laboratory control spike samples is to monitor method precision and accuracy independent of the sample matrix. Typically, the percentage recovery of the laboratory control spike sample is compared to the dynamic recovery limits based on the statistical analysis of the processed laboratory control spike sample analysis. Laboratory acceptance criteria indicate recoveries must generally lie between 70% and 130%.

Matrix spike samples

Matrix spike sample analysis is the analysis of one or more replicate portions of samples from the batch, after fortifying the additional portion(s) with known quantities of the analyte(s) of interest. The percentage recovery of target analyte(s) from matrix spike samples is used to determine the bias of the method in the specific sample matrix. Recoveries must generally lie between 70% and 130%.

Surrogate spike samples

Surrogate spike samples are samples with known additions of known amounts of compounds, which are similar to the analytes of interests in terms of extractability, recovery through clean-up procedures and response to chromatographic or other measurement. Surrogate compounds may be alkylated or halogenated analogues or structural isomers of analytes of interest. The purpose of surrogate spikes, which are added immediately before the sample extraction step, is to provide a check for every analysis that no gross processing errors have occurred, which could have led to significant analyte loss or faulty calculation. Recoveries must generally lie between 50% and 150%.

Internal standards

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

9.3 Data management

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

The individual testing laboratory conducts an assessment of the laboratory QC program internally; however, the results will also be independently reviewed and assessed by GHD, to ensure that no issues exist with the data prior to undertaking any data interpretation.

Laboratory duplicate samples should return RPDs within the NEPM acceptance guideline of ±30% or as per laboratory specified ranges. Percentage recovery is used to assess spiked samples and surrogate standards, percentage recovery; although dependent on the type of analyte tested, concentrations of analytes and sample matrix; should normally range from about 70% to 130%; however, the laboratory may specify an expected recovery range. Method (laboratory) blanks should return analyte concentrations as ‘not detected’.

All data will be stored in an electronic format.

10. Reporting

The DSI report will be prepared with reference to DER *Reporting of Site Assessments* and other *Contaminated Sites Management Series* guidelines. The reports will contain:

- Executive summary;
- Scope of work;
- Site definition;
- Description of geological and hydrogeological conditions;
- Compliance and deviation from the SAP;
- Preliminary CSM;
- Assessment of QA/QC (field and laboratory) program;
- Detailed description of field observations;
- Discussion of groundwater and soil investigation and laboratory test results with respect to relevant assessment criteria;
- Refined CSM; and
- Conclusions and recommendations.
- Appendices will include: field equipment calibration records, relevant photographs, soil lithological logs and well installation logs; CoC information; laboratory certificates of analysis and relevant figures.

11. References

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality,* ANZECC, Canberra.

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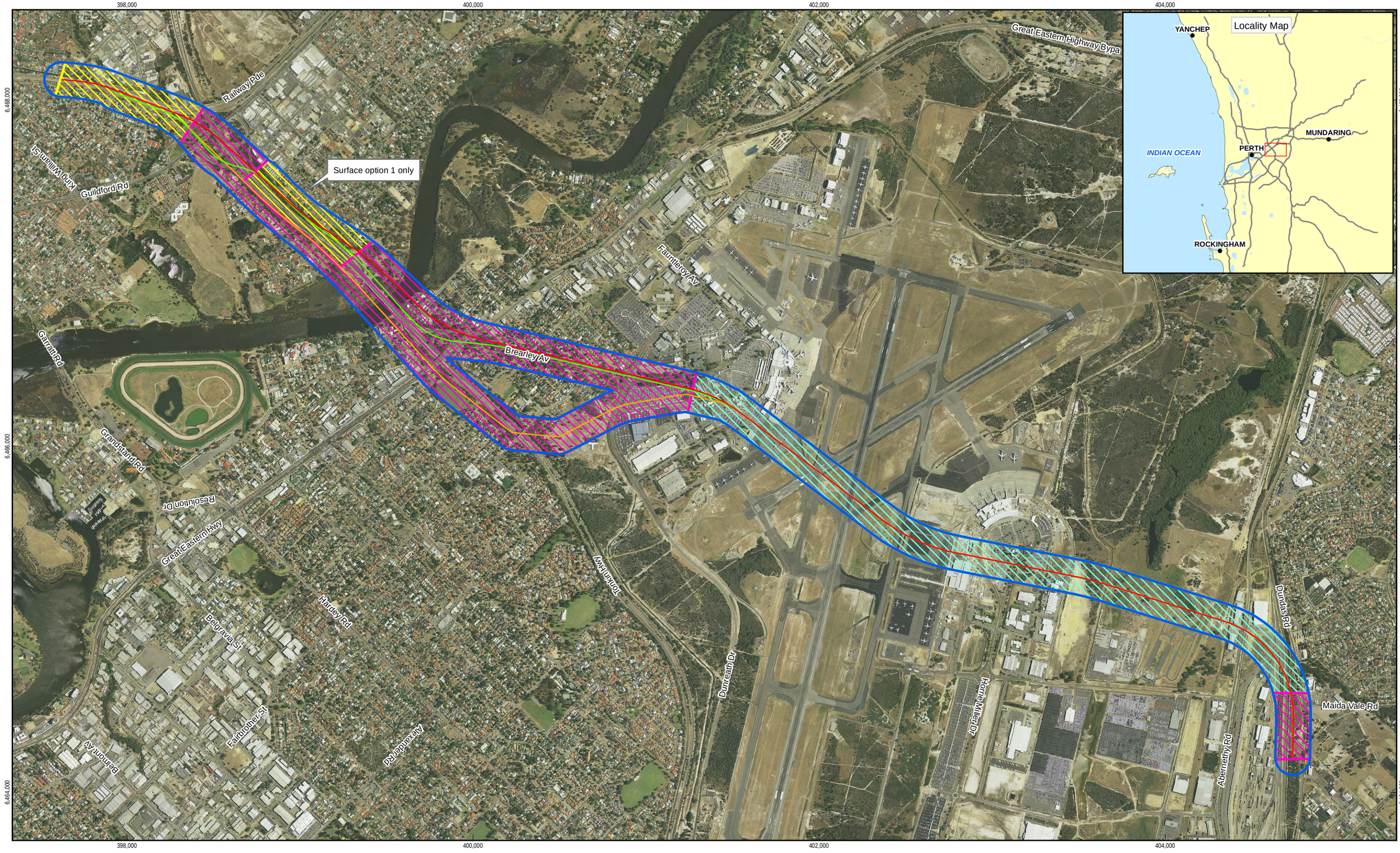
Standards Australia/Standards New Zealand (1998a) *AS/NZS 5667.11 – 1998 Water Quality – Sampling, Part 11: Guidance on sampling of groundwaters*, Standards Australia, NSW.

Standards Australia (2005) *AS 4482.1 - 2005 Guide to the Sampling and Investigation of Potentially Contaminated Soil - Part 1: Non-volatile and semi-volatile compounds*, Standards Australia, NSW.



1:20,000 (at A3)

0 100 200 400 600 800 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

LEGEND

The Alignment :

- Surface Option 1
- Surface Option 2
- Tunnel Option 3
- Study Area
- Shallow (< 1m disturbance)
- Sub water table disturbance from surface (cut/cover, piling)
- Tunnel: 0 m to 7 m below ground level (bgl) no disturbance; 7 m to 14 m bgl tunnel

Public Transport Authority
Perth Airport Rail Link PSI and SAP

Job Number	61-29667
Revision	0
Date	04 Oct 2013

Site location and definition

Figure 1

G:\61\29667\GIS\Maps\Working\6129667_G001_Fig1_Rev0.mxd

Data source: PTA:The Alignment - 20130807; GHD: Study Area - 20130807, Shallow (<1m disturbance), Sub water table disturbance from surface (cut/cover, piling), Tunnel: 0 m to 7 m below ground level (bgl) no disturbance; 7 m to 14 m bgl tunnel - 20130807; Landgate: Roads - 20130708, Metro Central Mosaic - 2013; GA: 250k Topo Serie 3 - 2006. Created by: vdinh, jrutherford

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1:6,000 (at A3)

0 30 60 120 180 240 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

Known and inferred sources of groundwater contamination (Hieschberg 1991 and water and river commission 1997) within 500 m

- Chemical fertilizer
- Industrial waste
- Petrol station

Legend

- Proposed groundwater monitoring well

Department of Water

- WIN Bores
- Potential Area of Environmental Concern
- Surface drain
- Gas fuel line

The Alignment :

- Surface Option 1
- Surface Option 2
- Tunnel Option 3
- Airport land

Contaminated sites (DEC database) within 500m

- Contaminated - remediation required
- Contaminated - restricted use
- Remediated for restricted use

Public Transport Authority
Perth Airport Rail Link PSI and SAP

Job Number 61-29667
Revision 0
Date 17 Jan 2014

Proposed monitoring well locations

Map 1 of 4

Figure 2

G:\61\29667\GIS\Maps\Working\6129667_G008_Fig2_Rev0.mxd

Data source: DoW: WIN Bores - 201308; DEC: Contaminated Sites (DEC database) within 600m - 20130807; PTA: Perth Airport ContaminatedSites - 20130807, The Alignment - 20130807; GHD: Potential Area of Environmental Concern - 20130820, Study Area - 20130807, Surface Drain - 20130807, Gas Fuel Line - 20130807, Airport Land - 20130807, Known and inferred sources of groundwater contamination (Hieschberg 1991 and water and river commission 1997) within 500 m, Proposed Monitoring Wells - 20140117; Landgate: Roads - 20130708, Metro Central Mosaic - 2013; GA: 250k Topo Serie 3 - 2006. Created by: vdinh, jrutherford, erice

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398,800 399,400 400,000 400,600

6,466,800

6,466,200

Claughton Reserve
River Rd
Wyatt Rd
Dunstone Rd
Duchess Ct
Wright Cr
Morey Cr
30,34 and 38 Wright Crescent
Swan River
Waterview Pde
Kanowna Av West
Locock St
The Esplanade
Forbes St
Tonkin Hwy
Great Eastern Hwy
Boulder Av
Central Av
Coolgardie Av
Bulong Av
First St
Darby P
Tibradd
Kwinana Fr
Rd
Ascot Pl
Thompson St
Ford St
Davis St
Ennis Pl
Nisbet St
Matheson Rd
20027858
Selby Park
20027734
20028137
The Court
Victoria St North
Kanowna Av East
Second St
Brearley Av
Epsom Av
Miller Av
Lyall St
Oneile Pde
Morieng St
Morrison St
Leake St
Aurum St
Keymer St
Kalgoorlie St
The Crescent
Victoria St
Smiths Av
Drummond St
Stanton Rd
Snook Rd
Dunreath Dr
12
13
B

Map 1
Map 2
Map 3
Map 4

398,800 399,400 400,000 400,600

1:6,000 (at A3)

0 30 60 120 180 240 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

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Department of Water

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Public Transport Authority
Perth Airport Rail Link PSI and SAP

Job Number 61-29667
Revision 0
Date 17 Jan 2014

Proposed monitoring well locations

Map 2 of 4

Figure 2

G:\61\29667\GIS\Maps\Working\6129667_G008_Fig2_Rev0.mxd

Data source: DoW: WIN Bores - 201308; DEC: Contaminated Sites (DEC database) within 600m - 20130807; PTA: Perth Airport ContaminatedSites - 20130807, The Alignment - 20130807; GHD: Potential Area of Environmental Concern - 20130820, Study Area - 20130807, Surface Drain - 20130807, Gas Fuel Line - 20130807, Airport Land - 20130807, Known and inferred sources of groundwater contamination (Hieschberg 1991 and water and river commission 1997) within 500 m, Proposed Monitoring Wells - 20140117; Landgate: Roads - 20130708, Metro Central Mosaic - 2013; GA: 250k Topo Serie 3 - 2006. Created by: vdinh, jrutherford, erice

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401,200 401,800 402,400 403,000

6,466,200 6,465,600

George Wencke Dr
Faunt Leroy Av
Coolgardie Av
Mccomb Rd
Baker Rd
Brearley Av
Snook Rd
Taplin Rd
Woods Rd
Miller Rd
Ross Dr
Boud Av
Dunreath Dr
Horrie Miller Dr
Sugarbird Lady Rd

MW14-01
MW4-02
MW4-01
MW6-01
MW6-02
MW6-03
former Ansett maintenance shed

Map 1
Map 2
Map 3
Map 4

MW5 - 01
MW5 - 02
MW5 - 03
MW3 - 17S / MW3 - 17I
MW3 - 19S / MW3 - 19I
MW3 - 16
MW3 - 15S / MW3 - 15I
MW3 - 12
MW3 - 11S / MW3 - 11I
MW3 - 18
MW3 - 07S / MW3 - 07I
MW3 - 10
MW3 - 06
MW3 - 14
MW3 - 09S / MW3 - 09I
MW3 - 05S / MW3 - 05I
MW3-01S / MW3 - 01I
MW3 - 13I / MW3 - 13S
MW3 - 04
MW3 - 02
MW3 - 08
MW3 - 03S / MW3 - 03I

1:6,000 (at A3)

0 30 60 120 180 240 300

Metres

Map Projection: Transverse Mercator
Horizontal Datum: Geocentric Datum of Australia
Grid: Map Grid of Australia 1994, Zone 50

N

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Public Transport Authority
Perth Airport Rail Link PSI and SAP

Job Number 61-29667
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Date 17 Jan 2014

Proposed monitoring well locations

Map 3 of 4

Figure 2

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Data source: DoW: WIN Bores - 201308; DEC: Contaminated Sites (DEC database) within 600m - 20130807; PTA: Perth Airport ContaminatedSites - 20130807, The Alignment - 20130807; GHD: Potential Area of Environmental Concern - 20130820, Study Area - 20130807, Surface Drain - 20130807, Gas Fuel Line - 20130807, Airport Land - 20130807, Known and inferred sources of groundwater contamination (Hieschberg 1991 and water and river commission 1997) within 500 m, Proposed Monitoring Wells - 20140117; Landgate: Roads - 20130708, Metro Central Mosaic - 2013; GA: 250k Topo Serie 3 - 2006. Created by: vdinh, jrutherford, erice

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403,000 403,600 404,200 404,800

6,465,000

6,464,400

Sugarbird Lady Rd
Horrie Miller Dr
Dawson Rd
Affleck Rd
Fricker Rd
Kingsford Smith Av
Grogan Rd
Abbott Rd
Abernethy Rd
Caltex
Onyx Ct
Koel Ct
Marshall Rd
Norton Rd
Perrin Way
Emms Ct
Lorikeet Loop
Palmer Cr
Dundas Rd
Durrant Way
Mack Pl
Maida Vale Rd
Ibis Pl
Sultana Rd West
Imperial St

RAC Driving Centre
Access Park
(882 Abernathy Road)

20028003
MW16-01
MW16-02
16
MW16-03
MW7-01
MW17-04
20027995
20027996
20027994
20027993
MW17-05
MW17-06
7
15
MW17-07
MW17-08

Map 1
Map 2
Map 3
Map 4

403,000 403,600 404,200 404,800

1:6,000 (at A3)

0 30 60 120 180 240 300

Metres

Map Projection: Transverse Mercator
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Grid: Map Grid of Australia 1994, Zone 50

N

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Proposed monitoring well locations

Map 4 of 4

Figure 2

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Data source: DoW: WIN Bores - 201308; DEC: Contaminated Sites (DEC database) within 600m - 20130807; PTA: Perth Airport ContaminatedSites - 20130807, The Alignment - 20130807; GHD: Potential Area of Environmental Concern - 20130820, Study Area - 20130807, Surface Drain - 20130807, Gas Fuel Line - 20130807, Airport Land - 20130807, Known and inferred sources of groundwater contamination (Hieschberg 1991 and water and river commission 1997) within 500 m, Proposed Monitoring Wells - 20140117; Landgate: Roads - 20130708, Metro Central Mosaic - 2013; GA: 250k Topo Serie 3 - 2006. Created by: vdinh, jrutherford, erice

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Appendix A - Field Sheets

GHD MANAGEMENT ENGINEERING ENVIRONMENT

SOIL BOREHOLE LOG

Borehole No.: .

Page: **1 of 1**

CLIENT:			COMMENCED:
PROJECT:	JOB No.:		COMPLETED:
LOCATION:			LOGGED BY:
CONTRACTOR:	EQUIPMENT:		CHECKED BY:
R.L. SURFACE (m):	VERTICAL DATUM:	TOTAL DEPTH (m):	DIAMETER (mm):
X-COORDINATE:	Y-COORDINATE:	HORIZONTAL DATUM:	

Depth (m)	Method	Support	Well Construction	Sample Number	Depth|Elevation (m)	DESCRIPTION AS1726 Soil Group Symbol, colour, soil types, particle characteristics or fines plasticity, secondary and minor components.	CONTAMINANT INDICATORS Odours, staining, waste materials, separate phase liquids, imported fill, ash.	Moisture Condition	PID Reading	Graphic Log	Depth (m)
0					0.00 0.00	Ground Surface					0
1											1
2											2
3											3
4											4

Groundwater Monitoring – Field Sheet

Client:		**BORE ID:**
Project:		**Job No.:**
Location:	**Casing diameter:** mm	**Date:**

BORE CONSTRUCTION

Head-works ☐ Flush-mount ☐ Monument ☐ casing only ☐ Locked	**Measurement Point** ☐ Top of PVC Casing	**Total Depth:** m

BORE DEVELOPMENT

Method:	**Date:**	**Undertaken By:**	**Vol. Removed:** L

Comments (e.g. sediment content):

PURGING DETAILS (measurement points in meters below top of casing as indicated above)

Method:	**Water Quality Meter used:**		**Undertaken By:**
Depth to water: m	**Water Column:** m	**Req Purge Vol. [1]:** L	**Flow Rate:** L/min
Presence of LNAPL ☐	**Presence of DNAPL** ☐	**Thickness of NAPL:** cm	**Depth to NAPL:** m
Pump intake: m			

PURGING MEASUREMENTS [2]

Vol. Purged (L)	Elapsed Time (min)	EC (µS/cm)	Temp. (°C)	Salinity (ppm|mg/L)	pH	DO %Sat	DO (ppm|mg/L)	Eh (mV)	Water Level (m b TOC)

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

SAMPLING DETAILS		**Sample ID:**
Time:	**Vol. Removed:** L	**No of Sample Containers:**

Type of Sample Containers (i.e. P = Plastic/G = Glass/V = Vial, volume and p = preserved/up = unpreserved):

Field Filtered ☐	**Duplicate Samples** ☐	**Duplicate Sample ID:**

Comments:

CoC Number:	**Checked by:**	**Date:**

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

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

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Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
A	Y. Binai	G.Ralph		G.Ralph		04/11/2013
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0	Y. Binai	G.Ralph		G.Ralph		17/01/2014
1	Y. Binai	G.Ralph		G.Ralph		03/02/2014

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