VICROADS

SEPTEMBER 2018

MORDIALLOC BYPASS

GROUNDWATER IMPACT ASSESSMENT

Report Number: 2135645A-SE-26-WAT-REP-0006 REV0

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Groundwater Impact Assessment

VicRoads

WSP
Level 15, 28 Freshwater Place
Southbank VIC 3006

Tel: +61 3 9861 1111
Fax: +61 3 9861 1144
wsp.com

REV	DATE	DETAILS
0	16/09/2018	Final

	NAME	DATE	SIGNATURE
Prepared by:	Alistair Stewart; Ellen Kwantes	16/09/2018	
Reviewed by:	Ray Hatley	16/09/2018	
Approved by:	Sean Myers	16/09/2018	

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GLOSSARY

Alluvial	Sediments deposited by flowing water.
Alluvium	General term for unconsolidated deposits of inorganic materials (clay, silt, sand, gravel, boulders) deposited by flowing water.
Alluvium aquifer	An aquifer formed within alluvium. See *Alluvium*.
Aquifer	Rock or sediment in a formation, group of formations or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.
Aquitard	Saturated geological unit with a relatively low permeability that can store large volumes of water but does not readily transmit or yield significant quantities of water to bores or springs. An aquitard can sometimes, if completely impermeable, be called an aquiclude.
Australian Height Datum (AHD)	A level datum, uniform throughout Australia, that generally approximates mean sea level.
Baseflow	The component of river or stream flow that is derived from groundwater discharge to the river or stream.
Baseline	A basic standard or level, usually regarded as a reference point for comparison.
Bore	Artificially constructed or improved groundwater cavity used for the purpose of accessing or recharging water from an aquifer. Interchangeable with borehole, piezometer.
Borehole	Includes a well, excavation, or other artificially constructed or improved groundwater cavity which can be used for the purpose of intercepting, collecting or storing water from an aquifer; observing or collecting data and information on water in an aquifer; or recharging an aquifer. Interchangeable with bores, wells, piezometers.
Clay	Deposit of particles with a diameter less than 0.002 mm, typically contain variable amounts of water within the mineral structure, and exhibit high plasticity.
Confined aquifer	An aquifer bounded above and below by impervious (confining) layers. In a confined aquifer, the water is under sufficient pressure so that when wells are drilled into the aquifer, measured water levels rise above the top of the aquifer.
Cumulative impact	The combined impact to one or more environmental values delivered by multiple projects being undertaken simultaneously within the same sphere of physical influence.
Drawdown	The change in groundwater level in a bore, or the change in water table elevation in an unconfined groundwater system, due to the extraction of groundwater.

Fault	Zone of displacement in rock formations resulting from forces of tension or compression in the earth's crust.
Formation	General term used to describe a sequence of rock layers.
Groundwater	Water found in the subsurface in the saturated zone below the water table or piezometric surface i.e. the water table marks the upper surface of groundwater systems.
Groundwater flow	The movement of water through openings and pore spaces in rocks below the water table i.e. in the saturated zone.
Groundwater resource	Groundwater available for beneficial use, including human usage, aquatic ecosystems and the greater environment.
Hydraulic conductivity	Measure of the ease with which water will pass through earth material; defined as the rate of flow through a cross-section of one square metre under a unit hydraulic gradient at right angles to the direction of flow (metres per day).
Hydraulic gradient	Change in the hydraulic head over a certain distance.
(Hydraulic) head	Elevation to which water will rise in a borehole connected to a point in an aquifer.
Hydrogeology	The study of the interrelationships of geological materials and processes with water, especially groundwater.
Hydrograph	Graph that shows groundwater or surface water properties as a function of time.
Impact	An event that disrupts ecosystem, community, or population structure and alters the physical environment, directly or indirectly.
Infiltration	The downward movement of water from the atmosphere into the ground; not to be confused with percolation.
Lithology	The physical character of rocks.
Modelling	The creation of a computerised model that simulates natural environment, allows simulations to project future outcomes.
Monitoring bore	A bore used to monitor groundwater levels or quality.
Permeability	The ease with which a fluid can pass through a porous medium and is defined as the volume of fluid discharged from a unit area of an aquifer under unit hydraulic gradient in unit time (metres per day).
Recharge	Recharge is defined as the process by which water is added from outside to the zone of saturation of an aquifer, either directly into a formation, or indirectly by way of another formation.
Runoff	All surface and subsurface flow from a catchment, but in practice refers to the flow in a river i.e. excludes groundwater not discharged into a river.
Semi-confined aquifer	An aquifer that is partly confined by layers of lower permeability material through which recharge and discharge may occur, also referred to as a leaky aquifer.

Stratigraphy	Branch of geology dealing with the classification, nomenclature, correlation, and interpretation of stratified rocks.
Terrestrial	Relating to, consisting of, or representing the Earth; relating to the land as distinct from the water.
Trigger level	The point at which some form of action is begun, such as exceedance of guidelines.
Water table	The surface in an unconfined aquifer or confining bed at which the pore water pressure is atmospheric; it can be measured by installing shallow wells extending a few feet into the zone of saturation and then measuring the water level in those wells.
Watercourse	A river, creek or other stream, including a stream in the form of an anabranch or a tributary, in which water flows permanently or intermittently, regardless of the frequency of flow events: — In a natural channel, whether artificially modified or not — In an artificial channel that has changed the course of the stream — It also includes weirs, lakes and dams.
Wetland	In Victoria, wetlands are defined as areas whether natural, modified or artificial, subject to permanent or temporary inundation, that hold static or very slow moving water and develop, or have the potential to develop, biota adapted to inundation and the aquatic environment. Wetlands may be formed by natural processes or human activities. Wetlands include freshwater and saline lakes, swamps and shallow waters in Victoria's estuaries, bays and inlets. The international treaty on wetlands, the Ramsar Convention on Wetlands, uses a broader definition of wetlands which also includes rivers and other shallow marine waters. Wetlands provide many values to the community: — Traditional Owners and Aboriginal people have used wetlands over many tens of thousands of years and they are an important part of Aboriginal cultural heritage. — Wetlands act as sediment traps and filter nutrients from catchments. This helps protect the water quality of rivers, estuaries and marine areas. — Wetlands reduce the impacts of flooding by holding and slowing floodwater. — Wetlands provide habitat for native plants such as river red gum (Eucalyptus camaldulensis), mangroves, saltmarshes and for native animals such as waterbirds, frogs and fish. — Wetlands provide a range of recreational opportunities such as boating, camping, bird watching, fishing and duck hunting which help to support tourism and local economies. Many wetlands in Victoria are recognised for their environmental significance.
Yield	The quantity of water removed from a water resource e.g. yield of a borehole.

ABBREVIATIONS

AHD	Australian Height Datum
ANZECC	Australian and New Zealand Environment and Conservation Council
BGL	Below ground level
BoM	Bureau of Meteorology
BTEXN	Benzene, toluene, ethylbenzene, xylene and naphthalene
CDFM	Cumulative departure from mean
CHM	Conceptual hydrogeological model
DELWP	Department of Environment, Land, Water and Planning
DO	Dissolved Oxygen
EC	Electrical Conductivity
EES	Environmental Effects Statement
EMF	Environmental management framework
EPA	Environment Protection Authority
EPR	Environmental Performance Requirements
ERA	Environmental Risk Assessment
ET	Evapotranspiration
GDE	Groundwater dependant ecosystem
GMA	Groundwater management area
GME	Groundwater monitoring event
GMU	Groundwater management unit
GMWL	Global meteoric water line
HSU	Hydrostratigraphic unit
LoR	Limit of reporting
LXRA	Level Crossing Removal Authority
NES	National environmental significance
NHRMC	National Health and Medical Research Council
ORP	Oxidation-reduction potential
PASS	Potentially acid sulfate soils
PVC	Permissible consumption volume
QA	Quaternary aquifer

SEPP	State Environmental Planning Policies
SEW	South East Water
SRMS	Scaled root mean squared
TDS	Total dissolved solids
TPH/TRH	Total petroleum hydrocarbons/total recoverable hydrocarbons
TRG	Technical Reference Group
UA	Unincorporated areas
UMTD	Upper-Mid Tertiary aquitard
UTAF	Upper Tertiary aquifer
VAF	Victorian aquifer framework
VRGS	VicRoads Geotechnical Services
WMIS	Water Measurement Information System
WMMP	Water Management and Monitoring Plan
WSPA	Water supply protection area

EXECUTIVE SUMMARY

VicRoads propose to construct the Mordialloc Bypass, a 9 km duel carriageway freeway connecting the Mornington Peninsular Freeway to the Southern end of the Dingley Bypass. The project would include the construction of several interchanges, embankment structures, waterway and wetland crossings, and intersection upgrades of local roads.

The purpose of this groundwater impact assessment is to characterise the existing environment and provide an impact assessment in line with *Scoping Requirements for Mordialloc Bypass Environment Effects Statement* (DELWP 2018) (Scoping Requirements). The initial version of this report (existing conditions) built upon previous desktop investigations, extensive geotechnical and hydrogeological drilling, water quality sampling and groundwater level monitoring conducted for the project.

The project study Area is located within Melbourne's southern movement corridor connects the Mornington Peninsula and Southern and Bayside suburbs to the central city and to National Employment Clusters in Monash and Dandenong. In addition to enabling cross-city movements, the corridor provides road users with access to residential zones, recreation areas and employment and activity centres within the City of Kingston and adjacent municipalities, including the significant national employment cluster in the City of Monash.

GROUNDWATER CONTEXT

The project is located within the Port Phillip Bay Basin and consists of low lying landform within a residential – light industrial – semi rural setting. Groundwater within the region is typically shallow with water levels being intersected within the first few meters below ground level. Groundwater – surface water interactions occur at several water bodies within study area. The shallow groundwater systems within the study area have the potential to maintain several ecologically significant wetlands including the Ramsar listed Edithvale-Seaford Wetlands located approximately 2 km from the proposed alignment.

This report assesses the potential impacts to the groundwater regime from the proposed project, including but not limited to the embankment structures. The embankment structures have the potential to reduce permeability through loading of soft unconsolidated sediments. The reduction in permeability has the potential to alter the local groundwater flow and possibly divert sustaining water flow into the wetlands.

This report provides a conceptual understanding of regional and local hydrogeological and assesses the potential impact of the project. The resulting impacts assessment helps inform the development of management and, if required, mitigation measures in the form of Environmental Performance Requirements (EPRs). The EPRs can be design consideration or management tools such as Water Management Plans. These are EPRs are statutory requirements that form part of a robust Environmental Management Framework.

METHOD

The groundwater impact assessment is built upon previous preliminary, desktop and intrusive hydrogeological investigations. The method utilised in this assessment included the following:

- Desktop Review
- Site investigations that included:
  - Hydrogeological drilling program both
  - Groundwater and surface water sampling and isotopic analysis
  - Groundwater level monitoring
  - Hydraulic testing

- Update of conceptual hydrogeological model to include data obtained in the site investigation, water quality data and geochemical analysis
- Development of numerical groundwater model to predict impacts to groundwater flow caused by embankment structures along the alignment
- Risk identification and assessment
- Impact assessment, using the results from the predictive numerical model to assess the potential impacts to beneficial users including to the following:
  - Edithvale-Seaford Wetlands (Edithvale only)
  - Waterway Estate Wetlands, Woodlands Industrial Estate Wetlands and Braeside Park Wetlands.

  The impact assessment consisted of an initial assessment to rank the initial risks rating and identify what additional mitigation measures would be require to lower potential impact resulting in a residual risk ranking.

EXISTING CONDITIONS

The study area consists of a relatively flat landscape with elevation dipping from the north east towards the south with elevation below sea level at Edithvale Wetlands. There are several natural and anthropogenic drainage features and water courses within the study area including Patterson River, Mordialloc Creek, Woodlands Industrial Estate Wetlands, Braeside Park Wetlands, Waterways Estate Wetlands and the Edithvale Wetlands.

The main geological units underlying the study area consists of the outcropping Brighton Group sediments in the northern section of the alignment, and Quaternary alluvial sediments associated with the former Carrum Swamp in the south. There are two primary aquifers within the study area that could be potentially impacted by the project:

- Quaternary Aquifer (QA): This aquifer is largely associated with the former Carrum Swamp and consists of a shallow unconfined aquifer with depths of approximately <10 m.
- Upper Tertiary Aquifer (UTAF): This aquifer is located across the entire project area and within the Brighton Group sediments. Where the Brighton Group outcrops, the UTAF consists of an unconfined aquifer. Where the Brighton Group sediments are overlain by the Quaternary alluvial, the UTAF becomes semi-confined. Depths of the UTAF within the study area are approximately in excess of 20 meters.

Groundwater flow within the QA is complex and influence by topography, land use and water courses. Regional groundwater flow in the UTAF is generally topographically driven with water groundwater flows from the north east towards the south-east discharge features such Port Phillip Bay, Patterson River and Edithvale Wetlands.

Groundwater levels vary within each aquifer depending on numerous factors including topography, seasonal variability and extraction from registered pumping bores. Groundwater levels are typically closer to surface during the wetter winter months and lower during the summer months that are typically drier and experience greater losses to evapotranspiration. Towards the southern portion of the alignment water levels are close to or below sea level. For locations close to Edithvale Wetlands this is conceptually correct with the wetlands acting as a discharge point for groundwater. The presence of a licenced extraction bore close to Springvale road has also altered groundwater levels with several groundwater bores influenced through groundwater extraction.

RISK AND IMPACT ASSESSMENT

A risk assessment was undertaken in accordance with AS/NZS ISO 31000:2009 Risk Management Process. The following risks were assessed for the construction and operation phases of the Project:

- Interference to groundwater availability (groundwater levels/flow)
- Impacts to groundwater quality
- Impact to the beneficial use of groundwater
- Water logging at surface.

Numerical groundwater modelling was developed to assess the impact to groundwater levels that could occur as a result of the embankment structures, and the reduction of permeability to underlying unconsolidated sediments. The embankment structures were identified as a potential risk causing groundwater to increase on the up gradient side and decrease down gradient causing a 'groundwater shadow' downgradient. The reduction of groundwater levels could reduce groundwater contributions to adjacent groundwater dependant ecosystems, include the Edithvale Wetlands.

KEY FINDINGS

Whilst the construction of the embankment structures would result in a decrease of permeability of the underlying aquifer, the numerical groundwater model indicated that impacts to groundwater would be minimal. Modelling results indicated that very small changes in groundwater level would occur (in the order of 10 to 15 cm maximum). Groundwater increases would occur beneath the embankment north of Governor Road adjacent the Braeside Park Wetlands and a small decrease beneath the Springvale Road embankment. The impact to water levels are predicted to occur within the project footprint underneath the embankment structures themselves with negligible changes to groundwater levels outside the embankments.

The risks caused by changes to groundwater levels or quality from the project are considered sufficiently low that mitigation methods beyond the project design phase would not be required. A Water Management and Monitoring Plan to validate and monitor predicted impacts to groundwater would be the only recommended Environmental Performance Requirement of the project.

Considering the observed seasonal groundwater variation are much larger by comparison (~0.5 to 1 m), these minimal impacts to groundwater levels are highly unlikely to have any measurable effects on groundwater levels adjacent to the sensitive wetlands nor on groundwater flow contributions to the wetland water balances.

ENVIRONMENTAL PERFORMANCE REQUIREMENTS

To validate, monitoring and manage predicted impacts the development of a Water Management and Monitoring Plan (WMMP) is recommended for the Project. To be implemented prior to construction, the WMMP allows for the monitoring and verification of predicted impacts to both surface and groundwater resources.

The WMMP incorporates baseline data acquired through the pre-development monitoring allowing the development site specific trigger levels for both water quality of surface water bodies, groundwater bores and groundwater levels. The WMMP also details what parameters are to be monitored including the frequency, location and duration.

1 INTRODUCTION

1.1 PROJECT OVERVIEW AND DESCRIPTION

The Mordialloc Bypass project (the project) is the proposed construction of a new freeway connecting the Dingley Bypass with the Mornington Peninsula Freeway; and is predominately to be constructed within an existing road reservation (Figure 1.1). The project passes between the western boundary of Braeside Park and the eastern boundary of the Woodlands Estate (constructed) wetlands, traverses constructed wetlands at Waterways and approaches to within one kilometre of the Ramsar-listed Edithvale-Seaford Wetlands. The northern and southern ends of the project pass through or border the South East Green Wedge.

The project corridor is approximately 9.7 kilometres in length, comprising two, two-lane 7.5 kilometre long carriageways (with a path for walking and cycling) along the greenfield alignment, and 2.2 kilometres of roadworks required to integrate the project with the Mornington Peninsula Freeway. It is expected that each carriageway will provide for two 3.5 metre wide lanes, with a 3.0 metre wide outside shoulder and 1.0 metre wide inside shoulder. The Mordialloc Bypass will also provide connections from the freeway onto the Dingley Bypass, Centre Dandenong Road, Lower Dandenong Road, Governor Road, Springvale Road and new north facing ramps at Thames Promenade. There will also be an overpass at Old Dandenong Road. Mordialloc Creek and the associated Waterways Wetlands will be spanned by twin 400 metre long bridges.

The proposed alignment allows for a future upgrade of the project to a six-lane freeway standard road within the construction footprint.

The proposed alignment is generally located within the existing road reservation, most of which is already covered by Public Acquisition Overlay, and some of which is already in VicRoads' ownership.

The proposed project consists of:

- Four-lane freeway standard cross-section (two lanes in each direction), divided by a centre median
- 100 km/hr posted speed limit
- Full diamond interchanges at Springvale Road, Governor Road and Lower Dandenong Road whereby Mordialloc Bypass is elevated over the arterial roadway with northbound and southbound entry and exit ramps providing access for all directions of travel
- Half single point urban interchange at Centre Dandenong Road whereby Mordialloc Bypass is elevated over Centre Dandenong Road and southbound entry and northbound exit ramps provide accessibility to and from the south
- Addition of northbound entry and southbound exit ramps at the existing Mornington Peninsula Freeway interchange at Thames Promenade to provide access to and from Mordialloc Bypass. The existing interchange provides ramps to and from Mornington Peninsula Freeway to the south only. The proposed entry and exit ramps will create a full diamond interchange at Thames Promenade
- An at-grade T-signalised intersection at Dingley Bypass
- Elevation of the bypass over Old Dandenong Road and Bowen Parkway to maintain existing connectivity on these routes
- Shared use path running north-south along the length of the Mordialloc Bypass and connecting existing paths along the north side of Dingley Bypass and the south side of Springvale Road adjacent to Chelsea Heights Hotel
- Bus queue jump lanes provided in intersection configurations at the proposed Springvale Road and Centre Dandenong Road interchanges.

1.2 CONTEXT

The potential for regional groundwater impacts to arise from the project was conceived and advanced in the development of the "Preliminary Groundwater Impact Assessment" (PGWIA) (2135645A-SE-26-WAT-REP-0002 RevB, June 2017), which documented a qualitative assessment of potential impacts, and considerations via an environmental risk assessment (RA) process. The risk assessment focused on *Matters of National Environmental Significance* (MNES) protected under the Australian Government's *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), including the Edithvale – Seaford Wetlands and protected flora and fauna.

The RA process identified that the Edithvale-Seaford Wetlands – Ramsar-listed wetlands – as having a potential high risk impact from the project, and thereby triggering further assessment, and as it effects this report, hydrological and hydrogeological assessment, to more confidently evaluate the risk. As a preliminary outcome, the RA also identified possible engineering mitigation measures to minimise recognised risk.

The key outcome of the RA workshop held on 16 August 2017 was to further assess the likely impact of the project on local and regional groundwater systems, which, in turn formed the basis of the groundwater impacts report ("Mordialloc Bypass – Groundwater impacts to Edithvale wetlands assessment and mitigations report", 2135645A-SE-26-WAT-REP-0003 Rev00, 19/10/2017). This document provided supporting technical material for the EPBC Act referral submission, and indicated what detailed work was required to quantify the potential impacts identified, and to provide a preliminary assessment of whether engineering solutions were going to be required to prevent impacts to the Ramsar-listed Edithvale-Seaford Wetlands.

The risk to the existing regional groundwater behaviour was assessed as being likely to stem from particular geotechnical effects arising from the construction of embankments on subsurface compressible soils, present beneath the project alignment. Typically, compression effects of this nature reduce the soil porosity though compaction and void closure effects, and thereby reducing permeability under the embankment. This, in turn, has the potential to constrict prevailing groundwater flow in the down-gradient areas. Groundwater flow changes induced by this constriction may impact the supply of water to the local wetlands surrounding the project alignment, thereby potentially affecting their ecological health (if sufficient mitigation is not applied).

On the basis of the preliminary impact assessments undertaken for the project and the RA (described above), VicRoads determined that a referral under the EPBC Act to the Commonwealth Government was appropriate. This submission, EPBC Act referral 2017/8091, was submitted on the 13/09/2017 and included the groundwater impacts report (19/10/2017, referred to above). The Minister's decision (under sec 7, EPBC Act), designating the project as a Controlled Action, was provided on the 8/1/2018, and defined project requirements for additional assessment. This was determined to be related to the likelihood that the proposed action (the project) may have a significant impact on the following national environmental significance (MNES) matters protected by the EPBC Act:

- Ramsar wetlands (sections 16 & 17B)
- Listed threatened species and communities (sections 18 & 18A)
- Listed migratory species (sections 20 & 20A).

The Victorian Minister for Planning determined under the *Environment Effects Act 1978* (EE Act) that VicRoads prepare an environment effects statement (EES) for the Mordialloc Bypass project (the project). The decision on EPBCA referral influence the contents on the EES scoping requirements specifically pertaining to MNES. The EES requirements included the following key matters for the EES to examine:

- Potential effects on biodiversity values, including through direct or indirect loss, degradation or fragmentation of habitat or through other causes including road-kill, as well as related ecological effects
- Potential effects on water environments and related beneficial uses, including as a result of changes to hydrology and groundwater
- Potential effects resulting from disturbance or mobilisation of anthropogenic soil contaminants or potential acid sulfate soils

- Potential effects on Indigenous cultural heritage values; and
- Other effects on land uses and the local communities.

The EES objectives, as it relates to groundwater matters, fall under "Water, catchment values and hydrology – To maintain the functions and values of groundwater, surface water and floodplain environments and minimise effects on water quality and beneficial uses, including the Ramsar listed Edithvale-Seaford Wetlands (under EP Act, Water Act, C&LP Act, SEPPs, EPBC Act)". The requirements of the EES are to characterise the existing environment, assess likely effect, design mitigation measure and define risk management methods.

This report addresses the EES requirements as defined in the relevant "Scoping Requirements" (November 2017).

1.3 PROJECT AREA

Melbourne's southern movement corridor connects the Mornington Peninsula and Southern and Bayside suburbs to the central city and to National Employment Clusters in Monash and Dandenong. In addition to enabling cross-city movements, the corridor provides road users with access to residential zones, recreation areas and employment and activity centres within the City of Kingston and adjacent municipalities, including the significant national employment cluster in the City of Monash. This project connects the Mornington Peninsula Freeway in the south to the Dingley Bypass to the north.

1.3.1 STUDY AREA

To adequately characterise the hydrogeological conditions, a regional scale understanding is required. Groundwater regimes are complex and can be influenced by broad geographical scales. The study area incorporates the project area defined above, and includes the broader areas with a 2 km buffer radius extending approximately to Port Phillip Bay to the west, Patterson River to the south, Dingley bypass in the north and approximately 2 km to the east of the project alignment.

This area has been selected as it incorporates important environmental receptors such as the Ramsar listed Edithvale-Seaford Wetlands (Edithvale Wetlands only), Braeside Park Wetlands, Woodlands Industrial Estate Wetlands, Waterways Estate Wetlands, Port Phillip Bay and Patterson River. This region is the basis of the groundwater impact assessment with the numerical groundwater model domain being situated within this study area as described in Section 4.5.

The Study area also covers landfill sites located at the northern end of the alignment adjacent Dingley Bypass. The regional characterisation of groundwater conditions from this impact assessment has been incorporated into the Contaminated Land Impact Assessment Technical Impact Assessment Report (Contaminated Land and Acid Sulfate Soil).

1.4 LEVEL CROSSING REMOVAL AUTHORITY

1.4.1 THE LXRA PROJECT

Prior to the referral of Mordialloc Bypass project, the Edithvale and Bonbeach level crossing removal project was referred to the Minister for Planning who confirmed the requirement for an EES. The Level Crossing Removal Authority (LXRA) and VicRoads projects share a similar geographical region with the Edithvale level crossing removal approximately 2.5 km to the west of the project alignment within the same hydrogeological regime.

1.4.2 PROJECT ALIGNMENT

Situated on the Frankston rail line, the LXRA project involves the excavation of significant trench structures to place the rail line and station under Edithvale Road. The trench would be 1,300 m in length with depths up to 15 m with piles extending to 24 m at the deepest part of the trench. This trench structure has the potential to impact the current hydrogeological regime by acting as a barrier to groundwater flow adjacent Port Phillip Bay.

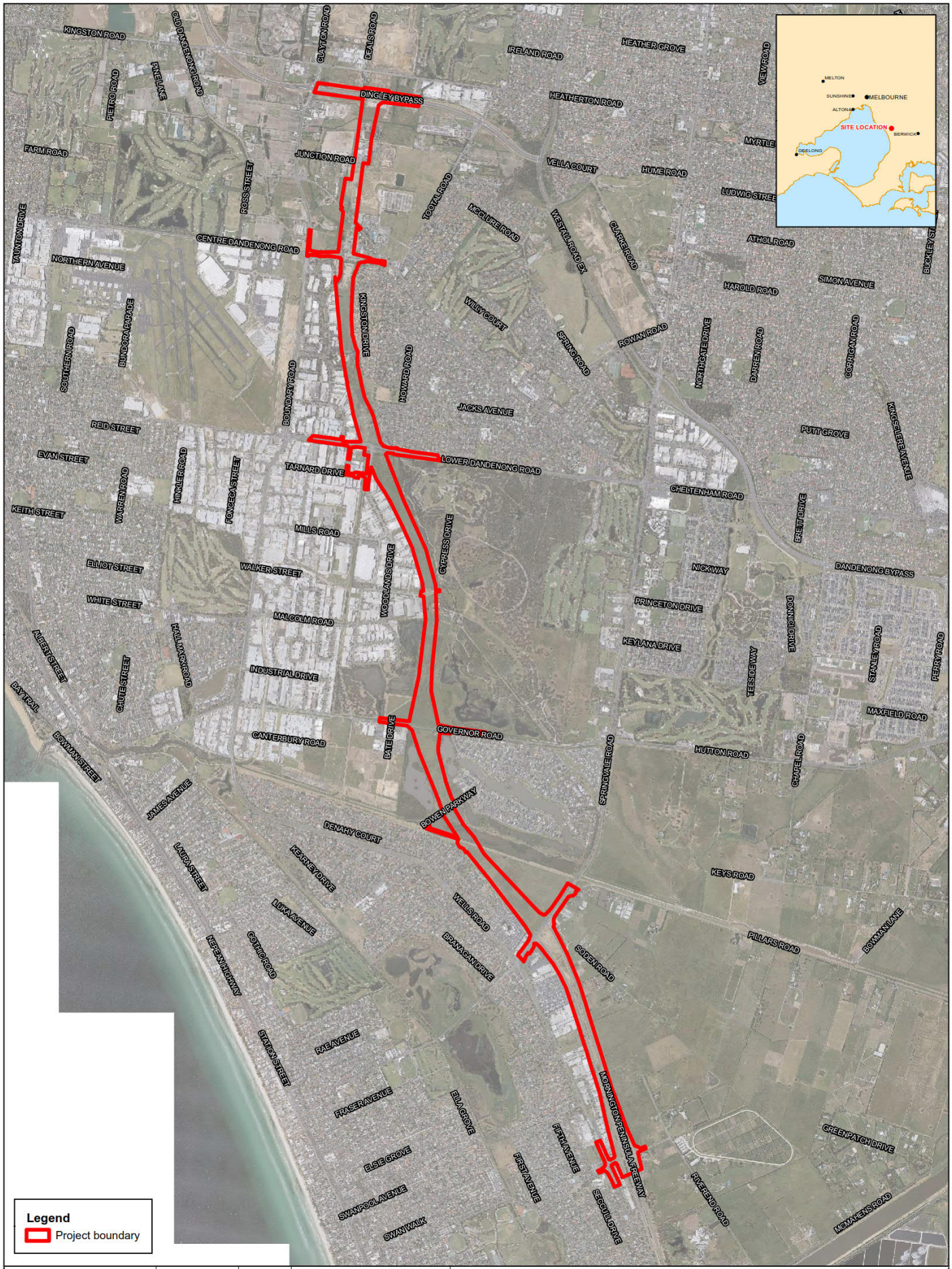
1.4.3 POTENTIAL IMPACTS TO GROUNDWATER AND ADJACENT WETLAND ECOLOGY

The potential impacts to groundwater have been addressed in the LXRA Groundwater Impact Assessment (AECOM-GHD JV 2018) and involve extensive desktop and intrusive site investigations that resulted in the development of a conceptual and numerical groundwater model.

1.4.4 CONTEXT – POTENTIAL CUMULATIVE PROJECT-RELATED IMPACTS

Whist the Mordialloc Bypass does not involve the excavation of trench structures, both projects identified the Edithvale portion of the Edithvale-Seaford Wetlands as a sensitive receptor to potential cumulative project-related impacts. As such VicRoads and LXRA established a data sharing and cooperative arrangement allowing VicRoads access to LXRA groundwater bores and water quality data. This has allowed the incorporation of select LXRA monitoring bores into the project groundwater monitoring network. The data obtained to date has assisted in the development and calibration of the project's own numerical groundwater model.

The groundwater impact assessment for the Mordialloc Bypass includes data obtained by LXRA with several references to LXRA groundwater bores and the LXRA Edithvale Wetlands site investigation program. To maintain consistency between projects, VicRoads has engaged the same independent third party reviewer.



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Coordinate system: GDA 1994 MGA Zone 55

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Figure 1.1

Project location

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Figure 1.2
Study area

2 EES OBJECTIVES AND REQUIREMENTS

2.1 EES OBJECTIVES

The following EES objectives relating to groundwater have been extracted from the Scoping Requirements for Mordialloc Bypass Environment Effects Statement (May 2018). The Scoping Requirements objectives provide a framework in which potential impacts from the project can be assessed in accordance with the *Ministerial guidelines for the assessment of environmental effects under the Environment Effects Act 1978.*

The *evaluation objectives* are to maintain the functions and values of groundwater, surface water and floodplain environments and minimise effects on water quality and beneficial uses, including the Ramsar listed Edithvale-Seaford Wetlands.

KEY ISSUES

- The potential for adverse effects on the functions, values and beneficial uses of surface water environments (including Braeside West and Mordialloc Creek Wetlands, Waterways wetlands, Woodland Industrial Estate wetlands, and associated Mordialloc Creek drainage system) due to the project's activities, interception or diversion of flows or changed water quality during construction and operation.
- The potential for adverse effects on the functions, values and beneficial uses of groundwater due to the project's activities, in particular on groundwater dependant ecosystems (GDEs) and the ecological character of the Edithvale-Seaford Wetlands due to changes in groundwater levels, behaviour or quality.
- The potential for adverse effects on nearby and downstream water environments (including the Mordialloc Creek catchment and Edithvale-Seaford Wetlands) due to changed flow regimes, floodplain storage, run-off rates or other waterway conditions during construction and operation.

All key issues pertaining to soil and groundwater contamination, and acid sulfate soils are discussed in the Technical Impact Assessment Report (Contaminated Land and Acid Sulfate Soil).

2.2 EES SCOPING REQUIREMENTS

The following table contains extracts from the Scoping Requirements relevant to groundwater, and corresponding sections of this report addressing each requirement.

Table 2.1 Scoping requirements for groundwater impact assessment

ASPECT	SCOPING REQUIREMENTS	REFER
Key Issues	The potential for adverse effects on the functions, values and beneficial uses of surface water environments (including Braeside West and Mordialloc Creek Wetlands, Waterways wetlands, Woodland Industrial Estate wetlands, and associated Mordialloc Creek drainage system) due to the project's activities, interception or diversion of flows or changed water quality during construction and operation. The potential for adverse effects on the functions, values and beneficial uses of groundwater due to the project's activities, in particular on groundwater depended ecosystems (GDEs) and the ecological character of the Edithvale-Seaford Wetlands due to changes in groundwater levels, behaviour or quality. The potential for adverse effects on nearby and downstream water environments (including the Mordialloc Creek catchment and Edithvale-Seaford Wetlands) due to changed flow regimes, floodplain storage, run-off rates or other waterway conditions during construction and operation.	Section 7 (Impact assessment)

ASPECT	SCOPING REQUIREMENTS	REFER
Priorities for characterising the existing environment	Identify and characterise relevant surface water, catchments and floodplain environments, including in terms of the existing drainage functions and behaviour. Identify and characterise the relevant groundwater environments, including the protected beneficial uses and values, existing drainage functions and behaviours, including the nearby wetlands such as the Edithvale-Seaford Wetlands Ramsar site and identifying any GDEs that might be affected by the project. Characterise the interaction between surface water and groundwater within the project site and the broader area. Characterise the physical and chemical properties of the project area groundwater, including the potential pre-existing contamination. Identify and characterise the nature and status of any nearby projects which may affect the relevant groundwater environments. Detail and evaluate the groundwater modelling techniques utilised.	Section 5 (Existing conditions) Technical Impact Assessment Report (Contaminated Land and Acid Sulfate Soil)
Design and mitigation measures	Identify and evaluate aspects of project works, and proposed design refinement options or measures, which could avoid or minimise significant effects on water environments, including the Edithvale-Seaford Wetlands Ramsar site and Braeside West, Waterways wetlands and Mordialloc Creek Wetlands. Describe further potential and proposed design options and measures which could avoid or minimise significant effects on beneficial uses of surface water, groundwater and downstream water environments during the project construction and operation. Identify methods to manage and, if required dispose of groundwater, including contaminated groundwater during construction.	Section 5.9 (Risk Assessment) Section 7 (Impact assessment) Technical Impact Assessment Report (Contaminated Land and Acid Sulfate Soil)

ASPECT	SCOPING REQUIREMENTS	REFER
Assessment of likely effects	Characterise the local and regional groundwater systems in order to predict short and long-term effects of the project on groundwater flow regime during construction and operation, including interactions between surface water and groundwater, and having regard to potential impacts of other relevant infrastructure projects. Identify and evaluate effects of the project and relevant alternatives on groundwater and adjacent surface water and floodplains environments in the vicinity of the project works and the Edithvale-Seaford Wetlands, including: — The likely extent, magnitude and duration (short and long term) of changes to groundwater level or flow paths during construction and operation, considering appropriate climate change scenarios — Changes to groundwater and surface water quality at all project phases, including from drawdown and rebound of groundwater levels, present contaminants, saline water intrusion into aquifers, sedimentation and downstream effects on ecological values (e.g. groundwater dependent ecosystems, EPBC Act listed communities and the Edithvale-Seaford Wetlands Ramsar site) — Changes to availability of groundwater for beneficial uses in the vicinity of the project — Changes to groundwater quality and flow construction, and compression of soil with the potential for reduced porosity and permeability, due to project works such as construction and placement of embankments, pilings and other structures in the project area — Risks associated with potential acid forming materials (e.g. soil) which may be disturbed or exposed by the project activities.	Section 7 (Impact assessment) Appendix D (numerical groundwater model report) EES Technical Impact Assessment Report (Contaminated Land and Acid Sulfate Soil)
Approach to manage performance	Describe any further methods that are proposed to manage risks of effects on groundwater and surface water environments and catchment values, as well as water quality, including as part of the EMF (see section 5). Describe any further methods that are proposed to manage risks of effects as a result of nearby projects impacting on water inflow to water environments and catchment values, as well as water quality. Describe and evaluate the approach to monitoring and the proposed contingency measures to be implemented in the event of adverse residual effects on water environments including water quality and catchment values requiring further management. Describe and evaluate the approach to monitoring and the proposed ongoing management measures to be implemented to avoid adverse residual effects on the Edithvale-Seaford Wetland Ramsar site.	Section 8 (Environmental performance requirements)

3 LEGISLATION AND POLICY

3.1 RELEVANT LEGISLATION

The following sections outline the Commonwealth and State legislation are relevant to the management of groundwater and water resources within the project area.

3.2 COMMONWEALTH

Commonwealth guidelines relevant to the management of groundwater include:

- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000 (ANZECC/ ARMCANZ, 2000)*. These guidelines provide for the sustainable use of Australia's water resources by protecting and enhancing quality, while maintaining economic and social development. These guidelines are used as groundwater quality criteria for assessing beneficial uses outlined in the SEPP (Groundwaters of Victoria).
- *Australian Drinking Water Guidelines (NHMRC, 2011)*. These guidelines provide guidance to the Australian community and the water supply industry on what constitutes good quality drinking water. These guidelines are used as groundwater quality criteria for assessing beneficial uses outlined in the SEPP (Groundwaters of Victoria).
- *The Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)* prescribes the Commonwealth's role in environmental assessment, biodiversity conservation and the management of protected areas and species, population and communities and heritage items.

Approval from the Commonwealth Minister for the Environment is required for:

- An action which has, would have, or is likely to have a significant impact on 'matters of National Environmental Significance' (NES matters). The current NES matters include:
  - World Heritage properties
  - National Heritage places
  - Wetlands of international importance
  - Listed threatened species and ecological communities
  - Migratory species protected under international agreements
  - Commonwealth marine areas
  - The Great Barrier Reef Marine Park
  - Nuclear actions (including uranium mines)
  - A water resource, in relation to coal seam gas development and large coal mining development
- An action by the Commonwealth or a Commonwealth agency which has, would have, or is likely to have a significant impact on the environment
- An action on Commonwealth land which has, would have, or is likely to have a significant impact on the environment
- An action which has, would have, or is likely to have a significant impact on the environment of Commonwealth land, no matter where it is to be carried out.

Impacts on NES matters are assessed through a referral process to the Commonwealth Department of Environment and Energy. If the Commonwealth Minister for the Environment determines that a project is likely to have a significant impact on a NES matter, then the project becomes a controlled action and approval of the Commonwealth Minister for the Environment would be required before construction works can commence.

3.3 STATE LEGISLATION

The framework for the management of groundwater in Victoria is established primarily through the:

- *Water Act 1989* – deals with the sustainable, efficient and equitable management and allocation of groundwater resources.
- *Environment Protection Act 1970* – empowers the Environment Protection Authority Victoria (EPA Victoria) to implement regulations, maintain State Environment Protection Policies (SEPPs), manage waste and protect the environment from pollution. The Act also regulates the discharge or emission of waste to water, land or air by a system of Works Approvals and licences.

A number of subordinate legislation and guidelines exist which further expand on the Water Act and the Environment Protection Act. SEPPs set out Victorian Government policies that control and reduce environmental pollution and have been formulated for discharges to land, water, atmosphere and noise emissions. These policies protect the environment and human activities (beneficial uses) from pollution caused by waste discharges and noise and are subordinate documents to the Environment Protection Act. The SEPP (Waters) has been reviewed and is currently open to consultation until June 2018, the finalised policy is anticipated to be released in 2018/2019.

The SEPP (Groundwaters of Victoria) is part of *the Environment Protection Act 1970* and was developed in 1997 (latest amendment 2002) to meet community demands for an integrated framework of environment protection goals for groundwater. It aims to maintain and, where necessary, improve groundwater quality to a standard that protects existing and potential beneficial uses of groundwater. It sets a consistent approach to, and provides quality objectives for, groundwater protection throughout Victoria. This policy overrides all existing groundwater protection provisions in other SEPPs.

The policy provides that groundwater is categorised into segments, with each segment having identified uses. Groundwater with higher concentrations of salinity (measured as mg/L TDS) is deemed to have fewer beneficial uses. The segments and their beneficial uses are summarised in Table 3.1 and Table 3.2.

Table 3.1 Segments (Government of Victoria, 1997)

SEGMENT	A1	A2	B	C	D
TDS range (mg/L)	0–500	501–1,000	1,001–3,500	3,501–13,000	Greater than 13,000

Table 3.2 Protected beneficial uses of the segments (Government of Victoria, 1997)

BENEFICIAL USES	SEGMENTS (mg/L TDS)				
	A1	A2	B	C	D
Maintenance of ecosystems	✓	✓	✓	✓	✓
Potable water supply (desirable)	✓				
Potable water supply (acceptable)		✓			
Potable mineral water supply	✓	✓	✓		
Agriculture, parks and gardens	✓	✓	✓		
Stock watering	✓	✓	✓	✓	
Industrial water use	✓	✓	✓	✓	✓
Primary contact recreation	✓	✓	✓	✓	
Buildings and structures	✓	✓	✓	✓	✓

EPA Victoria may determine these beneficial uses do not apply to groundwater where:

- There is insufficient aquifer yield to sustain the beneficial use
- The background level of a water quality indicator other than TDS may be detrimental to the beneficial use
- The beneficial use is impracticable due to one or more soil characteristics
- A polluted groundwater zone has been identified by the Authority.

SEPP (Groundwaters of Victoria) specifies groundwater quality objectives for various beneficial uses. For the majority of beneficial uses, these objectives are those contained within the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ, 2000) and Australian Drinking Water Guidelines (NHMRC, 2011). For the protection of aquatic ecosystems, reference is made to SEPP (Waters of Victoria (EPA Victoria, 2003)).

SEPP (Groundwaters of Victoria) also requires that occupational health and safety, odour and amenity be considered, due to the fact that vapours sourced from impacted groundwater may present a potential risk to workers, and that odours or discolouration may result in degradation of overall beneficial use.

3.3.1 GROUNDWATER LICENCING REQUIREMENTS

In Victoria, groundwater resource units are identified in Groundwater Management Areas (GMAs), Water Supply Protection Areas (WSPAs) or Unincorporated Areas (UAs). There are 40 GMAs in which groundwater has been extensively developed, or has the potential to be developed. They are geographically defined as such for the purposes of ongoing management of the aquifer and are carefully monitored via the Department of Environment, Land, Water and Planning (DELWP) State Observation Bore Network.

WSPAs are areas declared by the Minister for Water under the Act to protect stressed groundwater or surface water resources through the implementation of a statutory Groundwater Management Plan for the area. There are currently 16 WSPAs declared in Victoria. Collectively, these WSPAs and GMAs are referred to as Groundwater Management Units (GMUs).

Unincorporated Areas are areas where no significant development of the groundwater resource has occurred. This is usually because the resource is low yielding, or its quality has traditionally severely limited its use. They exist outside of GMU boundaries, although they will be defined within a GMU in the next few years.

Groundwater extraction is managed through licensing and is allocated under the *Water Act 1989*:

- To drill a groundwater bore, a Bore Construction License is required under Section 67 of the Act for all persons
- To extract groundwater for commercial purposes (not including domestic and stock users) a Take and Use Licence is required under Section 51 of the Act.

Rural Water corporations are responsible for assessing licence applications, deciding whether to issue licences, and the terms and conditions on which the licence is issued. The licence will specify the exact location and depth from which groundwater can be extracted, the annual volume of water that can be pumped and the rate at which the pumping can occur (Southern Rural Water, 2017).

Permissible Consumptive Volumes (PCVs) have been set by the Minister for Water, which detail the maximum volume of water that can be allocated in an area for all geological formation below the surface. Many areas have been allocated to their PCV limit, meaning no new licences can be issued in these areas. The only way to acquire new groundwater in these areas is to trade with an existing groundwater licence holder. PCVs are imposed to protect the resource and prevent depletion. PCVs do not apply to UAs.

The objective of the management plan, as set out in the *Water Act 1989*, is to make sure that the water resources of the area are managed in an equitable manner to ensure the long-term sustainability of those resources. The management plan does not place restrictions on the taking of groundwater already held under licence through S51 of the Water Act, but does allow for the taking of water to be restricted in the future, if deemed necessary to ensure the sustainability of the resource.

Mordialloc Bypass site is immediately adjacent to the Moorabbin GMA, which has a PCV of 2,700 ML/yr with the northern end of the project site near Heatherton just inside the GMA boundary (Figure 3.1). Both GMAs are included in the East Port Phillip Bay Groundwater Catchment Statement (Southern Rural Water/DEPI, 2014).

Where excavations penetrate the water table and dewatering is required, a licence to take groundwater must be sought from Southern Rural Water. An analysis will need to be carried out to estimate the required dewatering rate and volume (Southern Rural Water, 2017).

The discharge of dewatered groundwater to the environment or to drainage infrastructure will need to be licensed by the relevant authority, water disposal to a licensed facility will not require a licence. An assessment of volume and water chemistry will need to be carried out to assess the most appropriate discharge method and obtain the relevant approvals.

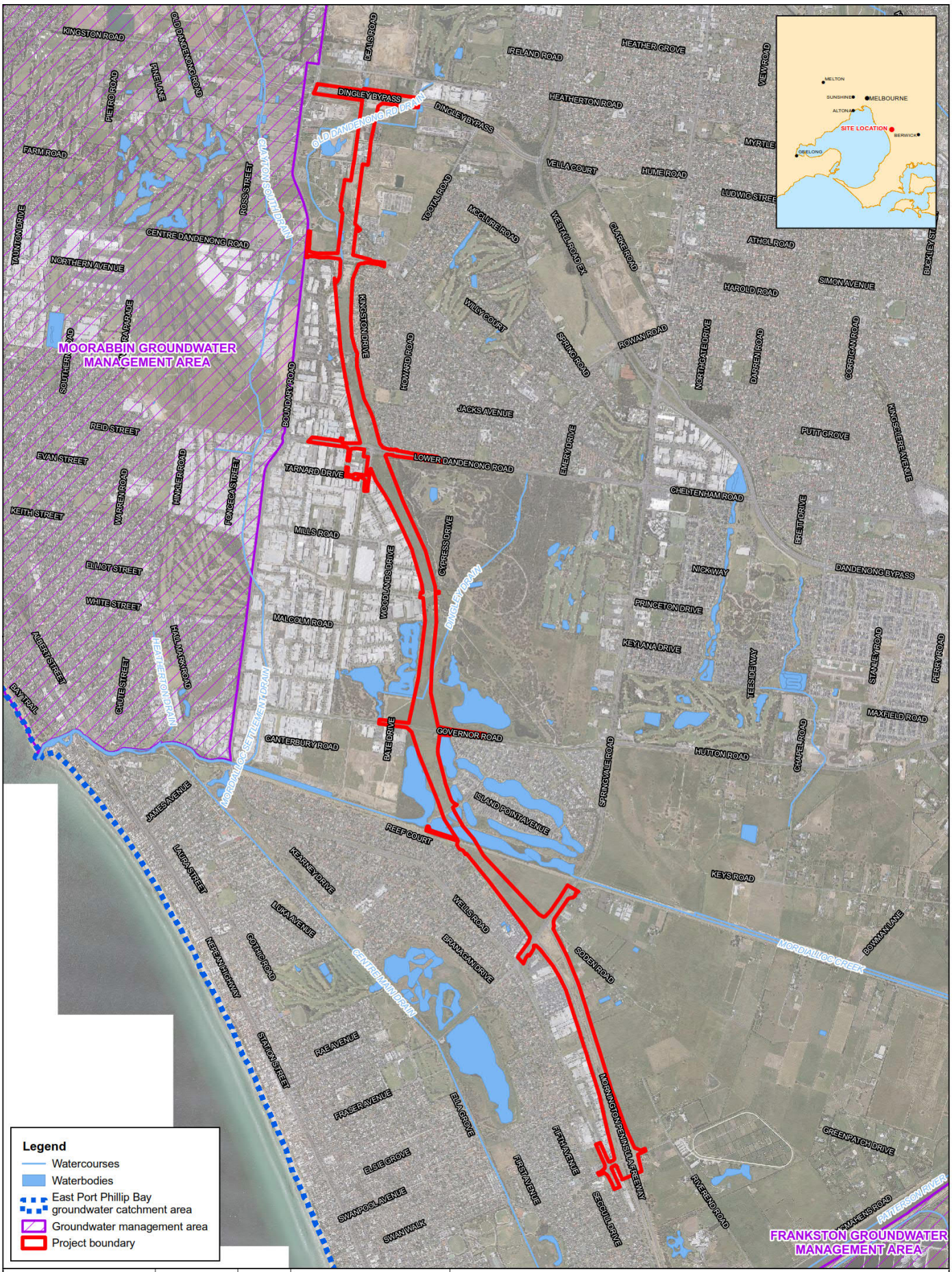

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Figure 3.1

Groundwater management areas at the Mordialloc Bypass project site

4 METHODOLOGY

4.1 METHODOLOGY OVERVIEW

As described in Section 1.2, the EES report, this report, focusses on satisfying both the Australian Government's requirements under the EPBC Act and Victoria State Government requirements under the Water Act (1989) the Environment Protection Act (1970), and State Environment Protection Policy (SEPP) (Groundwaters of Victoria) instruments described in Section 3.

4.1.1 AIMS AND OBJECTIVES

The overall aim of this EES is to describe the existing groundwater conditions and potential for impact of the project on the local and regional groundwater systems including the Braeside Park wetlands, Woodland Industrial Estate wetlands, Waterways Estate Wetlands (Waterways Wetlands) and Ramsar-listed Edithvale-Seaford Wetlands (Edithvale portion only), and, associated existing and potential beneficial uses of groundwater (groundwater users and the areas environmental values, including those ecosystems sustained/dependant on groundwater (refer to Section 3.3).

As such, this report has the following objectives:

- Create a conceptual hydrogeological model (CHM) representative of groundwater regime at the Project area
- Characterisation of the existing site groundwater levels, flows and quality
- Assess the potential for change in groundwater levels and quality in response construction of the embankments and piled portions of the roadway
- Assess the groundwater related impacts on the adjacent Edithvale Wetlands, Waterway Estate Wetlands, Woodlands Industrial Estate Wetland and the Braeside Park as result of the project
- Assess the change in groundwater flow due to compaction from embankments
- Evaluate if the groundwater input to the wetlands is linked in some way to the project area
- Recommend mitigation measures, if required, which may minimise or avoid impacts to the groundwater regime, where such impacts are meaningful when considered against the natural variations encountered in wetlands within a built environment
- Provide recommendations for additional assessment work as required.

4.1.2 SCOPE OF WORK

The achieve the aims and objectives described above, the following key activities were undertaken:

- A desktop review of publicly available information on the known regional groundwater setting that might sustain the ecological values of the wetlands.
- A field investigation to establish the site-specific conditions having a bearing on the local and regional conditions that are identified in the desktop review. These intrusive investigations were designed to install a targeted groundwater monitoring network, gather water level data from the key aquifers, collect and analyse water quality parameters of the groundwater systems underlying the project alignment, measure the permeability (hydraulic conductivity) of the aquifer units, and set the monitoring bores up for ongoing (pre-construction, construction phase and post construction groundwater monitoring).
- An assessment of existing site baseline conditions and the physical mechanisms that might result in the inferred groundwater impacts potentially arising from the project, and subsequently the quantification of the impacts to the groundwater regime.
- Confirm the risk assessment outcome (Section 1.2) and provide conclusions and recommendations on the risk ranking to ecological impacts on the Edithvale-Seaford Wetlands based on inferred groundwater disruption and precautionary design measures to be included in the project design process.

Aspects pertaining to soil and groundwater contamination, and acid sulfate soils are outside the scope of the groundwater impact assessment and discussed in the Technical Impact Assessment Report (Contaminated Land and Acid Sulfate Soil).

4.2 PRELIMINARY IMPACT IDENTIFICATION

4.2.1 DESKTOP ASSESSMENT

Impacts to groundwater resources can be simplified into two categories: impacts to *groundwater quality* and impacts to groundwater levels (*groundwater quantity*). A preliminary groundwater desktop assessment was undertaken to identify potential impacts to groundwater quality and or quantity caused by the project. Table 4.1 outlines the potential impacts using a source – pathway – receptor approach.

Potential risks identified during the preliminary desktop investigation influenced the design site investigation program and development of the numerical groundwater model

Table 4.1 Groundwater risk identification

SOURCE	PATHWAY	RECEPTOR
Groundwater mounding	Groundwater levels up gradient from embankment structures could rise due to reduction of permeability under the embankment structures (due to compaction effects), causing in impact to the existing groundwater regime. The potential increase in groundwater levels could impact vegetation with increased duration and spatial coverage of subsurface saturation.	Groundwater dependent ecosystems Existing groundwater users Residents
Groundwater mounding	Groundwater levels up gradient from embankment structures could rise due to reduction of permeability under the embankment structures (due to compaction effects), potentially causing groundwater to pool in low lying depressions.	Human Health (exposure during construction) Residents
Groundwater drawdown	Groundwater levels down gradient from the embankment structures could decreased due to the reduction of permeability under the embankment structures (due to compaction effects). The potential "groundwater shadow" could impact the groundwater regime decreasing the availability to groundwater users.	Groundwater dependent ecosystems Existing groundwater users
Groundwater drawdown	Groundwater levels down gradient from the embankment structures could activate coastal acid sulfate soils impacting on groundwater quality.	Human Health (exposure during construction) Environment (groundwater and land
Groundwater contamination	Groundwater quality impacted during construction due to spills or exposure of contaminated material.	Groundwater dependant ecosystems Existing groundwater users.

4.3 EXISTING CONDITIONS ASSESSMENT

4.3.1 REGIONAL GROUNDWATER CONCEPTUALISATION AND DESKTOP INVESTIGATION

Built off previous WSP desktop investigations and risk analysis (WSP2017a, WSP2017b), the conceptual regional groundwater understanding was developed and refined through different stages of the project. The desktop investigation identified:

- Sensitive receptors e.g. registered groundwater users, groundwater dependent ecosystems and surface water bodies.
- Areas of potential impact
- Data gaps requiring additional information to complete understanding of the hydrogeological regime in the region surrounding the project footprint.

These findings assisted in developing and planning the site investigation based on the potential areas of concern identified previously. Areas of the alignment requiring additional information pertaining to surface and groundwater were:

- *Northern end* – potential impacts from landfills and drainage infrastructure.
- *North of Governor Road* – water levels and quality adjacent Woodland Industrial Estate Wetland and Braeside Park Wetlands.
- *South of Governors Road* – water level and quality to assess impact of current embankment of Governor road, Waterway Estate Wetlands and potential to identify the present of a groundwater shadow.
- *North and South of Mordialloc Creek* – water level and quality to assess impact of water bodies and connectivity of surface and groundwater.
- *Springvale Road* – assessing current impact of existing embankments to the groundwater regime.

4.3.2 SITE INVESTIGATION

The intrusive site investigation consisted of a multi-stage drilling program followed by several sampling rounds and aquifer testings. The initial site investigations were limited to within the project footprint explaining the liner nature of bores. Additional bores were required to adequately assess potential impacts and for the development of a numerical groundwater model. A description of the site investigation is summarised in the following sections.

4.3.2.1 GROUNDWATER MONITORING NETWORK

The groundwater monitoring network consists of 35 groundwater monitoring bores. In the initial phase of the project 19 groundwater monitoring bores and a leachate monitoring bore were drilled and installed using a rotary drilling rig. The requirement for a numerical groundwater model led to the installation of an additional 16 groundwater bores to increase the spatial coverage of the monitoring network.

The groundwater monitoring bores target the aquifer units of concern being the Quaternary alluvial aquifer, Brighton Group and Fyansford Formation. At several locations, two monitoring bores were installed as a 'nested location' to assess the vertical gradient between aquifers.

The groundwater bores were installed under supervision of WSP qualified personal and constructed to Minimum Construction Requirements for Water Bores in Australian 3rd edition (NUDLC 2012). The newly installed groundwater monitoring bores were developed by the drillers by air injection to remove fine/silts from the screen area. Monitoring points were surveyed to MGA94 (Zone 54) and Australian Height Datum (AHD) by a professional surveyor (see Table 4.2 and Figure 4.1). Detailed bore logs, construction design, bore construction licences are presented in Appendix A.

The groundwater monitoring network is intended, where practical, to continue though the construction phase and for a 2-year post-construction period (based on criteria established during baseline monitoring).

Table 4.2 Monitoring bore construction summary

BORE ID	EASTING	NORTHING	BORE DEPTH (m)	RL MEASURING POINT (TOC) (mAHD)	SCREEN (mBGL)	NATURAL SURFACE (mAHD)
GW17-26-03	334703.908	5793927.098	8	8.716	5-8	8.716
GW17-26-04	335118.243	5791871.368	7.7	2.787	3.6-6.6	2.167
GW17-26-05	335220.271	5791850.618	7	3.059	3.5-6.5	2.366
GW17-26-06	335116.854	5791315.911	6	2.292	2.5-5.5	1.745
GW17-26-07	335273.806	5791347.127	6	2.213	2.5-5.5	1.764
GW17-26-08	335302.172	5790811.848	6	2.315	2.5-5.5	1.830
GW17-26-09	335395.023	5790840.764	6.0	2.574	2.5-5.5	2.133
GW17-26-10-D	335509.169	5790434.978	20.0	2.836	8-17	2.283
GW17-26-10-S	335505.673	5790431.824	6.9	2.722	3.4-6.4	2.098
GW17-26-11D	335663.984	5790405.428	19.9	3.172	7.9-16.9	2.608
GW17-26-11S	335669.993	5790402.978	7.0	3.191	3.5-6.5	2.616
GW17-26-12D	336042.764	5789766.170	19.9	2.979	7.9-16.9	2.307
GW17-26-12S	336046.533	5789769.069	7.0	2.943	3.5-6.5	2.270
GW17-26-13D	336181.995	5789838.004	20.0	2.845	8-17	2.130
GW17-26-13S	336185.530	5789835.199	7.0	2.732	3.5-6.5	2.084
GW17-26-14D	336214.639	5789509.777	16.0	2.443	8-15	1.779
GW17-26-14S	336218.268	5789512.780	7.1	2.472	3.6-6.6	1.886
GW17-26-15D	336358.068	5789591.838	16.0	2.152	8-15	1.507
GW17-26-15S	336355.809	5789595.717	7.1	2.082	3.6-6.6	1.497
GW18-26-16D	335715.06	5791857.72	17.5	3.46	7.5-16.5	3.46
GW18-26-16S	335712.34	5791858.58	6.8	3.358	2.8-5.8	3.358
GW18-26-17D	335466.59	5791097.37	18.4	1.895	7.7-16.7	1.895
GW18-26-17S	335467.82	5791100.36	7.1	1.871	2.3-5.3	1.871
GW18-26-18D	334926.29	5790618.76	17.7	2.359	7.7-16.7	2.359
GW18-26-18S	334925.47	5790615.60	6.3	2.370	2.3-5.3	2.370
GW18-26-19D	336008.79	5790191.94	17.4	1.995	7.5-16.5	1.995
GW18-26-19S	336009.94	5790191.20	6.4	1.998	2.4-5.3	1.998
GW18-26-20D	335781.43	5790084.91	18.3	2.313	8.3-17.7	2.313
GW18-26-20S	335780.73	5790086.16	7.3	2.275	3.3-6.3	2.275
GW18-26-21D	336979.66	5789120.49	17.7	2.091	7.7-16.9	2.091

BORE ID	EASTING	NORTHING	BORE DEPTH (m)	RL MEASURING POINT (TOC) (mAHD)	SCREEN (mBGL)	NATURAL SURFACE (mAHD)
GW18-26-21S	336982.70	5789118.12	6.5	2.115	2.5-5.5	2.115
GW18-26-22D	335796.25	5789569.39	17.6	2.555	7.6-16.6	2.555
GW18-26-22S	335793.73	5789572.16	5.9	2.534	1.9-4.9	2.534
GW18-26-23D	335386.74	5789497.06	17	1.212	7-16	1.212
GW18-26-23S	335382.50	5789500.85	6.6	1.172	2.6-5.6	1.172

RL: reduced level, TOC: top of casing, mAHD: metres Australian Height Datum, mBGL: metres below ground level.

4.3.2.2 GROUNDWATER LEVEL MONITORING

Automated groundwater level monitoring and data recording equipment has been installed in 20 of the 35 groundwater monitoring bores. The Solinst© Level Loggers have been synchronised and record water levels at 6 hour intervals. A barometric logger has also been installed to allow data to be compensated for atmospheric influences. Additionally, manual groundwater levels have been obtained at each quarterly groundwater sampling event. To date 3 quarterly sampling events have occurred.

4.3.2.3 GROUNDWATER AND SURFACE WATER QUALITY MONITORING

To obtain baseline water quality data, quarterly water quality sampling has occurred commencing in August 2017. Quarterly water quality sampling captures any seasonal variability within the groundwater regime and surrounding Wetlands. To date three groundwater monitoring events (GMEs) have occurred (August/September, November 2017 and February/March 2018).

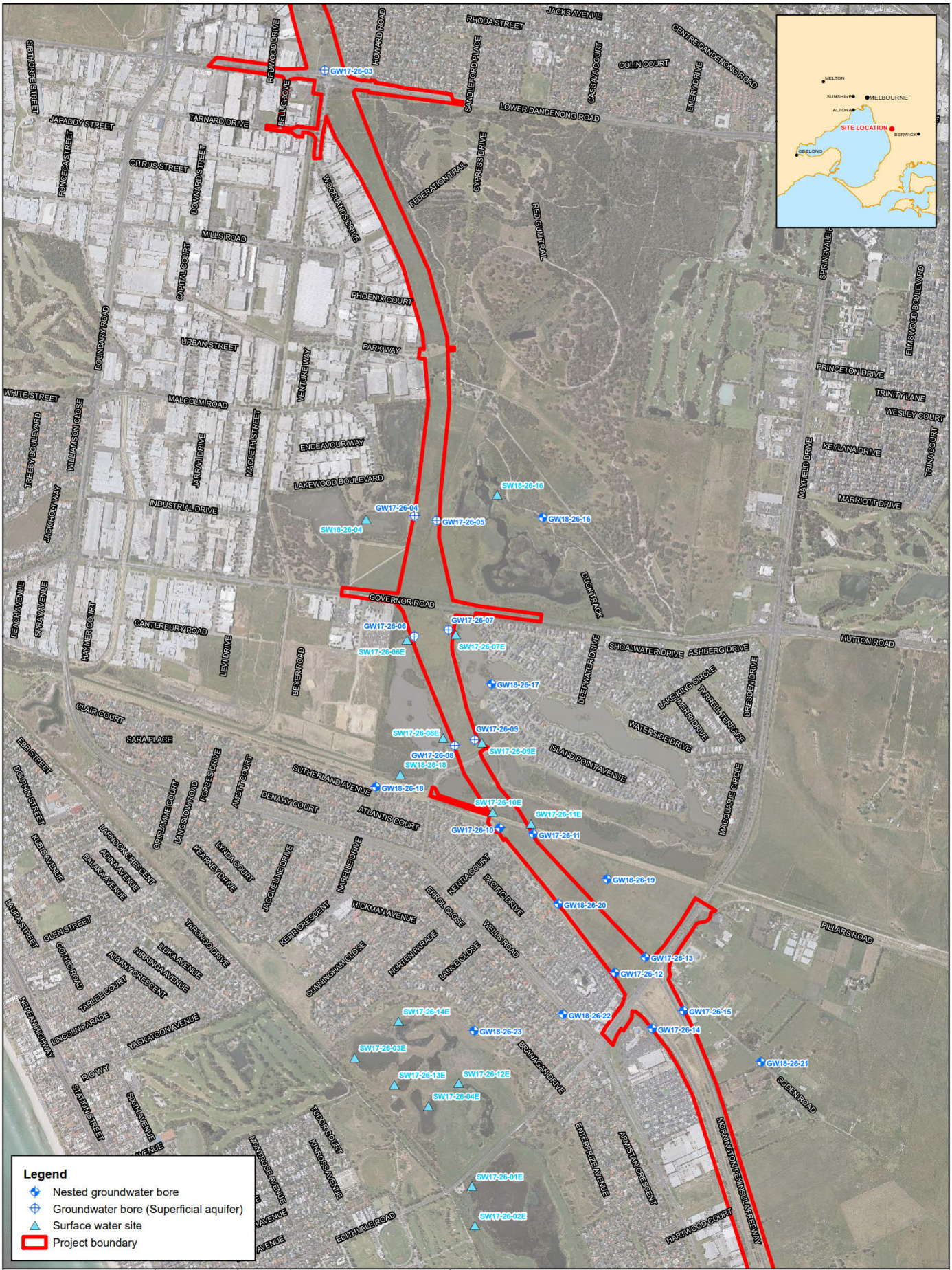
The GME collected water quality samples from both groundwater monitoring bores and wetland waterbodies. Groundwater was sampled with a 12-volt submersible pump was positioned within the well screen sections of the water column.

Surface water samples were collected as grab samples using an extended sampling pole from the edge embankment of the wetland cells. Samples were collected from Waterways Wetlands, Mordialloc Creek, Edithvale North and South Wetlands and Port Phillip Bay at Edithvale. Additional surface water sampling locations were added to the February GME at Woodlands Industrial Wetland and Braeside Park Wetland. Surface water sample locations are presented in Figure 4.1.

Field parameters (including dissolved oxygen (DO), temperature, pH, redox, electrical conductivity (EC)) were recorded periodically and water samples were obtained following stabilisation of parameters to within 10% (or 0.2°C for temperature), in accordance with EPA Victoria publication 669.

Groundwater and surface water samples were collected in laboratory supplied bottles with appropriate preservation where required. Samples collected for dissolved metal analysis were field filtered through a 0.45 µm filter.

Water samples were transported under appropriate chain-of-custody protocols in an ice-filled esky to ALS (NATA accredited) within holding times and were analysed for major ions, dissolved metals, nutrients, hydrocarbons, oil and grease and pesticides. Field duplicates were collected at a ratio of 1 in 10 for quality control. Water samples for stable isotope analysis (deuterium (δ^2H) and oxygen-18 ($\delta^{18}O$)) were submitted to ANSTO.



Map: 2135645A_GIS_947_A	Author: MB
Date: 4/09/2018	Approved by: AS

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Coordinate system: GDA 1994 MGA Zone 55

Scale ratio correct when printed at A3

Data source: VicRoads.
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Figure 4.1

Groundwater monitoring network

To characterise baseline water quality conditions within the regional and local groundwater, major ions and metals we selected for analysis. A range of hydrocarbons and pesticides were also included to confirm if contaminated groundwater was present. Stable isotopes were included at a later date to assist in the geochemical analysis of surface water bodies and groundwater. As such, the water quality samples were analysed for the following:

- Physico-chemical parameters (pH, EC, TDS)
- Major Ions (Ca, Cl, HCO_3, Mg, K, Na, NO_3, SO_4, Br, F)
- Dissolved Metals (Al, As, Ba, Be, B, Cd, Cr, Co, Hg, Pb, Mn, Ni, Se, V, Zn)
- TRH/TPH & BTEXN
- Pesticides (First sampling event only)
- Stable Isotopes (deuterium (δ^2H) and oxygen-18 ($\delta^{18}O$) - second and third sampling events only).

The details of this investigation program and the data interpretation are provided in Section 5.8, with a summary of relevant information provided in summary in the following sections. Laboratory results are located within Appendix B.

4.3.2.4 AQUIFER HYDRAULIC TESTING

In-situ rising and falling head (slug) testing was completed on 34 of the 35 monitoring bores to provide estimates of hydraulic conductivity (K, m/day) of both the Quaternary alluvial aquifer and Upper Tertiary Aquifer (UTAF) at each location. The rising and falling head tests were analysed in AQTESOLV software using the Bower and Rice (1976) and Cooper-Breadroot-Papadopoulos (1967) solutions.

The hydraulic conductivity values are required in the validation of parameters for the numerical groundwater model (Section 4.5). Results of the aquifer tests are presented in Appendix B.

4.4 RISK ASSESSMENT

As outlined in the Ministerial Guidelines for Assessment of Environmental Effects (2006) and the Scoping Requirements for the Mordialloc Bypass Project EES (2018), a risk-based approach was adopted for the EES studies to direct a greater level of effort at investigating matters that pose relatively higher risk of adverse environmental effects. The following definitions were adopted for the assessment:

- *Environmental impact:* is described as any change to the environment as a result of a project activities.
- *Environmental risk:* As defined by the Ministerial Guidelines for Assessment of Environmental Effects Under the Environment Effects Act 1978 (DSE, 2006), *"Environmental risk reflects the potential for negative change, injury or loss with respect to environmental assets".*

The purpose of the risk assessment was to provide a systematic approach to identifying and assessing the environmental risks, including heritage, cultural, social, health, safety and economic aspects as a result of the project. It articulates the likelihood of an incident with environmental effects occurring and the consequential impact to the environment.

The impact assessment and risk assessment processes were integrated throughout the development of the EES. The environmental risk assessment (ERA) process allowed the project team to identify as many environmental risks as a result of the project as possible and refine and target impact assessments accordingly. The impact assessments ensured the project team has a robust understanding of the nature and significance of impacts and the mitigation measures developed to minimise and control those impacts.

The risk and impact assessment processes were essential components of the project design process and in the formulation of construction and additional mitigation measures to minimise environmental impacts. These assessments also underpin the establishment of the Environmental Performance Requirements (EPRs), which set out the desired environmental outcomes for the project.

The below methodology was developed to assess the potential impacts of the Mordialloc Bypass on groundwater and sets out the process, methods and tools used to complete the impact and risk assessments.

4.4.1 RISK ASSESSMENT METHODOLOGY

The risk assessment is a critical part of the EES process as it guided the level and extent of impact assessment work required and facilitated a consistent approach to risk assessment across the various technical disciplines. The risk assessment process was based on the approach defined in *ISO 31000:2018 Risk Management – Principles and Guidelines*, which describes an environmental risk management process which is iterative and supported by ongoing communication and consultation with project stakeholders. The ERA process incorporated VicRoads key risk management requirements, specifically from the VicRoads Environmental Risk Management Guidelines (2012) and the VicRoads Environmental Sustainability Toolkit (2017).

4.4.1.1 SCOPE AND BOUNDARIES

The ERA assessed all project phases, namely: Initial Phase (the current approvals and concept design stage); Construction Phase; and Operations and maintenance Phase. The risk process evaluated environmental risks that would result from the development of the project based on the concept designs for the project, the draft construction methodology and the existing conditions of the study area, as well as the draft environmental impact assessment reports which were in development during the ERA.

4.4.1.2 RISK IDENTIFICATION

To effectively and comprehensively recognise all potential environmental risks that may result from the project, it was necessary to identify impact pathways for all project activities during all its project phases. An impact pathway is the cause and effect pathway or causal relationship that exists between a project activity and an asset, value or use of the environment

Environmental impact pathways were identified under two categories:

- Primary environmental impacts: The impacts to environmental values that are directly attributable to project activities within a cause and effect paradigm. Project activities cause environmental impacts (effects) on environmental values through an environmental impact pathway such as construction activities. The assessment of these impacts and their associated risks assumes that all standard mitigation measures are in place and working as intended.
- Cumulative impacts: The potential cumulative impacts to environmental values that may result from the implementation of the project. This allowed for the identification of:
  - Secondary environmental risks which may result from the implementation of a risk response in mitigating a primary environmental risk
  - On-site aggregate risks resulting from multiple on-site project activities on an environmental asset (risks were assessed in two ways, as a single project phase and as a whole project risk)
  - Off-site cumulative environmental risks which accounted for potential off-site cumulative impacts of the Mordialloc Bypass project in conjunction with surrounding off-site projects in the local area.

4.4.1.3 RISK ANALYSIS

With risks identified for each discipline, VicRoads and industry best practice and standard mitigation controls that are considered intrinsic to a project of this nature were identified, including requirements under relevant sections of the VicRoads Standard Specifications, EPA guidelines and Government environmental management policies.

4.4.1.4 RISK EVALUATION

The ERA process developed for the project is based on the risk analysis matrix used on recent and similar VicRoads projects, as presented in Table 4.3. It follows the standard industry semi-quantitative risk analysis methodology that utilises pre-defined consequence and likelihood criteria as the factors to arrive at a risk rating.

Table 4.3 Risk analysis matrix

			LIKELIHOOD				
CONSEQUENCE	Risk Categories		Rare	Unlikely	Possible	Likely	Almost Certain
			A	B	C	D	E
	Catastrophic	5	Medium	High	High	Extreme	Extreme
	Major	4	Medium	Medium	High	High	Extreme
	Moderate	3	Low	Medium	Medium	High	High
	Minor	2	Negligible	Low	Low	Medium	Medium
	Insignificant	1	Negligible	Negligible	Negligible	Low	Low

Based on the project objectives and context, a set of project-specific and appropriate likelihood and consequence criteria were developed in consultation with VicRoads, the TRG and technical specialists (Table 4.4 and Table 4.5).

Table 4.4 Likelihood categories

LIKELIHOOD				
Less than once in 12 months OR 5% chance of occurrence during course of the project	Once to twice in 12 months OR 5 - 10% chance of occurrence during course of the project	3 to 4 times in 12 months OR 30% chance of occurrence during course of the project	5 to 6 times in 12 months OR 50% chance of occurrence during course of the project	More than 6 times in 12 months OR 100% chance of occurrence during course of the project
The event may occur only in exceptional circumstances	The event could occur but is not expected	The event could occur	The event will probably occur in most circumstances	The event is expected to occur in most circumstances
It has not happened in Victoria but has occurred on other road projects in Australia.	It has not happened in metropolitan Melbourne but has occurred on other road projects in Victoria	It has happened in metropolitan Melbourne	It has happened on a road project in metropolitan Melbourne in the last 5 years	It has happened on a road project of similar size and nature in metropolitan Melbourne within the last 2 years. OR It has happened multiple times on a road project in the region within the last 5 years.
Rare	Unlikely	Possible	Likely	Almost Certain
A	B	C	D	E

Table 4.5 Environmental risk assessment consequence descriptors

PROJECT PHASE	INSIGNIFICANT	MINOR	MODERATE	MAJOR	CATASTROPHIC
Construction impacts on Groundwater	No detectable change to groundwater regime, quality and availability.	Temporary changes to groundwater regime, quality and availability but no significant implication.	Changes to groundwater regime, quality and availability with minor implications (localised).	Groundwater regime, quality or availability significantly compromised.	Widespread groundwater resource depletion, contamination or subsidence.
Operation impacts on Groundwater	No detectable change to groundwater regime, quality and availability.	Changes to groundwater regime, quality and availability but no significant implication.	Changes to groundwater regime, quality and availability with minor implications for a localised area.	Groundwater regime, quality or availability significantly compromised.	Widespread groundwater resource depletion, contamination or subsidence.
Construction effects beneficial users (including groundwater dependent ecosystems)	Negligible change to groundwater quality and groundwater levels affecting existing users (registered bore owners, GDEs and surface water).	Temporary minor change to groundwater quality and groundwater levels affecting existing users (registered bore owners, GDEs and surface water).	Permanent minor change to groundwater quality and groundwater levels affecting existing users (registered bore owners, GDEs and surface water).	Localised significant change to groundwater quality and groundwater levels affecting existing users (registered bore owners, GDEs and surface water). "Make good" measures required.	Widespread significant change to groundwater quality and groundwater levels affecting existing users (registered bore owners, GDEs and surface water). "Make good" measures required.

For all risks rated medium, high or extreme in the initial risk rating, technical specialists were required to identify additional controls which could be implemented to further reduce risk and to perform the residual risk rating. Additional controls specify management measures over and above those considered as Standard Controls to ensure the residual risk has been effectively avoided or mitigated to as low as reasonably practicable.

Where risks could not be eliminated or sufficiently reduced (e.g. by engineering controls or re-design), these will typically be addressed by specific conditions in a site Environmental Management Plan (EMP), or be the subject of a separate management plan, including adaptive management plans based on ongoing studies or monitoring.

4.5 IMPACT ASSESSMENT METHOD

4.5.1 ASSESSMENT METHODOLOGY

Assessing the groundwater related impacts of the proposed project was a two-fold process, involving:

- A preliminary assessment of effects of embankment placement compaction effects
- Finite difference numerical model development.

The methodology employed to calculate the impact effects are provided in the following sections:

4.5.2 EMBANKMENT CONSOLIDATION STUDY

As suggested earlier in this report, construction of embankments on subsurface compressible soils present beneath the project alignment may reduce the soil porosity though compaction and void closure effects, and thereby reduce permeability, under the embankment approached to the elevated viaduct structures. This has the potential to constrict prevailing groundwater flow in the down-gradient areas. As such, groundwater flow changes induced may impact the ecological health of the Edithvale-Seaford Wetlands without sufficient mitigation.

The effect of soil porosity reduction on the permeability of subsoil layers was investigated based on the available laboratory test results. The Boussinesq stress distribution method was used to simulate the stress distribution in the soil due to the weight of the embankment. The assessment methodology and results of the analysis are presented Appendix C.

4.5.3 IMPACT QUANTIFICATION – FINITE DIFFERENCE NUMERICAL MODELLING

To quantify potential impacts to groundwater identified during the preliminary groundwater impact assessments and risk assessment process (Section 1), a regional numerical model has been developed using MODFLOW USG and the Groundwater Vistas Version 7 graphic user interface. The following sections summarise the methodology used in the development of the numerical groundwater model. A detailed description of the development, calibration, and predictions are located the separate groundwater modelling report (Appendix D), whilst the results of the impact predictions are provided in Section 7.

4.5.3.1 NUMERICAL MODEL SETUP

The regional numerical model built for this Project was develop to conform with the Australian groundwater modelling guidelines (Barnett et al, 2012) which provide guiding principles and minimum standards of numerical groundwater models. The guidelines recommend that the overall reliability, complexity and confidence level of the model should be assessed and agreed prior to construction of the model, and if possible re-assessed at a later stage in the modelling project.

4.5.3.2 MODEL DESIGNS

The model domain is 8 km by 10.35 km. The major hydrostratigraphic units are represented by 4 model layers, pinched out where they are absent or less than a threshold of 0.1 m thick. The model cell size is 50 x 50 m over most of the model domain, but has been refined using quad-tree refinement to 12.5 x 12.5 m around the project area and at the Edithvale Wetlands. Cells outside the model domain are defined as inactive. The total number of active model cells after refinement is 138,860 (34,715 per layer). The model domain is shown on Figure 4.2.

The model domain extends far enough to allow the effects of cumulative impacts from the LXRA project to be assessed, although results of the LXRA modelling indicate that impacts from that project are very unlikely to extend to the Edithvale Wetlands (shown on Figure 4.2).

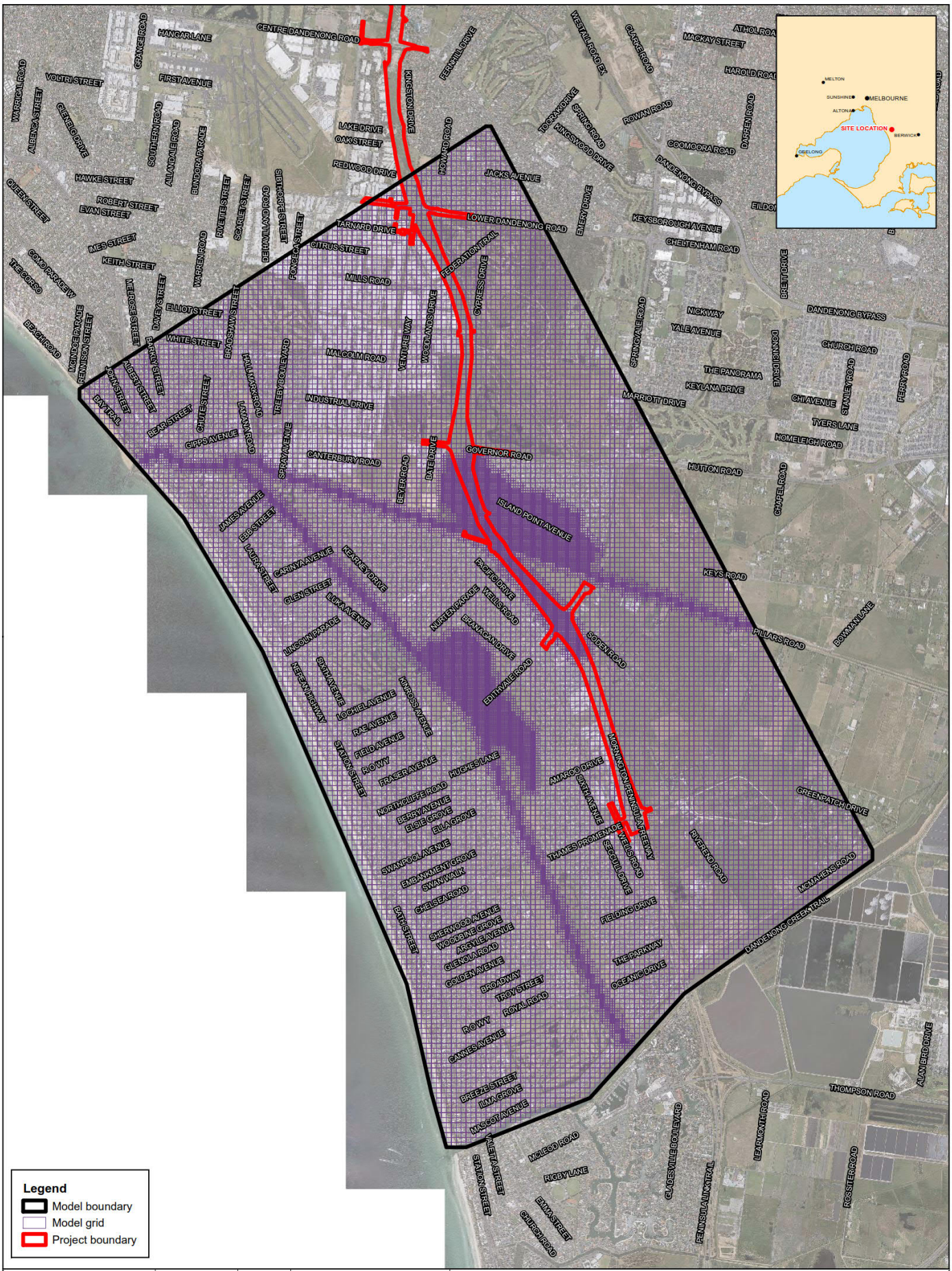

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Figure 4.2
Model domain

4.5.4 INDEPENDENT PEER REVIEW OF IMPACT MODELLING

The involvement of an independent peer review is recommendation of the Australian Groundwater Modelling guidelines (Barnett *et* al, 2012). As such, VicRoads has engaged Dr Anthony Smith (CDM Smith Pty Ltd) as a *suitably qualified person* to undertake and independent peer review of the groundwater impact assessment and numerical groundwater model. The independent review ensures the modelling approach adopted for the groundwater impact assessment meets industry standard with appropriate assumptions and inputs.

Dr Smith was also engaged by LXRA to review the numerical groundwater model for the Edithvale Bonbeach EES.

4.6 ENVIRONMENTAL MANAGEMENT FRAMEWORK

The development of the *Environmental Management Framework* (EMF) incorporates baseline environmental conditions to be used to monitor and evaluate the residual environmental effects of the project as well as the efficacy of applied mitigation measures.

In relation to groundwater, the EMF can be outlined in an Environmental Management Plan (EMP). The EMP contains details of statutory approvals, consents, procedures for monitoring or verifying compliance against each environmental performance requirements, as well as statutory reporting conditions and standards.

The EPRs, are outcomes of the risk based assessment process described in Section 4.4 and 4.5. The EPRs identified for the project have been assessed and residual risks managed through design mitigation or management processes. The EPRs listed within this report form part of the Environmental Management framework (EMF) that is required to be developed to manage environmental effects during project construction, operation and if required, reinstatement.

The final EPRs recommended for the project are detailed in Section 8 of this report.

4.7 LINKAGE TO OTHER TECHNICAL REPORTS

This report is supported by several previous technical assessments that have assisted in the identification of potential risks and the development of the conceptual groundwater understanding of the Study area.

- A preliminary groundwater impact assessment undertaken by WSP the technical report titled: *Mordialloc Bypass Preliminary Groundwater Impact Assessment,* June 2017.
- Mordialloc Bypass EPBC Act referral undertaken by WSP, *Groundwater Impacts to Edithvale Wetlands – Assessment and Mitigations Report,* October 2017.
- Desktop and targeted contaminated land investigations including landfill assessment in the northern portion of the alignment and acid sulfate soil investigation undertaken by WSP, report titled *Mordialloc Bypass – Technical Impact Assessment Report (Contaminated Land and Acid Sulfate Soil). Report number 2135645A-SE-26-CLM-0012 RevA.* May 2018.
- Surface Water Impact Assessment undertaken by WSP, report title *Mordialloc Bypass – Technical Impact Assessment Report (Surface Water). Report number 2135645A-SE-26-SW-RevB3.* May 2018.
- Geotechnical report undertaken by WSP, report title. "*Mordialloc Embankment – Preliminary Assessment of Change in permeability due to embankment loading*" (DRAFT), September 2017.
- Environmental Risk Assessment methodology undertaken by WSP, report title *Mordialloc Bypass – Environmental Risk Assessment. Report Number 2135645A-SE-26-ENV-REP-0013 RevA* (Draft), May 2018.

In addition to the technical assessments listed above, the LXRA Edithvale and Bonbeach EES process has provided groundwater data and allowed access to groundwater monitoring bores that has assisted in the development and calibration of the numerical groundwater model as described in Section 1.4.

5 EXISTING CONDITIONS

5.1 EXISTING CONDITIONS OVERVIEW

The combined desktop and site investigation (detailed above in Section 4) has been completed to develop a description of the existing conditions and conceptual understanding of Study area (which embraces the Project Area) including climatic, hydrological, hydrogeological and ecological aspects. This is a particular requirement of the EES scoping requirements (Section 1).

The following sections describe each of these aspects.

5.2 TOPOGRAPHY

Along the proposed alignment, elevations range between 30 mAHD in the north and approximately 2 mAHD in the south. Between the alignment and Port Phillip Bay, a coastal dune system runs parallel to the coast between Mordialloc and Frankston with a surface elevation up to 8 mAHD. In the coastal dune areas, elevations drop to, at, or below mean sea level, particularly within the Edithvale Wetlands (as low as -1 mAHD) and nearby wetlands, such as the Seaford and Carrum Carrum Wetlands.

5.3 CLIMATE

Meteorological data was obtained from Bonbeach (86210), the closest BOM weather station shown on Figure 5.1. Highest rainfall occurs between April to December whilst January to March have the lowest long-term monthly averages. Historical data shows that the coastal region at Bonbeach receives on average approximately 712 mm per year based on rainfall data from 1956 to 2017 (BOM, 2017a).

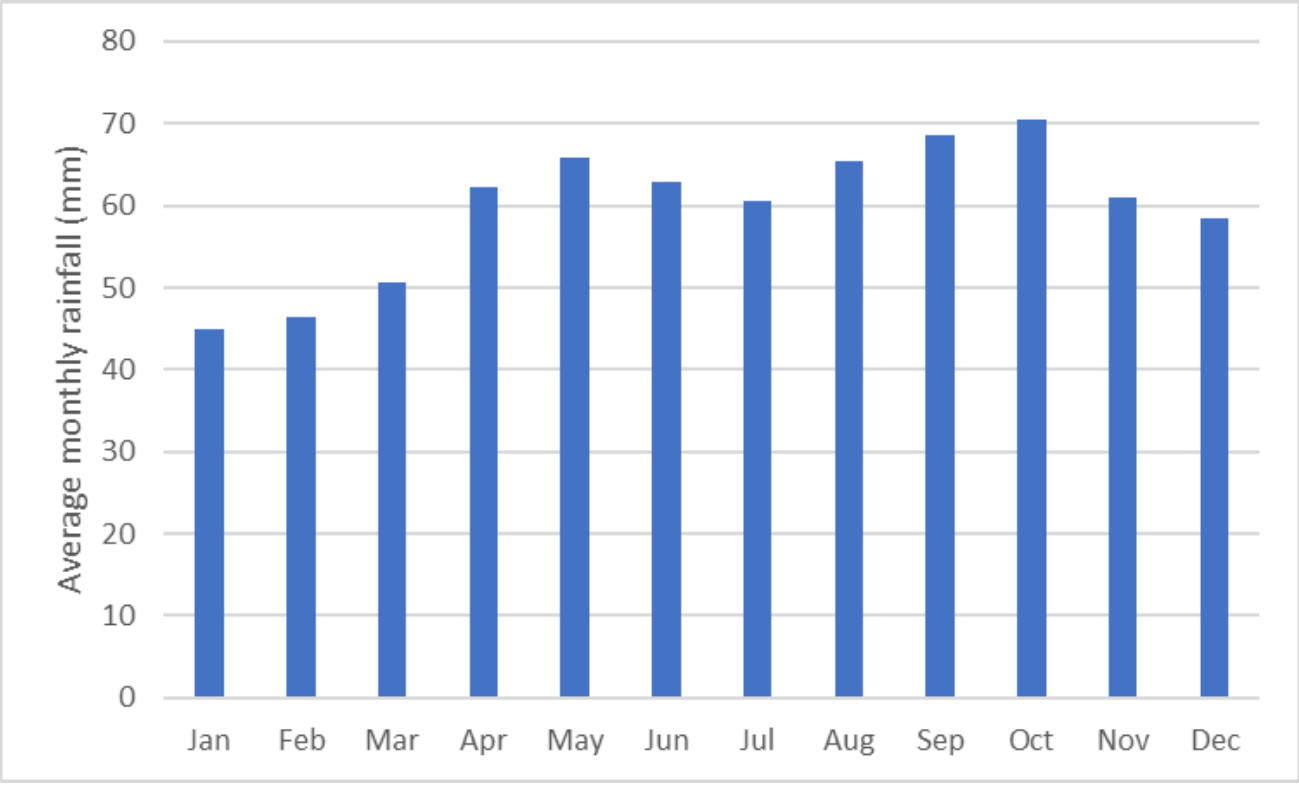

Figure 5.1 Average monthly rainfall (1955 to 2017 period for Bonbeach)

5.3.1 LONG TERM RAINFALL TREND

The long-term, annual cumulative deviation from mean (CDFM) rainfall for the 1956 to 2017 period at the Bonbeach station is plotted in Figure 5.2. The long-term cumulative rainfall residual plots provide an indication of the broad scale trends in rainfall pattern behaviour and are formulated by subtracting the average annual rainfall for the recorded period from the actual annual rainfall and then accumulating these residuals over the assessment period. Periods of below average rainfall are represented as downward trending slopes while periods of above average rainfall are represented as upward trending slopes.

The cumulative deviation plot shows a general upward sloping cumulative deviation trend from 1956 to 1974, followed by a downward sloping trend until 1986. The record over the next 10 years shows an upward sloping trend, indicating above average rainfall conditions.

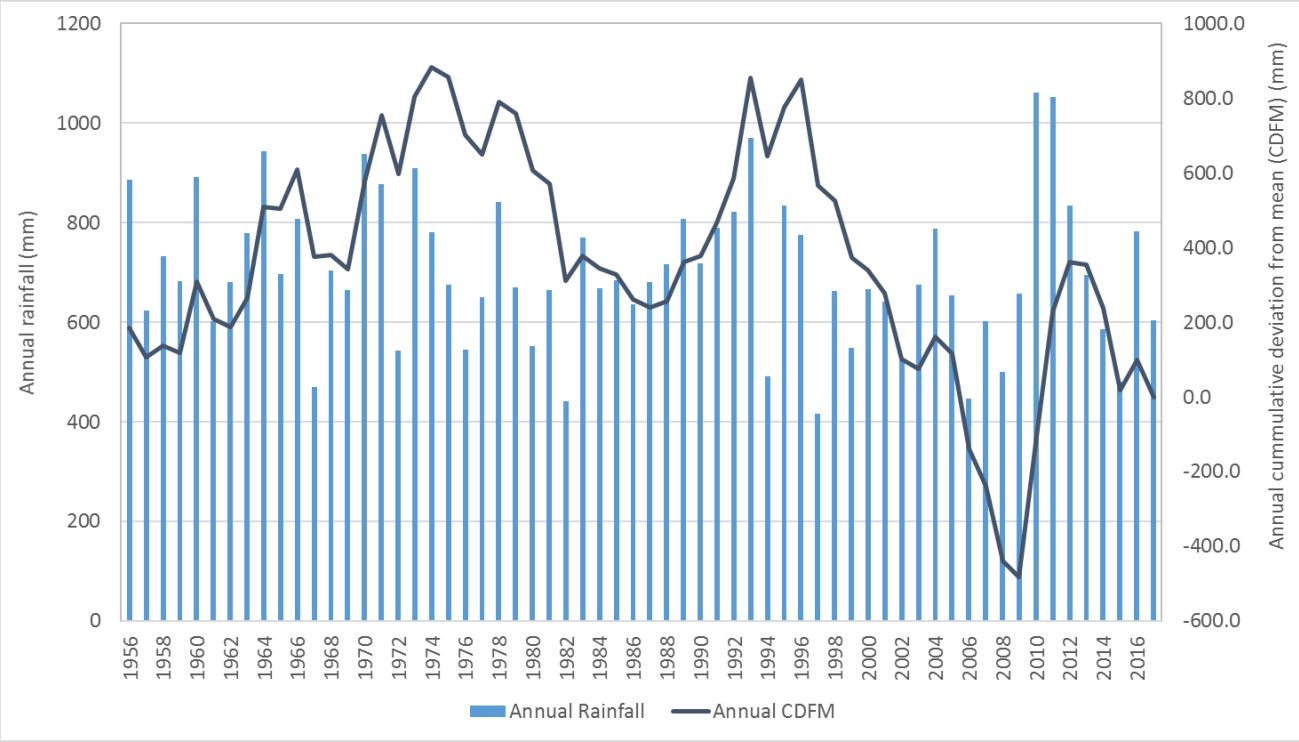

Figure 5.2 Long-term annual rainfall (Bonbeach) and CDFM curve (Bonbeach – 86210)

5.3.2 EVAPORATION

Actual evaporation data was obtained from the Bonbeach (86210) station. Daily evaporation data is greatest in the summer months of December, January and February with evaporation of 5.5, 6.1, and 5.6 mm/day respectively. The months of May, June and July show the lowest evaporation rates with 1.3 mm/day observed for June.

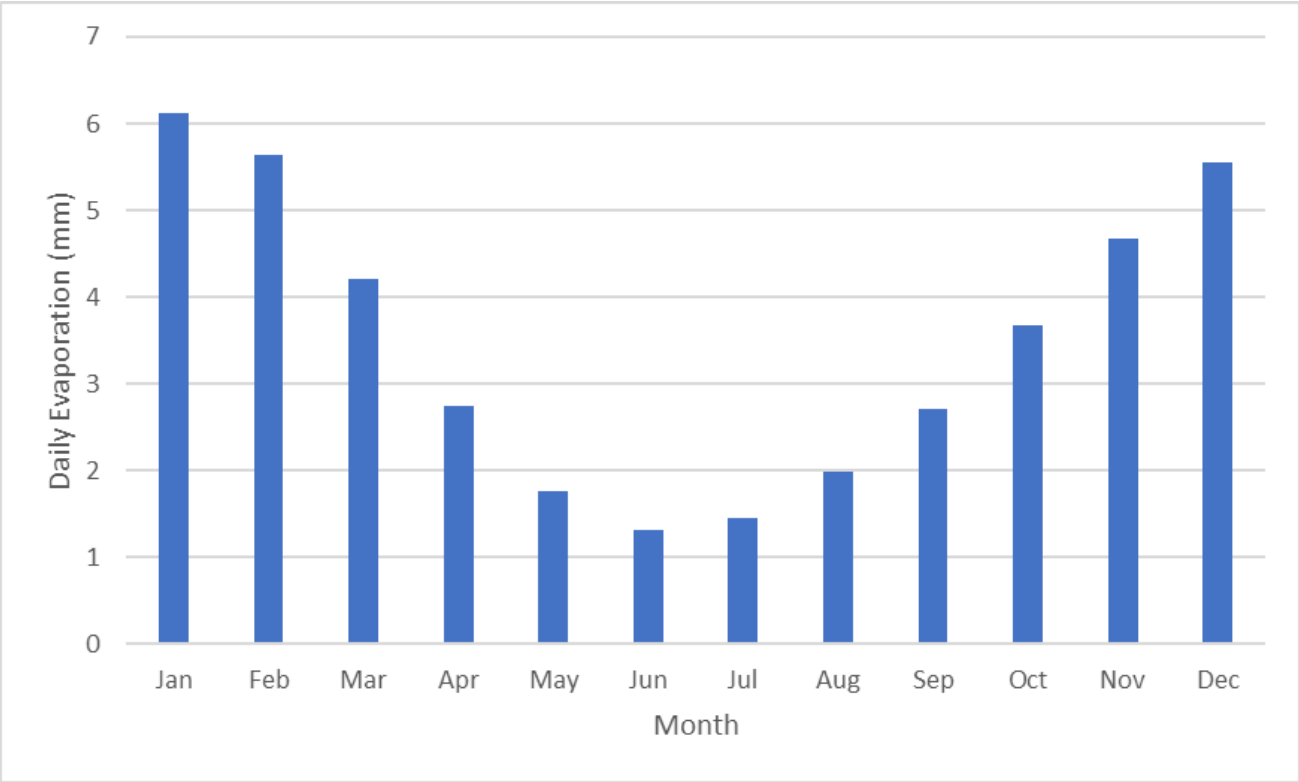

Figure 5.3 Average daily evaporation for Bonbeach (86210)

5.4 SURFACE WATER FEATURES

5.4.1 SURFACE WATER OVERVIEW

Prior to European settlement the Carrum Carrum Swamp was a freshwater wetland that drained to Port Phillip Bay via Kananook Creek. Figure 5.4 shows the physiography of the Carrum Sunklands that developed between the Beaumaris Monocline and the Selwyn Fault.

The hydrology of the Carrum Carrum Swamp wetlands has been significantly altered since European Settlement. Swamp drains were excavated starting in the late 1870's as part of the works to drain the Carrum Swamp to prevent flooding of the Eumemmering Creek and to make the area suitable for ongoing agricultural activities. Although previously cleared, the anthropogenically altered Edithvale and Seaford Wetlands are the last remnants of the Carrum Swamp.

The Edithvale-Seaford Wetlands provide essential functions within the regional drainage system by receiving, retaining and diverting stormwater and other surface run-off. These wetlands have a critical flood storage capacity that protects surrounding and downstream properties from flooding, and contribute to protecting the water quality of Port Phillip Bay by retaining and treating the local, urban and industrial stormwater and other run-off from the surrounding parklands and built environment.

In addition, these wetlands provide critical habitat for local and migratory birds. This environmental service led to the 2001 listing of the Edithvale-Seaford wetlands under the Ramsar Convention (Department of Sustainability and Environment Melbourne, 2012) (Section 1.2).

The other wetlands and several of the surface water features within the Study area are also anthropogenically developed to mitigate flooding and relieve water logging within the former Carrum Carrum Swamp area.

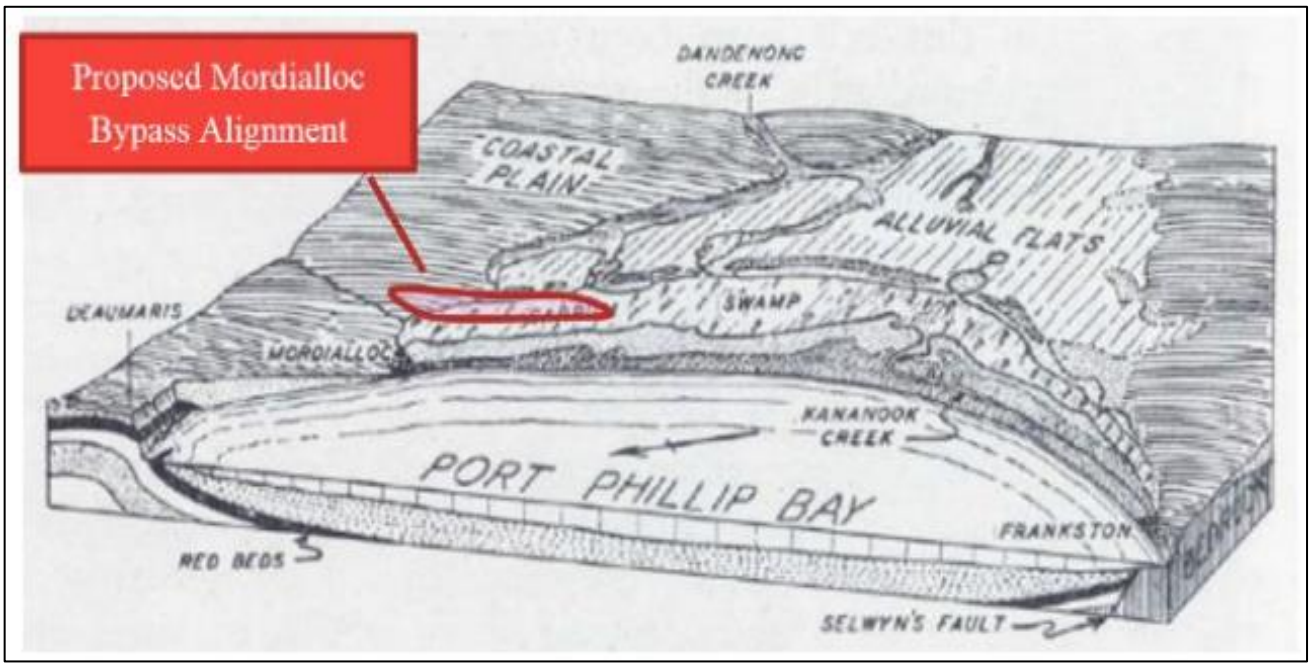

Figure 5.4 Carrum Sunklands (after Sherbourne Hills, 1951)

5.4.2 STREAMS AND WATERWAYS

The location of the alignment within the Carrum Sunkland is shown on Figure 5.5. Key surface-water features include the Mordialloc Creek, Edithvale Wetlands, Woodland Industrial Estate Wetlands, Waterways Estate Wetlands, Braeside Park and Chelsea Heights Swamp. Several anthropogenic drains have been constructed such as the Centre Drain (along the western side of the Edithvale Swamp/Wetlands) and the Dingley Drain. The Patterson River, which hydraulically separates the Edithvale and Seaford Wetlands.

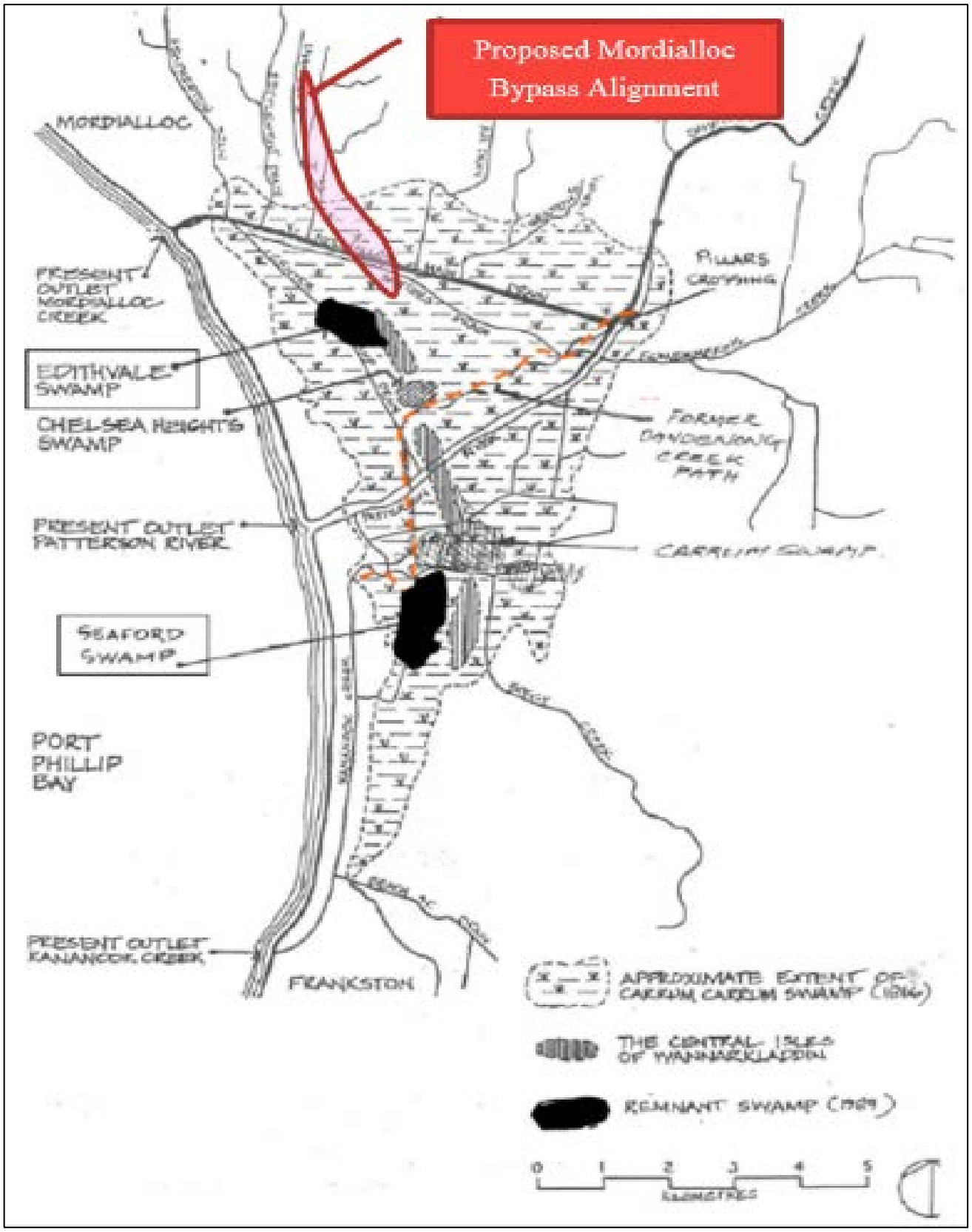

Figure 5.5 Former Carrum Sunklands with Remnant Wetlands (after Sherbourne Hills, 1951)

5.4.3 WETLANDS

5.4.3.1 EDITHVALE-SEAFORD WETLANDS

To the southwest of the proposed project alignment lies the Ramsar-listed Edithvale-Seaford Wetlands. The Edithvale Wetlands have been anthropogenically modified and receive water largely from local stormwater inlets, with groundwater intrusions also occurring (predominantly in the northern portion of the Edithvale Wetlands). Details of the ponds (including weir elevations) are presented on Figure 5.6. The Edithvale Wetlands comprise of two parts, north and south of Edithvale Road, referred to here as 'Edithvale South Wetlands' and 'Edithvale North Wetlands':

- *Edithvale South Wetlands* comprises a natural depression on the south side of Edithvale Road with the lowest point being -0.3 m Australia Height Datum (mAHD) (GHD, 2005). Edithvale South Wetlands are predominantly fed by three drains from catchments to the east (with negligible groundwater recharge) which initially entered sediment ponds at the edge of the macrophyte zone, with limited recharge from groundwater sources. The winter and spring standing water level generally sits at around 0.00 mAHD, but rises to 0.78 mAHD during rain events and discharges to Edithvale North Wetlands and Centre Swamp Drain; the invert level of the weir is -0.02 mAHD, and therefore, any water above that level discharges to Edithvale North Wetlands. Reduced rainfall during summer and autumn will result in evaporation and water levels drop below 0.00 mAHD. A manually operated pump on Centre Swamp Drain can pump water when the drain holds water into the northern pool during dry periods.
- *Edithvale North Wetlands* predominantly comprises a series of constructed wetlands within the former floodplain on the north side of Edithvale Road. Stormwater recharge enters the wetland from stormwater drains from the east via two sediment ponds and from Edithvale South Wetland via a pipe under Edithvale Road (known as the overflow pit). A series of weirs control flow of water between different wetland cells and limit total drawdown during prolonged dry or drought conditions. Stormwater supplies these cells from a series of drains and overland flow. A groundwater component of recharge supplements water inflows to EN2, EN3 and EN3a (Figure 5.6) ponds due to their hydraulic connection with the Brighton Sands aquifers, into which they were excavated.

The Centre Main drain forms discharged point for both Edithvale North and South Wetlands during wet periods.

5.4.3.2 BRAESIDE PARK, WOODLANDS ESTATE AND WATERWAYS ESTATE WETLANDS

The alignment at Governor Road is straddle by perennial Waterways Estate Wetlands to the south and by the Woodland Estate and Braeside Park Wetlands to the north (Figure 5.7). Like the other wetlands within the former Carrum Swamp, these wetlands were drained and cleared during European settlement and have since been excavated and reinstated.

The Braeside Park wetlands were reinstated in the 1980's after Parks Victoria took responsibility in 1982 (formerly known as Parks and Garden Section of the Melbourne Metropolitan Board of Works, City of Kingston). The Woodlands Industrial Estate Wetlands were reinstated in the 1990's when the land to the west of the former treatment works was sub-divided. The Woodland Estate and Braeside Park wetlands receive water from Melbourne Water drainage reserve and the Dingley Drain.

The Waterways Wetlands were created in early 2000's from cleared rural land as part of the residential development of Waterways Estate and are part of Melbourne Water's filtration system for Mordialloc Creek.

These wetlands also provide storage and flood protection for the City of Kingston.

Map: 2135645A_GIS_949_A	Author: MB
Date: 4/09/2018	Approved by: AS

0 40 80 m

1:4,000

Coordinate system: GDA 1994 MGA Zone 55

Scale ratio correct when printed at A3

Data source: VicRoads.
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Figure 5.6

Edithvale Wetlands - Location of wetland cells and indication of water sources

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5.4.4 SURFACE WATER MONITORING

Surface water monitoring has occurred quarterly coinciding with the groundwater monitoring events. The initial two sampling events in August/September and November collected samples from Edithvale Wetlands, Waterways Wetlands and Mordialloc Creek. With the expansion of the groundwater monitoring network the February/March 2018 sampling event was expanded to collect water samples from both Woodlands Industrial Estate Wetlands and Braeside Park wetlands.

Field and laboratory water quality parameters were previously listed in Section 4.3.2.3. Locations of surface water monitoring locations are presented in Figure 4.1. Water quality results and interpretations are discussed in Section 5.8.

5.5 GEOLOGY

The geological units described below were current at the time of intrusive investigations. Geoscience Australia maintains the Australian Stratigraphic Units Database, renamed both the Brighton Group sediments and the Fyansford Formation to the Sandringham Sandstone and Gellibrand Marl respectively in January 2018. To maintain consistency with previous reports, including the LXRA Edithvale – Bonbeach EES, the previous stratigraphic names have adopted for ease of interpretation and comparison with previous project data.

5.5.1 REGIONAL GEOLOGY

Situated within the Port Phillip Basin, the regional surface geology of the study area is presented in Figure 5.8 (Department of Economic Development, Jobs, Transport and Resources, 2010). This illustrates that the surface geology comprises Tertiary-aged sediments assigned to the Brighton Group as well as Quaternary-aged swamp and wind-deposited dune sediments, which were deposited on top of the Brighton Group sediments. Various thicknesses of fill material derived from various sources (not shown) is also present across the region. These geological profile features were confirmed by the outcome of intrusive investigation undertaken for geotechnical assessment and groundwater assessments undertaken along the project alignment.

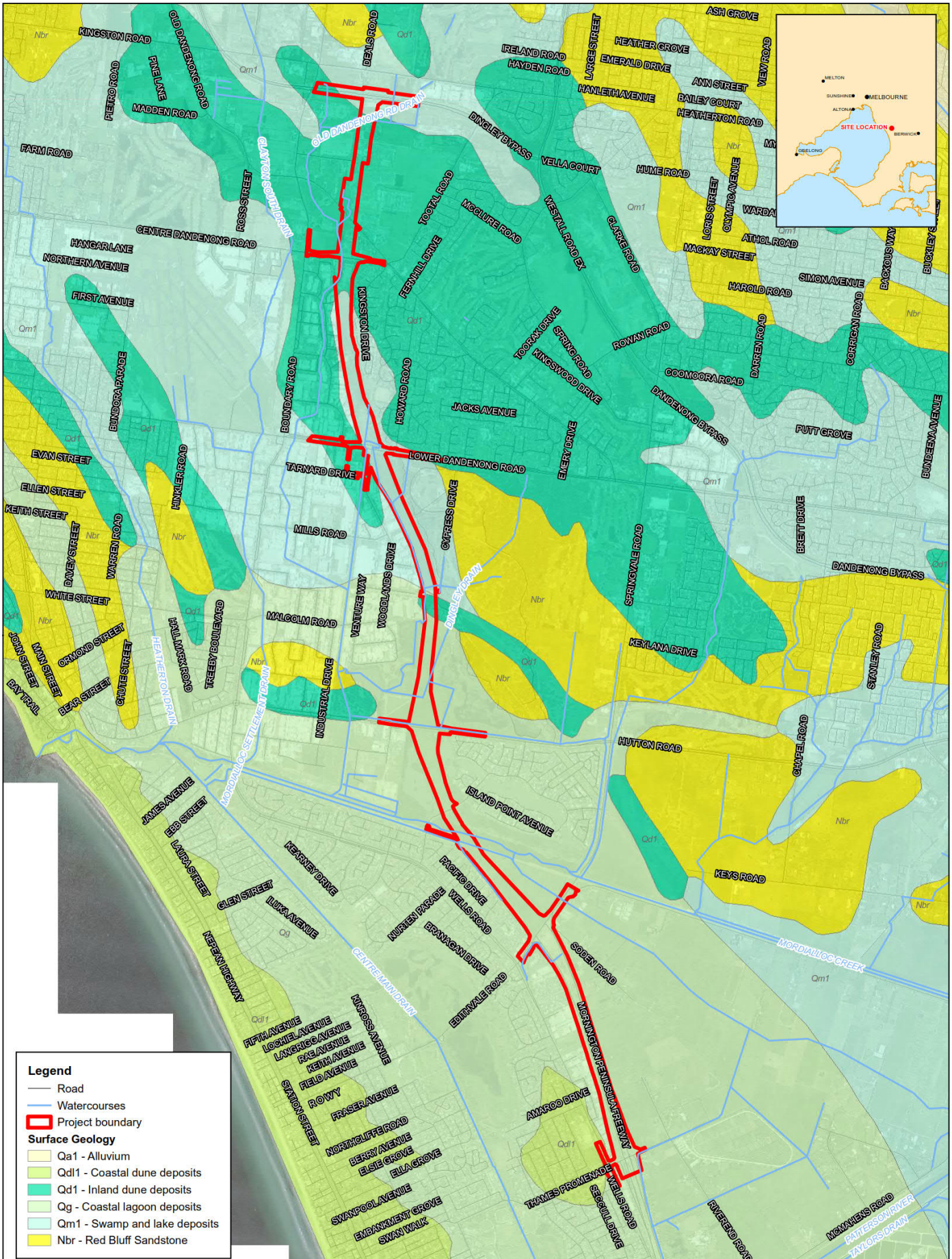
These revealed two primary geological units:

- The *Quaternary* swamp sediments comprising the current wetlands are the remnants of the former Carrum Swamp. The swamp sediments penetrated in geotechnical boreholes located along the alignment ranged in thickness between approximately 2 m below ground level (mBGL) and 8 mBGL. Typically, a layer of peat formed the basal portion of the swamp deposits also referred to as the Pleistocene Clay (WSP, 2017c). Between the shoreline of Port Phillip Bay and the swamp deposits unconsolidated sediments comprising aeolian sands deposited in dunes running parallel to the coast.
- The *Brighton Group* sediments, which were deposited in a fluvial environment, comprise clayey sands to sandy clays with sand intervals. Tertiary sediments assigned to the Fyansford Formation underlie the Quaternary and Brighton Group sediments. The Fyansford Formation sediments were deposited on the sediments assigned to the Werribee Formation, which were deposited on the regional bedrock consisting of strata assigned to the Palaeozoic-aged Melbourne Formation.

The site geotechnical and groundwater intrusive investigations intersected the natural profile including the Quaternary gravel, sand and silts of the alluvium (thin, locally variable and surficial), Tertiary Brighton Group materials and the Fyansford Formation. Table 5.1 presents a summary of the geological units along the alignment. It is anticipated that Recent fill, Quaternary alluvium, Brighton Group and Fyansford Formation sediments would be encountered during construction of the motorway.

Table 5.1 Geological units underlying the alignment

AGE	FORMATION	LITHOLOGY
Recent	Fill	Variable (anthropogenic fill – mixed materials).
Quaternary	Alluvium (Coastal lagoon deposits, Swamp and lake deposits) (thin, locally variable and surficial). Includes Cranbourne Sands (aeolian dune deposits)	Poorly sorted gravel, sand and silty sand (thin, locally variable and surficial).
		Silt, clay: dark grey to black; variably consolidated.
		Grey to black carbonaceous mud, silt, clay, minor peat: generally unconsolidated – dune deposits/swamp deposits.
Tertiary	Red Bluff Sandstone (part of the Brighton Group) currently known as Sandringham Sandstone.	Highly weathered sandstone, conglomerate: pale yellow and brown; fine to coarse-grained, massive to well-bedded; cross-bedded; local ironstone; clayey sands to sandy clays with sand intervals.
	Black Rock Member (part of the Brighton Group) currently known as Sandringham Sandstone.	Basal layer of ferruginous and phosphatic nodules in a matrix of quartz sand and gravel; clayey sands to sandy clays with sand intervals.
	Fyansford Formation, currently known as the Gellibrand Marl	Clayey silt, clay to sandy silt and silty sand of marine origin.
	Werribee Formation	Sand, gravel, clay and silt with minor coal.
Palaeozoic	Melbourne Formation	Sedimentary (fractured rock) comprised of sandstone, siltstone and mudstone.



Map: 2135645A_GIS_950_A	Author: MB
Date: 4/09/2018	Approved by: AS

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Coordinate system: GDA 1994 MGA Zone 55

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Figure 5.8
Surface geology

5.6 HYDROGEOLOGY

5.6.1 HYDROSTRATIGRAPHIC UNIT

The *Victorian Aquifer Framework* (VAF), developed by DELWP (2017), developed and delineated a three-dimensional model of Hydrostratigraphic Units (HSUs) within Victoria. HSUs are comprised of geological materials of similar hydrogeological properties. To ensure that the HSUs behave in as a hydrogeological unit they are generally based on stratigraphic units, although similarity in storage and transfer of groundwater is more of an importance than just stratigraphic units.

The HSUs delineated within the VAF were adopted for this groundwater impact assessment as the VAF provides a consistent state wide framework defining aquifers and aquitards. The HSUs present within the Study area have been identified using the Department of Environment, Land, Water and Planning (DELWP)'s interactive online map and groundwater resource reports. The VAF model was also downloaded and used in the development of the numerical groundwater model and refined through observations and results of the drilling and installation of dedicated groundwater monitoring bores and geotechnical investigation.

Within the Study area the HSUs largely align with the geological stratigraphy outlined in Section 5.5. Table 5.2 outlines the relevant HSUs identified with detailed description of the HSU in the following section.

Table 5.2 Groundwater resource units present at Mordialloc Bypass (DELWP, 2017a)

GROUNDWATER RESOURCE UNIT (GEOLOGY UNIT)	ESTIMATED DEPTH BELOW SURFACE (m)	GROUNDWATER SALINITY (mg/L)	CHARACTERISTICS
Quaternary Aquifer (**QA**) – sand, gravels, clay, silt	0–3	1,001–3,500	Unconfined to semi-unconfined water bearing zones.
Upper Tertiary Aquifer (**UTAF**) (fluvial) – sand, gravel and clay (Red Bluff Sandstone, Brighton Group)	3–16	501–1,000 (N) 1,001–3,500 (S)	Mostly confined by overlying clay, silt and basalt deposits. Completely eroded in some areas. Low productivity.
Upper-Mid Tertiary Aquitard (**UMTD**) – clay, silt, marl (fractured rock) and minor sand (Fyansford Formation)	16–47	Unknown	Widespread subsurface aquitard with low yields and poor water quality.
Lower Tertiary Aquifer (**LTA**) – sand, gravel, clay and silt, minor coal (Werribee Formation)	47–53	1,001–3,500	Extensive semi-confined to confined fractured rock water bearing zones.
Mesozoic and Palaeozoic Bedrock (**BSE**) – basement sedimentary (fractured rock): sandstone, siltstone, mudstone, shale, igneous (fractured rock), includes volcanics, granites, granodiorites Murrindindi Supergroup	>53	<500 (S) 501–1,000 (N)	Widespread subsurface aquitard, generally with low yields and poor water quality.

5.6.2 RELEVANT AQUIFERS

5.6.2.1 QUATERNARY AQUIFER (QA)

The Quaternary aquifer is largely associated with the Carrum Swamp system and is located within the southern portion of the Study area, roughly south of Governor Road. The QA consists of windblown Aeolian sands, clays and silts from the swam system and alluvial sands and gravels.

Within the southern portion of the Study area the QA consists of an unconfined aquifer forming the water table aquifer. Drilling within the Study area has indicated the QA is generally less than 7 m thick although greater thickness was intersected to the south consistent conceptual understanding, with thickness of >11 m encountered.

The Pleistocene Clay sediments associated with the Carrum Carrum Swamp is classified within the QA based on the depositional age. The Pleistocene Clay is a shallow swamp deposit at variable thickness across the Study area and was intersected during drilling within the southern portion of the Study area.

Hydrogeologically, the Pleistocene Clay is reported to act as a local aquitard confining the UTAF (AECOM-GHD JV 2018). The lower permeability was confirmed during laboratory permeability tests from core samples obtained during the LXRA drilling program. The lower permeability was also observed during sampling with bores screened with the QA having lower yields.

The Pleistocene Clay was anecdotally partially excavated through during the reinstatement and construction of the EN3 and Dog Pond cells of the Edithvale Wetlands explaining the change in water quality between these locations compared to the water quality of the remaining wetland cells.

Hydraulic properties and water quality of the QA are discussed in Sections 0 and 5.8.

5.6.2.2 UPPER TERTIARY AQUIFER (UTAF)

The UTAF is present across the entire Study area is comprised of the Tertiary Brighton Group sediments. The outcrops in the northern section of the alignment approximately north of Governor Road with an observed thickness over 25 meters. Where the UTAF outcrops it consists of an unconfined aquifer, to the south of Governor Road where the UTAF is overlain by QA sediments the UTAF represents a confined to semi-confined aquifer. Observed depth of the UTAF in the southern portion of the alignment is generally 6 to 20 meters. The UTAF is likely hydraulically connected to the overlying QA however the underlying Fyansford Formation (UMTD) is generally regarded as an aquitard limiting vertical recharge into the UMTD.

Groundwater flow in the UTAF is on an intermediate to regional scale. Recharge occurs mainly to the east where the Brighton Group sediments crop out. Along the shoreline of Port Phillip Bay sea water intrudes locally inland into the UTAF, which is believed to reflect the evapotranspiration effects associated with the wetlands and local groundwater users.

5.6.2.3 UPPER-MIDDLE TERTIARY AQUITARD (UMTD)

The UMTD underlies the UTAF throughout the Study area and is comprised of the clay, sand, gravel and limestone of the Fyansford Formation. The transition between the UTAF and UMTD is often difficult to demarcate as both are highly heterogeneous. Sand and gravel content within the UMTD has led to the suggestion that I can behave as an aquifer at local scale (GHD 2018) however a high plasticity clay of several meter thickness is often encountered and used as the transition depth between the UTAF and UMTD.

5.6.3 RECHARGE AND DISCHARGE

The primary recharge mechanism to the QA and UTAF aquifers is considered to be direct rainfall infiltration, as observed in recorded water levels. The proportion of net rainfall recharging the groundwater systems depends largely on the characteristics of the surface geology, soils, the land use and depth to the water table. Recharge is expected to be

lower in areas where the surface is covered by residual clayey soils and colluvium with a low hydraulic conductivity and specific yield.

Recharge to the residual clayey soils is a predominantly recharge-in / ET-out process, associated with rainfall infiltration, which typically characterise the behaviour of shallow perched water systems and limited vertical infiltration from the perched, shallow system down to the deeper regional UTAF aquifer.

Recharge also occurs via leakage from surface water features in areas where the groundwater table is below the stream and wetland water levels. Recharge rates will largely depend on the river stage and hydraulic characteristics of the river bed material and underlying geology.

The lower aquifers are recharged locally where they outcrop and by vertical leakage from the upper aquifers in places where the hydraulic head of the upper aquifer is above that of the lower aquifer, mostly where low permeability units are absent.

Groundwater can discharge from shallow perched aquifers into creeks or drains via seepage depending on the hydraulic gradient of the geological units in the aquifer. Groundwater in lower aquifers moves by subsurface flow discharging into wetlands and surface streams providing baseflow to streams or discharging directly into Port Phillip Bay and Westernport Bay.

Extraction of groundwater through the use of existing bores in the project areas is also be considered a mechanism of discharge from the groundwater systems. Evapotranspiration from the water table is another mechanism of groundwater discharge. The evapotranspiration rate depends on land use and depth to groundwater. In areas where the water table is shallow and within the rooting depth of vegetation evapotranspiration can be a significant component of the water.

5.6.4 GROUNDWATER MANAGEMENT ARRANGEMENTS

Previously described in Section 3.3, groundwater resource units are identified in Groundwater Management Areas (GMAs), Water Supply Protection Areas (WSPAs) or Unincorporated Areas (UAs). Of the three administrative boundaries, only the WSPAs are declared by the Minister for Water under the Act. Declared WSPAs protect stressed groundwater or surface water resources through the implementation of a statutory Groundwater Management Plan for the area. There are currently 16 WSPAs declared in Victoria. Collectively, these WSPAs and GMAs are referred to as Groundwater Management Units (GMUs).

Unincorporated Areas are areas where no significant development of the groundwater resource has occurred. This is usually because the resource is low yielding, or its quality has traditionally severely limited its use.

The project alignment is entirely within an unincorporated area.

5.6.5 GROUNDWATER LEVEL MEASUREMENT

Groundwater levels were recorded in the Study area using both manual measurements and through the installation of electronic groundwater level loggers in the groundwater monitoring bores as previously described in Section 4.3.2.2.

During the initial August GME, manual groundwater levels were recorded prior the installation of the groundwater level loggers. In total the 18 bores in August with an additional installation in a single groundwater monitoring bore occurring in November in GW17-26-03. These loggers were synchronised and set to monitor groundwater levels every six hours. To calibrate the level recorded by the data loggers, manual groundwater level measurements were recorded when the logger was installed. A barometric pressure transducer was also installed to allow data compensation for atmospheric conditions.

Of the 19 monitoring groundwater bores, 12 are at ‘nested’ locations. Nested locations are adjacent monitoring bores installed and screened in different HSUs. This allows for both the monitoring of groundwater levels at the same location and to assess the vertical flow gradient between HSUs.

Groundwater levels across the study area are relatively close to groundwater with August water levels recorded ranging from 1.11 to 3.13 mBGL within the QA and 0.84 to 2.89 mBGL within the UTAF. Water levels display a noticeable

response to rainfall within the QA and outcropping sections of the UTAF and a more muted response in the UTAF where overlain by the QA. While water levels within both aquifer show short term increases to rainfall, overall waters levels reflect seasonable influences with water levels declining in summer months where rainfall is reduced and higher evapotranspiration is experienced.

Water levels within the QA and UTAF for the period of August 2017 to February 2018 presented in Figure 5.9 and Figure 5.10 respective. Water levels have been converted to mAHD and plotted against daily rainfall recorded from the Bonbeach weather station.

Water levels within both HSU follow a topographic trend with greater elevations recorded in the north and declining towards the south. Close to the Springvale Road bores GW17-26-12D, GW17-26-13D, GW17-26-14D and GW17-26-15D all are impacted by an extraction from registered bore (Bore ID WRK03902). These bores display typical drawdown and recovery responses that correlate with the commencement of pumping at WRK03902. Spatial coordinates for WRK03902 extracted from the *National Groundwater Information System* place this bore within the centre medium strip of the Mornington Peninsular Freeway. Site investigations failed to locate this bore and it is most likely located within semi-rural land to the north of the existing freeway.

The field recorded groundwater levels from each GME are summarised in Table 5.3.

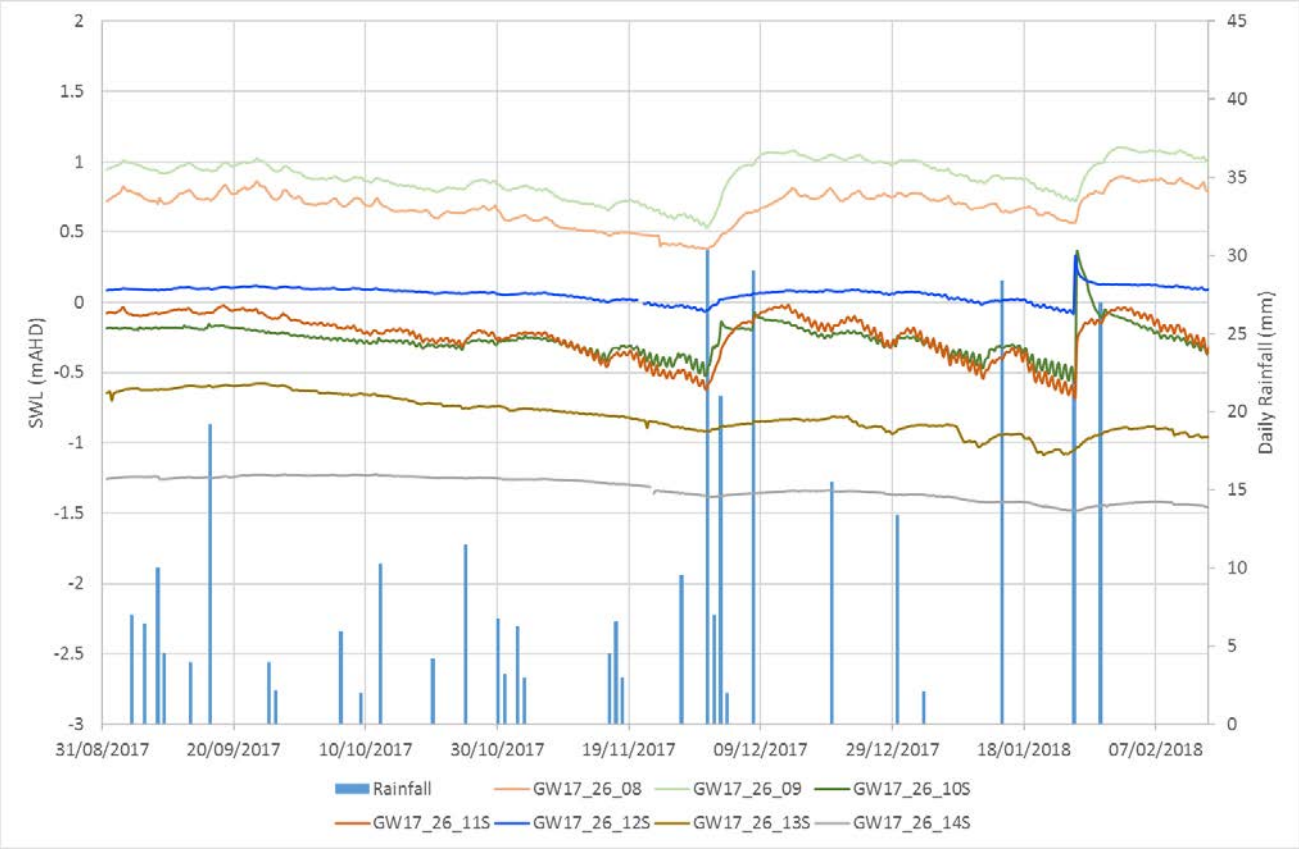


Figure 5.9 Quaternary aquifer water levels with daily rainfall

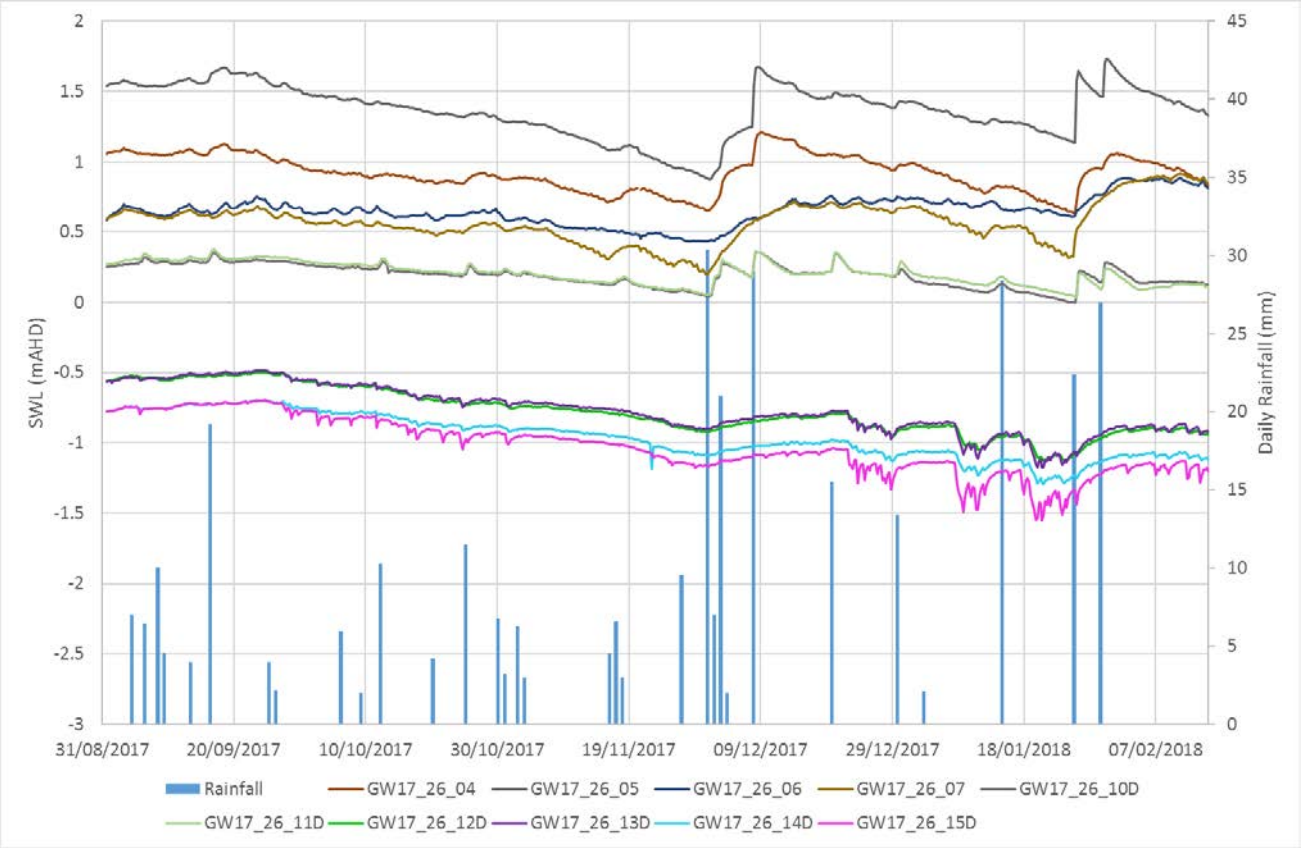


Figure 5.10 UTAF aquifer water levels with daily rainfall

Table 5.3 Summary of groundwater levels from GMEs

GME DATE	HSU	WATER LEVEL MIN (mBGL)	WATER LEVEL MAX (mBGL)	WATER LEVEL MIN (mAHD)	WATER LEVEL MAX (mAHD)
August 2017	QA	1.11	3.13	-1.25	0.94
	UTAF	0.84	2.89	-0.78	1.53
November 2017	QA	1.36	3.73	-1.3	4.99
	UTAF	1.24	3.19	-1.07	1.08
February 2018	QA	1.05	3.48	-1.45	1.16
	UTAF	0.92	4.49	-2.48	1.79

Note: mAHD: metres Australian Height Datum, mBGL: metres below ground level.

5.6.6 VERTICAL FLOW GRADIENT

Nested bores allow for the monitoring of vertical flow gradient (groundwater flux) HSUs by determining the pressure head in each aquifer at the same location. A total of six nested bore locations are monitored with electronic data loggers. However, the monitoring bore GW17-26-15S appears to be compromised during construction and is not representative of aquifer conditions. Therefore, vertical flow gradients were assessed at 5 locations and summarised below.

- Nested bore location GW17-26-10S/GW17-26-10D & GW17-26-11S/GW17-26-11D are located south of Mordialloc Creek on the eastern and western sides of the project alignment. Both locations monitor the QA and UTAF aquifers. At both locations, the hydrographs for this location (Figure 5.11) shows a consistent positive gradient is monitored at this location.

- Nested bore location GW17-26-12S/GW17-26-12D & GW17-26-13S/GW17-26-13D are located north of Springvale Road on the eastern and western sides of the project alignment. Both locations monitor the QA and UTAF aquifers. A negative gradient was noted for GW17-26-12S/GW17-26-12D with a difference of approximately 0.4 m between aquifers. Water levels at GW17-26-13S/GW17-26-13D were largely similar with flux reversing from positive to negative between August to January (Figure 5.12). It is important to note that influence from a registered pumping bore is observed at this location.
- Nested bore location GW17-26-14S/GW17-26-14D is located south of Springvale Road on the western side of the project alignment and monitors the QA and UTAF aquifers respectively. A positive gradient was noted with a difference of approximately 0.4 m between aquifers. (Figure 5.13). It is important to note that influence from a registered pumping bore is observed at this location.

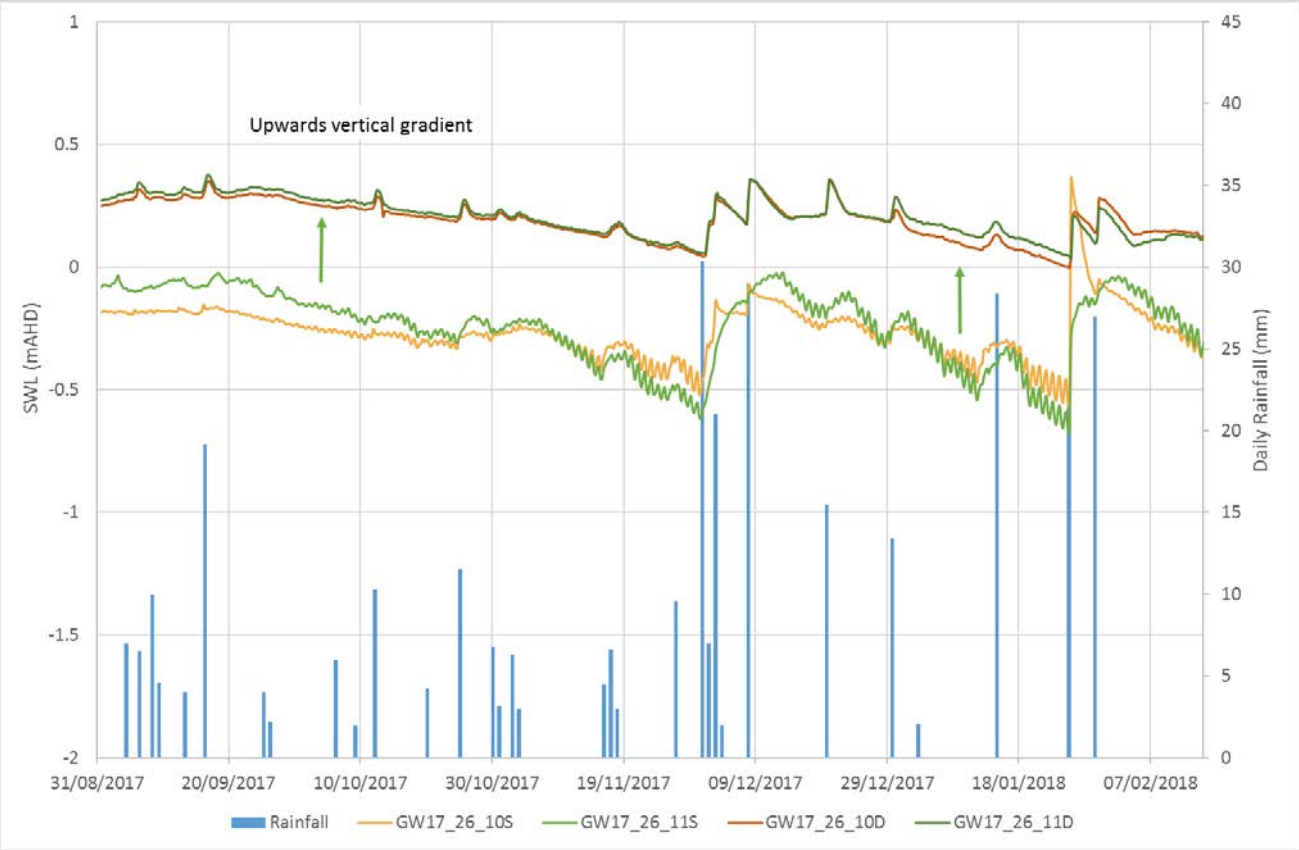


Figure 5.11 Nested bore hydrograph GW17-26-10S/D & GW17-26-11S/D

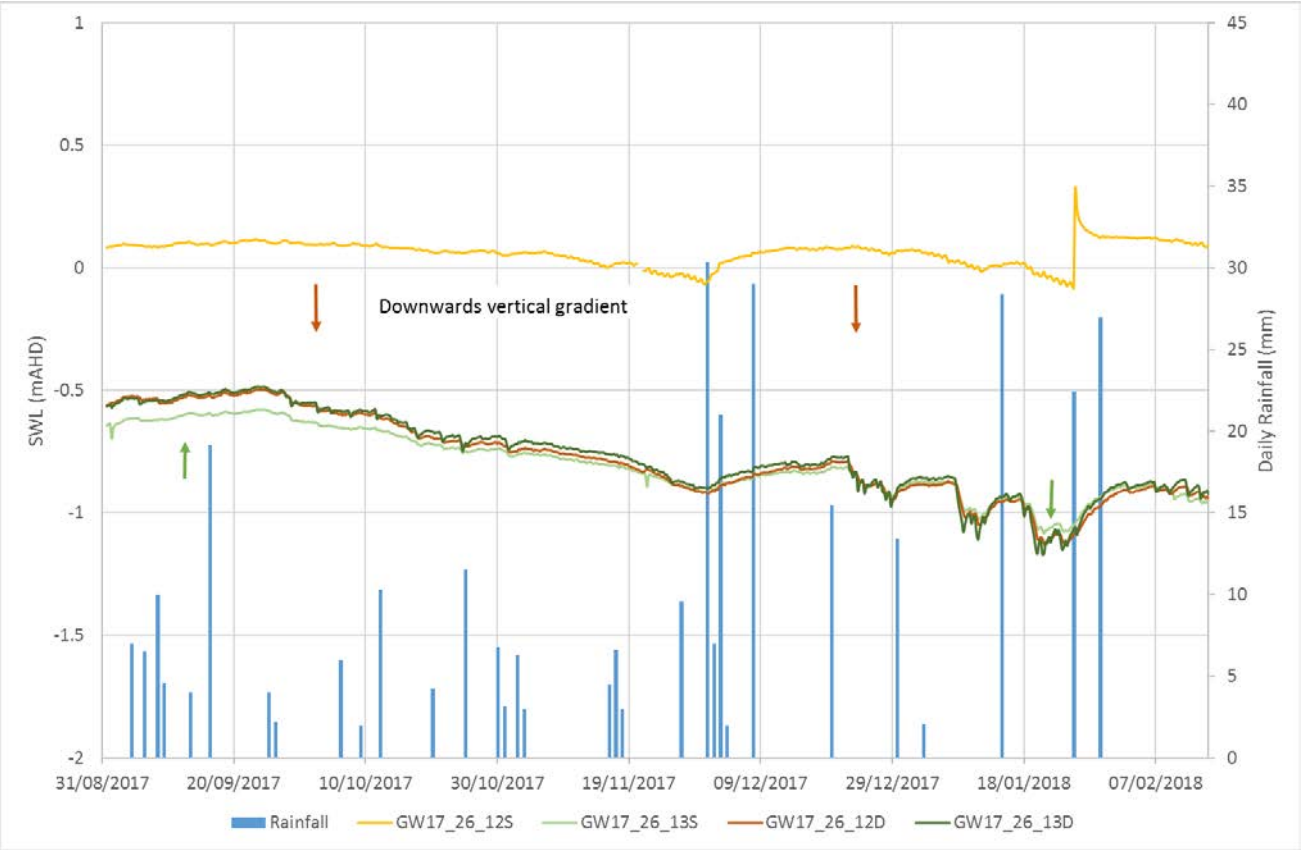


Figure 5.12 Nested bore hydrograph GW17-26-12S/D & GW17-26-13S/D

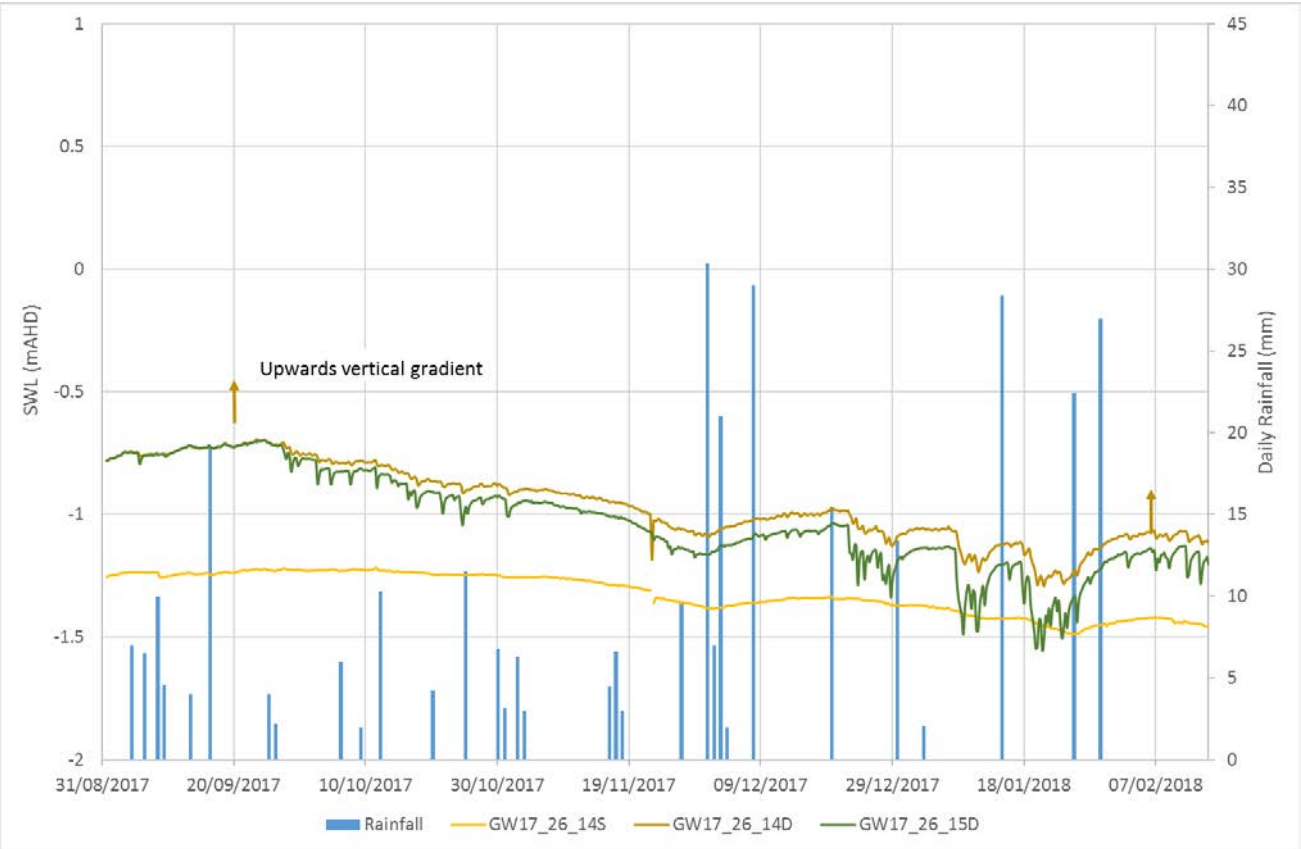
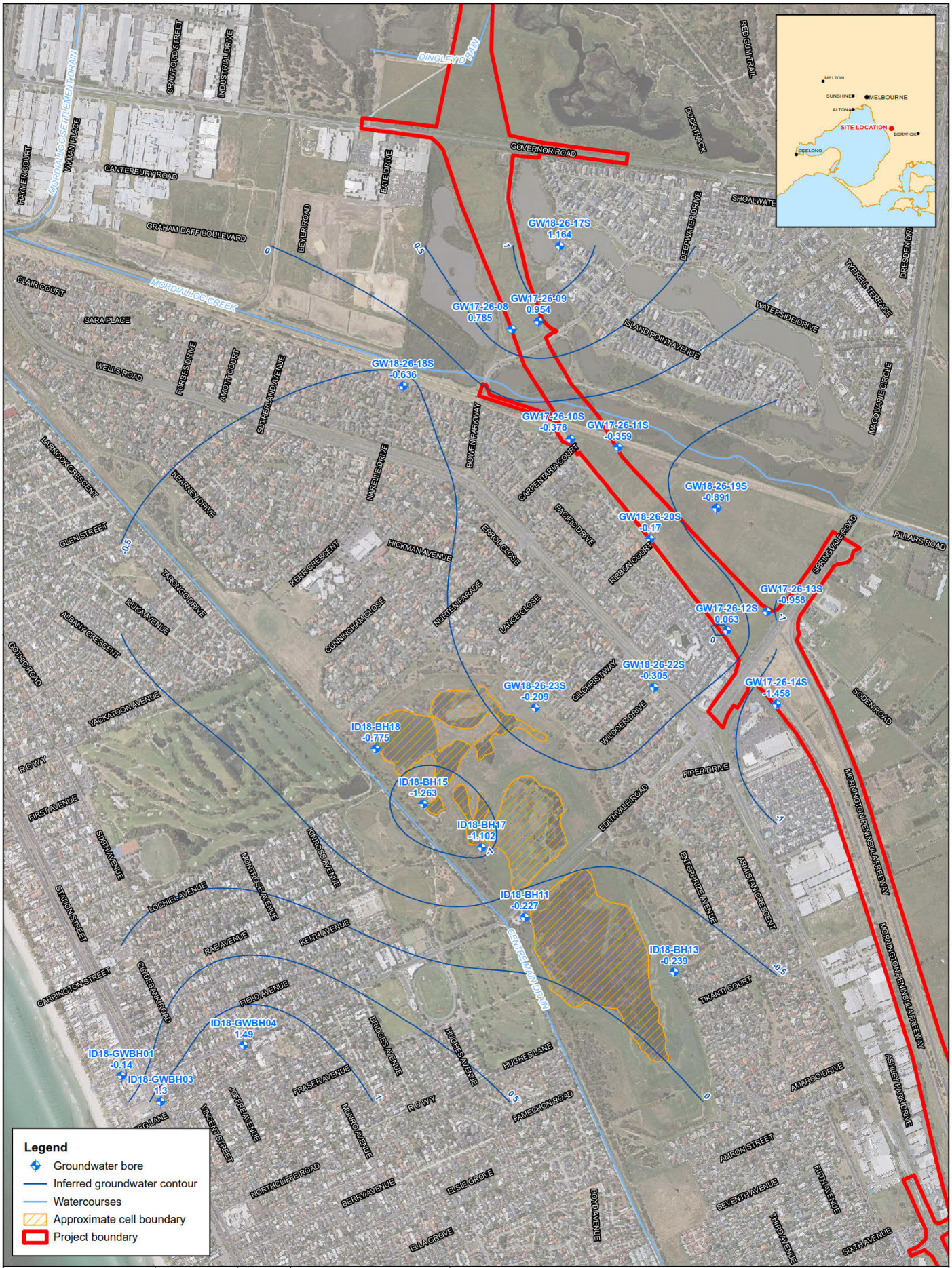


Figure 5.13 Nested bore hydrograph GW17-26-14S/D & GW17-26-15D

5.6.7 INFERRED FLOW DIRECTION

Groundwater flow direction in the QA and UTAF aquifer is complex, largely resulting from topographic effects, land-use, intimate connection with water bodies, groundwater use, proximity of Port Phillip Bay and, the influence of the built environment and associated urban run-off management. This complexity is illustrated in the monitoring data collected.

- Based on the data available from groundwater levels at site, the groundwater within the QA aquifers appears to move towards the south to southwest (Figure 5.14).
- Groundwater flow within the deeper semi-confined UTAF is in a south south-easterly direction (Figure 5.15), towards discharge features such as Port Phillip Bay, Patterson River and Edithvale Wetlands. Which is conceptually correct.
- There is evidence that pumping from surface water bodies to maintain wetland cells during drier months can influence groundwater levels, in the QA as observed in Figure 5.11.
- The presences of a registered extraction bore (WRK039072) towards the southern portion of the alignment has impacted on groundwater levels and flow direction in the UTAF. The registered bore has an annual allocation of 3.5 ML/yr however the radius of influence from this bore suggests that the extraction volume of this bore is several times the allocated amount. The influence on this extraction bores can be observed on Figure 5.15 with groundwater flow near Springvale Road directed in a southerly direction towards the extraction bore.



Map: 2135645A_GIS_952_A	Author: MB
Date: 4/09/2018	Approved by: AS

0 100 200 m

1:12,000

Coordinate system: GDA 1994 MGA Zone 55

Scale ratio correct when printed at A3

Data source: VicRoads.
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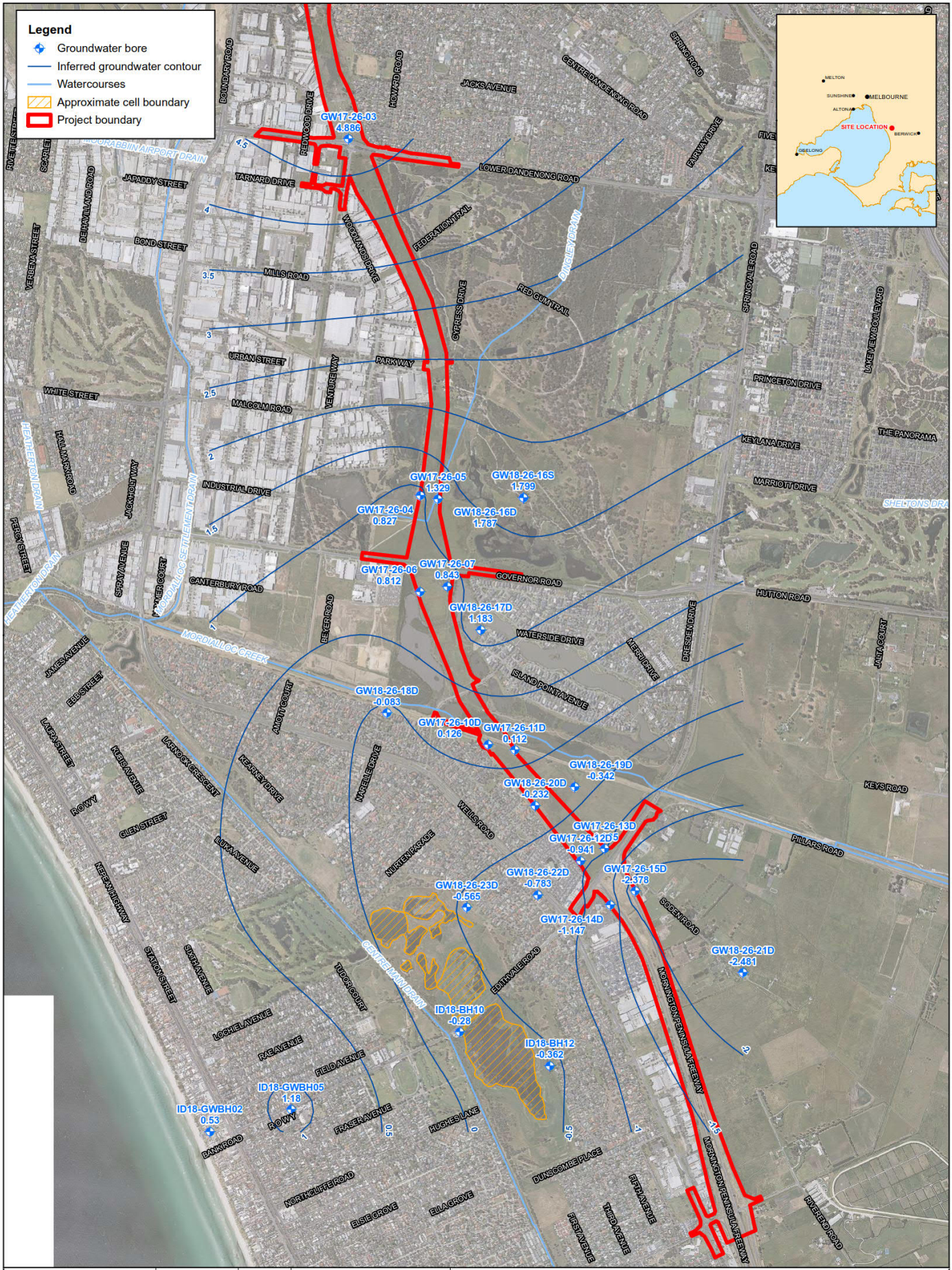
Engineering and Technical Services for Mordialloc Bypass Upgrade

Figure 5.14

Groundwater level contours of Quaternary aquifer



Map: 2135645A_GIS_953_A	Author: MB
Date: 4/09/2018	Approved by: AS

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Coordinate system: GDA 1994 MGA Zone 55
Scale ratio correct when printed at A3

MAJOR ROAD PROJECTS AUTHORITY
VICTORIA State Government
wsp

Engineering and Technical Services for Mordialloc Bypass Upgrade
Figure 5.15
Groundwater level contours of UTAF aquifer

Data source: VicRoads.
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5.7 HYDRAULIC TESTING

Hydraulic testing of the aquifer units was carried out at 34 groundwater monitoring bores, using slug test methods (also referred to as falling and rising head tests), to obtain an estimate of the hydraulic conductivity of the aquifer media around the well/borehole. Hydraulic conductivity (K) is rate of flow through a porous medium in a unit of time under a unit hydraulic gradient through a cross sectional area commonly measured at a rate of meters per day (m/day).

The accuracy of these tests is at the "indicative" level (plus/minus one order of magnitude). The slug tests were performed with insertion and removal of a physical slug tube (made of solid acrylic) to create the water level displacement required (to apply an instantaneous head pressure differential from which equilibration is measured).

The Bower and Rice (1976) solution was adopted for bores screened within the QA aquifer and UTAF where unconfined. For bores screened within the confined UTAF, the Cooper, Bredehoeft and Papadopulos (1967) solution was used.

Hydraulic conductivity results from slug testing are estimates of close area conditions of limited radius. Testing can often be compromised due to poor bore design or development. While these factors do not seem to of impacted testing, slug testing can often over estimate.

Summary of results of the falling-head and rising-head hydraulic testing (slug tests) for each HSU performed at site are presented as estimates of hydraulic conductivity (m/day) in Table 5.4. The AQTESOLV reports are included in Appendix B. Bores screened in the alluvium have hydraulic conductivity (K) values ranging between 0.05 and 0.80 m/day. The remaining bores screened in the Brighton Group have a range in K values between 0.13 and 0.70 m/day. The rising and falling head tests were analysed using the Bouwer and Rice (1976) and Cooper-Bredehoeft-Papadopulos (1967) solution which provide hydraulic conductivities within the same order of magnitude and all show good and reliable curve matching results.

Table 5.4 Hydraulic conductivity results from slug tests

GEOLOGICAL UNIT	NUMBER OF BORES	NUMBER OF TESTS	MINIMUM K (m/DAY)	MAXIMUM K (m/DAY)	GEOMETRIC MEAN (m/DAY)
Alluvium	12	36	0.03	0.80	0.22
UTAF	22	44	0.03	3.93	0.32

5.8 WATER QUALITY

Water quality data for the Project has been obtained through surface and groundwater monitoring events (GMEs). To capture seasonal variability, sampling has occurred quarterly with three GMEs occurring to date. The monitoring network was expanded early 2018 to increase the spatial coverage and address the release of the scoping requirements. As such only a single round GME has occurred since the expansion of the monitoring network.

Water sampling and collection methodology was previously described in Section 4.3.2.3. Samples were submitted and analysed by NATA accredited laboratory. Full water quality results and laboratory reports are presented in Appendix B.

To allow for comparison of water types, surface water sample locations were situated close to groundwater monitoring bores with samples collected on the same date. Summary of similar water bodies are presented in the following sections.

5.8.1 SURFACE WATER QUALITY

5.8.1.1 WATERWAYS WETLANDS AND MORDIALLOC CREEK

Surface water the Waterways Wetlands and Mordialloc Creek is of similar quality and a summary of water quality samples from the Waterways Wetland and Mordialloc Creek are presented in Table 5.5.

- Surface water is fresh to marginal, with EC values ranging from 293 µS/cm to 954 µS/cm. The highest salinities were detected during the November 2017 GME, and were associated with low monthly rainfall.
- The pH conditions are neutral to slightly alkaline, with pH values ranging from 7.40 to 8.24.
- Major ion chemistry for the Waterways Wetlands and Mordialloc Creek is plotted with other wetlands, Melbourne rainfall (Crosbie et al., 2012) and sea water (form Port Phillip Bay) on the Piper diagram in Figure 5.16. A piper diagram is a graphical representation of the relative concentrations of major ions (Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, Cl^{-}, HCO_3^{-} and SO_4^{2-}), and is used to distinguish the chemical profile of major water types. Surface water in the Waterway Wetland is chemically classified as Na-Cl-HCO_3 type water, which is similar to shallow groundwater at the southern boundary of the wetlands and to average Melbourne rainfall.
- Dissolved metal and nutrient concentrations were typically close to or below the laboratory limit of reporting (LoR), although some minor exceedances of the ANZECC 2000 FW 95% guidelines were recorded for Al, Cu and Zn. TPH/ BTEX compounds and pesticides were not detected above LoR.

Table 5.5 Summary of Waterways Wetland and Mordialloc Creek water quality

PARAMETER	SUMMARY OF LABORATORY RESULTS
Field electrical conductivity	Fresh to marginal; field EC values ranging from 293 µS/cm to 954 µS/cm. Highest EC values detected in November 2017 GME.
Field pH	Neutral to slightly alkaline (7.40 to 8.21). Minimal pH variation between GMEs.
Major ions	Na-Cl-HCO_3
Dissolved metals	Below LoR: Be, Cd, Cr, Co, Pb, Se, V, Hg, and Se. Minor exceedances of dissolved metals concentrations were reported for Al, Cu, and Zn above the ANZECC 2000 FW 95% guidelines.
Nutrients	All nutrients were typically at low concentrations close to the LoR.
BTEX compounds	Total BTEX below LoR (1 µg/L).
Petroleum hydrocarbons	TPH C_{10}-C_{36} (sum) and TRH C_{10}-C_{40} (sum) were below LoR.
Pesticides	Below LoR – SW17-26-08 and SW17-26-09 analysed only.

Notes: LoR is Limit or reporting.

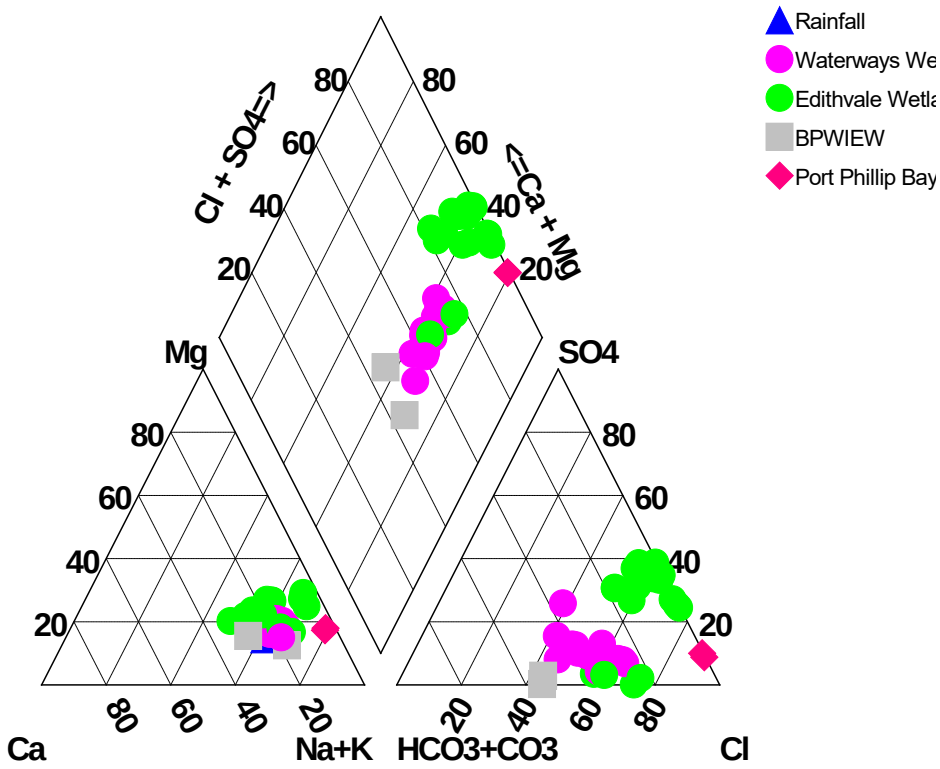


Figure 5.16 Piper diagram showing major ion chemistry for wetland surface waters

5.8.1.2 WOODLANDS INDUSTRIAL ESTATE AND BRAESIDE PARK WETLANDS

The Woodlands Industrial Estate and Braeside Park wetlands were included in the February 2018 GME. A summary of water quality samples from the Woodlands Industrial Estate and Braeside Creek wetlands are presented in Table 5.6:

- Surface water was of similar quality in both wetlands. Surface water in both wetlands is fresh, with EC values of 375 µS/cm and 450 µS/cm at Braeside Park and Woodlands Industrial Estate wetlands, respectively.
- pH conditions were comparable, and near neutral.
- Major ion chemistry is plotted on the Piper diagram in Figure 5.16. Surface water in the Woodlands Industrial Estate and Braeside Park Wetlands is chemically classified as Na-HCO_3-Cl type water, and geochemically distinct from surface waters in the Edithvale Wetlands and local groundwater.
- Dissolved metal and nutrient concentrations were typically close to or below the LoR while TPH/BTEX compounds were not present above LoR.

Table 5.6 Summary of Woodland Industrial Estate and Braeside Park wetlands water quality

PARAMETER	SUMMARY OF LABORATORY RESULTS
Field electrical conductivity	Fresh; 375 µS/cm (Braeside Park) and 450 µS/cm (Woodlands Industrial Estate).
Field pH	Circumneutral; 7.46 (Braeside Park) and 7.52 (Woodlands Industrial Estate).
Major ions	Na-HCO_3-Cl
Dissolved metals	Below LoR: Al, Be, B, Cd, Cr, Co, Cu, Pb, Se, V, Zn, Hg, and Se. No exceedances above ANZECC 2000 FW 95% guidelines.
Nutrients	Nutrient concentrations were close to or below LoR with the exception of reactive phosphorus (0.33 mg/L) at Braeside Park Wetlands.
BTEX compounds	Total BTEX below LoR (1 µg/L).

PARAMETER	SUMMARY OF LABORATORY RESULTS
Petroleum hydrocarbons	TPH C_{10}-C_{36} (sum) and TRH C_{10}-C_{40} (sum) were below the LoR at Woodlands Industrial Estate. Low level of heavy fraction hydrocarbons detected at Braeside Park Wetlands (TRH C_{16}-C_{40} – 490 µg/L, TPH C_{15}-C_{28} – 310 µg/L and TPH C_{29}-C_{36} – 230 µg/L).
Pesticides	Not analysed.

Notes: LoR is Limit or reporting.

5.8.1.3 EDITHVALE WETLANDS

A summary of water quality samples from the Edithvale Wetlands is presented in Table 5.6 and discussed below:

- Electrical conductivity varies significantly between wetland cells in the Edithvale Wetlands. ES1, EN1, EN3 and EN3a had marginal to brackish salinities ranging from 1,151 µS/cm (EN1) to 4,016 µS/cm (EN3). EC values were higher in the November 2017 GME, which can be associated with seasonal drying (higher evaporation rates/lower precipitation). EN2 was saline, with EC ranging from 20,954 µS/cm to 23,386 µS/cm. It is known that this wetland cell was deepened in 1987–1988 and is connected to the brackish to saline groundwater in the UTAF. The Dog Pond had an EC of 69,694 µS/cm in November 2017 and 81.644 µS/cm in February 2018. Water level in the Dog Pond is controlled by groundwater and is usually dry by the end of January, high salinity reflects the effects of evaporation. Halite precipitation adjacent the adjacent the wetland cell was also observed.
- The pH varies from near neutral (pH 7.22, EN1) to alkaline (pH 8.49, EN2), and small variations in pH were observed between GMEs, although no seasonal trends were apparent.
- Major ion chemistry is plotted on the Piper diagram in Figure 5.16. Surface water in the Edithvale Wetlands is dominated by sodium and chloride with relative percentages of sulfate and bicarbonate varying between wetland cells. EN2, EN3, EN3a and the Dog Pond are chemically classified as Na-Mg-Cl-SO_4, while ES1 and EN1 are Na-Cl-HCO_3 type waters and are chemically similar to Melbourne rainfall and Waterways Wetlands.
- Nutrient (nitrogen and phosphorus) concentrations are consistent with urban runoff into the wetlands and significant nutrient removal capacity of wetlands as water moves through the wetland cells. Edithvale-Seaford Wetlands have been recognised for the ecosystem service as they provide through the treatment of stormwater before it enters Port Phillip Bay. Dissolved metal and TPH/BTEX concentrations are indicative of urban runoff into the wetlands. Boron concentrations were elevated above ANZECC 2000 FW 95% guideline at EN2 (1.57 mg/L to 2.1 mg/L) and the Dog Pond (4.2 mg/L to 9.53 mg/L), which is consistent with concentrations observed in groundwater at this location.

Table 5.7 Summary of Edithvale Wetlands water quality

PARAMETER	SUMMARY OF LABORATORY RESULTS
Field electrical conductivity	Wetland cells ES1, EN1, EN3, and EN3a: marginal to brackish salinity; EC ranging from 1,151 µS/cm (ES1) to 4,016 µS/cm (EN3). EN2 is saline (EC 20,954 µS/cm to 23,386 µS/cm) and Dog Pond hypersaline (81,644 µS/cm Feb 2018). Seasonal variation apparent.
Field pH	Circumneutral to alkaline (pH 7.22 to 8.49).
Major ions	ES1 and EN1 – Na-Cl-HCO_3; EN2, EN3, EN3a and the Dog Pond -Na-Mg-Cl-SO_4
Dissolved metals	Below LoR: Be, Cd, Cr, Co, Pb, Hg, Mo, Se, and V. Some exceedances of ANZECC 2000 FW 95% guidelines: B at EN2 (1.57 mg/L to 1.61 mg/L); Ni at Dog Pond (17 µg/L); Zn (9 µg/L) and Cu (4 µg/L) at ES1.

PARAMETER	SUMMARY OF LABORATORY RESULTS
Nutrients	Nitrate (as N) detected at ES1 (<0.01 mg/L to 0.06 mg/L) and EN3 (<0.01 mg/L to 0.04 mg/L). Reactive phosphorus (as P) detected in most wetland cells with highest concentration at EN1 (0.39 mg/L). Ammonia (as N) was detected in all wetland cells with the highest concentration detected at ES1 (5.66 mg/L).
BTEX compounds	Total BTEX below LoR (1 µg/L).
Petroleum hydrocarbons	TPH C_{10}-C_{36} (sum) and TRH C_{10}-C_{40} (sum) detected in all wetland cells. TPH C_{10}-C_{36} (sum) ranging from LoR (50 µg/L) to 1,130 µg/L (EN1) and TRH C_{10}-C_{40} (sum) ranging from LoR (100 µg/L) to 1,170 µg/L (EN1).
Pesticides	Analysed Aug 2017 GME only – below LoR.

Notes: LoR is Limit or reporting.

5.8.2 GROUNDWATER QUALITY

Groundwater quality (pH and EC) obtained during the three GMEs is discussed in the following section. The main water quality results for the QA and UTAF aquifers are summarised in Table 5.8.

Groundwater quality in the QA is highly variable, largely resulting from land-use (the influence of the built environment and associated urban run-off management) and intimate connection with water bodies:

- Groundwater salinity is marginal to saline, with EC values ranging from 359 µS/cm (ID18-GWBH04) to 26,601 µS/cm (GW-17-206-08). There are no obvious temporal trends in salinity apparent at this stage. QA groundwater samples collected from within the Edithvale Wetlands are moderately saline, with EC values ranging from 9,651 µS/cm to 13,836 µS/cm. Groundwater in the QA is typically more saline than surface water in the wetland cells, with the exception of the Dog Pond and EN2. Groundwater salinity in the semi-confined UTAF is also highly variable ranging from fresh to saline. The EC values ranging from 745 µS/cm (GW17-26-03) to 28,559 µS/cm (GW17-26-05). Salinity in the UTAF is higher where the aquifer is unconfined in the north and in proximity to port Phillip Bay. Salinity decreases generally along the flow path and decreased temporally, with lowest values recorded in February 2018 GME.
- The pH conditions in the Quaternary aquifer vary from slightly acidic to slightly alkaline, with pH ranging 5.23 (GW17-26-08) to 7.77 (GW17-26-14s). Acid sulfate sediments and acidic sediments, have been identified previously in the area and acidic conditions occur where sediments have been oxidised by fluctuating water levels. The pH values in the UTAF are near-neutral to alkaline, with values ranging from 6.34 (GW18-26-22D) to 8.44 (GW18-26-10D).
- Major ion chemistry for both aquifers is plotted with rainwater (Melbourne) and sea water (Port Phillip Bay) on Figure 5.17. In the Quaternary aquifer groundwater changes from Na-Cl-HCO_3 type in the lowest salinity samples to Na-Cl, Na-Mg-Cl or Na-Mg-Cl-SO_4 in brackish to saline groundwater samples. The relative proportion of sulfate varies in the QA and is elevated in groundwater underlying and south of the Waterways Wetlands. Groundwater in the UTAF is chemically classified as Na-Mg-Ca-Cl type water where it is unconfined; the rest of the aquifer is dominated by sodium and chloride.

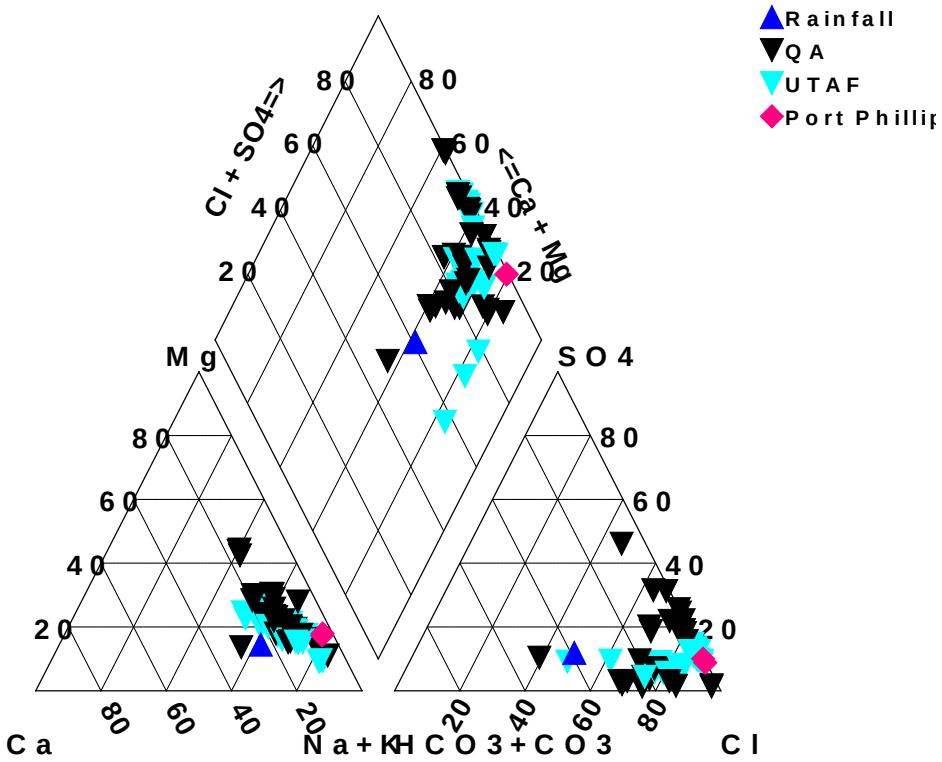


Figure 5.17 Piper diagram for groundwater samples collected from the Quaternary and Brighton Group aquifers

- Dissolved metals are more frequently detected above laboratory limits of reporting (LoR) in groundwater than surface water. The results show that there are more dissolved metal concentrations recorded above ANZECC 2000 FW 95% guidelines in the QA compared to the UTAF, potentially reflecting urban run-off effects, as well as higher salinity, lower pH and local lithological variations. Dissolved metals detected above ANZECC 2000 FW 95% in the QA include aluminium, arsenic, cadmium, copper, manganese, nickel and zinc. In the UTAF, ANZECC 2000 FW 95% guidelines surpassed for metals As, Cu, Ni and Zn at several monitoring bores. Arsenic is prevalent in both aquifers with maximum concentrations of 164 µg/L and 622 µg/L in the QA and UTAF, respectively.
- Boron is ubiquitous in both aquifers, with concentrations ranging from 0.05 mg/L to 0.45 mg/L in the QA and 0.07 mg/L to 2.10 mg/L in the UTAF. The highest concentrations were detected in the QA in the vicinity of the Edithvale Wetlands and is consistent with high concentrations in surface water. High boron concentrations are associated with saline intrusion of sea water; boron concentrations of up to 4.45 mg/L were measured in Port Phillip Bay.
- Nitrate (as N), nitrite (as N) and reactive phosphorus concentrations were typically low in the QA and UTAF aquifers, with the exception of nitrate in several UTAF bores north of the Waterways Wetlands (concentrations up to 0.79 mg/L at GW17-26-03). Ammonia was detected in both aquifers with concentrations above with ANZECC 2000 FW 95% guidelines at several locations.
- TPH/BTEX concentrations were typically below laboratory LoR; with two minor detections (see Table 5.8). Pesticides were below LoR.

Table 5.8 Summary of groundwater quality

PARAMETER	QUATERNARY AQUIFER WATER QUALITY	UTAF AQUIFER WATER QUALITY
Field electrical conductivity (EC)	Fresh to saline; EC values ranging from 359 µS/cm (ID18-GWBH04) to 26,601 µS/cm (GW-17-206-08). No temporal trends apparent.	Fresh to saline; EC values ranging from 745 µS/cm (GW17-26-03) to 28,559 µS/cm (GW17-26-05). Salinity higher in north and in proximity to Port Phillip Bay.
Field pH	Field values for pH are slightly acidic to slightly alkaline (range of 5.23 to 7.77).	pH is near-neutral to alkaline (range of 6.34 to 8.44).
Major ions	Predominantly Na-Cl, Na-Mg-Cl or Na-Mg-Cl-SO_4; low salinity water (Na-Cl-HCO_3).	Predominantly Na-Cl; Na-Mg-Ca-Cl type where aquifer is unconfined.
Dissolved metals	Below LoR: Hg, Se and V. Elevated concentrations of the metals Mn (8.14 mg/L) and Al (2.54 mg/L) were detected at GW17-26-08. ANZECC 2000 FW 95% guidelines surpassed for metals Al, Cd, Cu, Mn, Ni and Zn at several monitoring bores.	Below LoR: Al, Be, Cd, Cr, Pb, V, Hg and Se. ANZECC 2000 FW 95% guidelines surpassed for metals As, Cu, Ni and Zn at several monitoring bores.
Nutrients	Elevated ammonia (up to 6.59 mg/L) – several exceedances of ANZECC 2000 FW 95% guideline). Low nitrate and nitrite concentrations (as N) ranged between the LoR (0.1 mg/L) and 0.06 mg/L. Reactive Phosphorus as P) ranged between the LoR (0.1 mg/L) and 0.02 mg/L.	Elevated ammonia (range 0.28 and 2.99 mg/L) - several exceedances of ANZECC 2000 FW 95% guideline). Typically, low nitrate and nitrite concentrations (as N), with higher nitrate detected at GW17-26-03 (0.79 mg/L) and GW18-26-18D (0.73 mg/L). Reactive Phosphorus as P) ranged between the LoR (0.1 mg/L) and 0.06 mg/L.
BTEX compounds	Total BTEX below LoR (1 µg/L).	Total BTEX below LoR (1 µg/L), with one exception (GW18-26-22D – 3 µg/L toluene).
Petroleum hydrocarbons	TPH C_{10}-C_{36} (sum) and TRH C_{10}-C_{40} (sum) were all below LoR, with one exception (GW18-26-18S (TRH C_{16}-C_{34} – 180 µg/L).	TPH C_{10}-C_{36} (sum) and TRH C_{10}-C_{40} (sum) were all below LoR.
Pesticides	Below LoR.	Below LoR.

Notes: LoR is Limit or Reporting.

5.8.2.1 BENEFICIAL USES

Based on the TDS ranges stipulated in Groundwaters of Victoria SEPP, the groundwater of both the QA and UTAF range from Segment A2, B, C and D reflecting the variability observed within the QA and UTAF.

Only two bores would have beneficial uses classification of A2. Bore GW17-26-03, screened within the UTAF, and GW18-26-23S screened within the QA have TDS concentrations ranging from 632 to 865 mg/L. These bores are both located close to surface water bodies being an unlined portion of Dingley Drain and cell EN3a respectively. TDS values from these bores appear to be influenced from surface water bodies and considerably lower than other groundwater samples.

TDS concentrations within the remaining QA ranges from 1,365 mg/L to 18,000 mg/L (Segments B, C & D), with the remaining UTAF bores ranging from 2,424 mg/L to 26,325 mg/L (Segments B, C & D).

EPA Victoria adopts a conservative approach to classification of groundwater to protect all potential beneficial uses. With this approach *Segment A2* would be adopted. However as previously stated both GW17-26-03 and GW18-26-23S appear influenced by adjacent surface water bodies and not representative of regional aquifer conditions. This variability within the study area indicates that beneficial uses vary across the study area and cannot be applied in a consistent relevance in either the QA or UTAF.

To maintain consistency with the SEPP the following protected beneficial uses would be required to be protected for Segment A2 classification.

- Maintenance of ecosystems
- Potable water supply (desirable)
- Potable mineral water supply
- Agriculture, parks and gardens
- Stock Watering
- Industrial water use
- Primary contact recreation (swimming/bathing)
- Buildings and structures.

5.8.3 GEOCHEMICAL ANALYSIS

5.8.3.1 MAJOR ION COMPOSITION

Major ion composition of both groundwater and surface water samples are representative of regional water quality dominated by sodium and chloride ions, with elevated and varying concentrations in the superficial QA and the Edithvale Wetlands as discussed in Sections 5.8.1.3 and 5.8.2. Surface waters in the Waterways Wetland, Woodlands Industrial Estate Wetland and Braeside Park Wetland have a geochemical signature which is distinct from that of the superficial/semi-confined aquifers (Figure 5.18) and similar to that of rainfall, suggesting precipitation/surface run-off as major recharge sources.

It is apparent from the surface water and groundwater results, particularly the salinity indicator EC and major ion geochemical signatures (Figure 5.18), that the water quality of the Edithvale Wetlands is highly variable, suggesting that intrusion of saline groundwater, particularly via the UTAF, and evaporation, is influencing the wetlands and surrounding aquifer. The deep excavation of the Edithvale Wetlands into the UTAF aquifer unit has potentially provided a hydraulic connection with that aquifer unit, as such it may be inducing and enhanced groundwater flow (arising from evaporative removal of surface water in the pond/s), with the consequence of drawdown of the local water table and flow of seawater toward the wetlands environment.

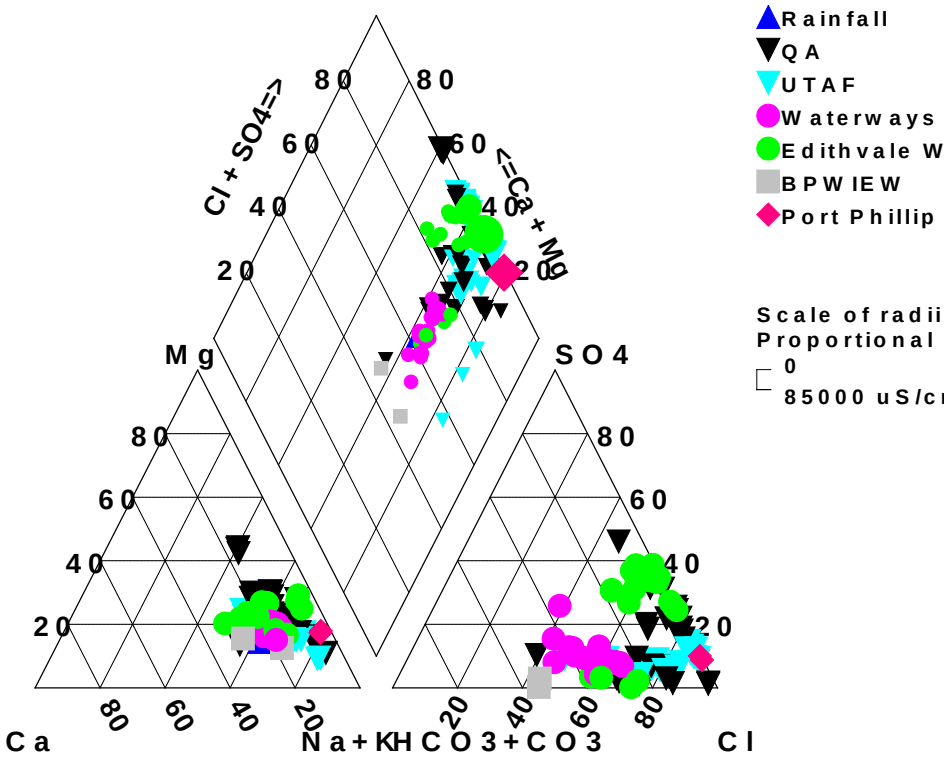


Figure 5.18 Piper diagram showing relative percentage of major ions for groundwater and surface water samples

5.8.3.2 CHLORIDE AND BROMIDE MASS RATIOS

Chloride/bromide (Cl/Br) ratios may be used to determine causes of groundwater salinisation. Seawater has a Cl/Br molar ratio of 655 and coastal rainwater will have similar ratios. With increasing distance from the coast Cl/Br ratios will vary depending on aerosol inputs. Surface water and groundwater that have undergone evaporation can have similar ratios to seawater until halite precipitates (Alcala & Custodio, 2008, Han et al., 2011). Since Br is less compatible in precipitating salts, it is enriched relative to Cl^- in residual brines, leading to Cl/Br ratios below 650. By contrast precipitated salts are depleted in Br^- which causes Cl/Br ratios above 3000 for water that has dissolved halite (Han et al., 2011).

Cl/Br ratios for groundwater and surface water versus Cl are compared to seawater (Cl/Br 655) in Figure 5.19. Cl/Br ratios for the beach samples collected from Port Phillip Bay were lower than seawater at 382 (Nov 2017) and 293 (Feb 2018). The Cl/Br ratio of rainfall is slightly lower than Port Phillip Bay samples and is approximately 214 (Crosbie et al. 2012). The Cl/Br ratios of the QA ranged from 318 to 1602, with an average of 571. These ratios are similar to groundwater in the UTAF, which had ratios ranging from 296 to 1022 and an average of 519. Several moderately saline samples collected from the QA and UTAF in the Waterways Wetlands had elevated Cl/Br ratios (above seawater ~655). The most likely mechanism for increases in Cl/Br ratio in the shallow aquifer is dissolution of minor volumes of halite from the unsaturated zone.

The Waterways Wetland has Cl/Br ratios comparable to groundwater from both aquifers, with ratios ranging from 341 to 621 (average 479). Surface water Cl/Br ratios for the Edithvale Wetlands show two distinct groups; a low Cl/Br ratio group comprising ES1 and EN1, and a higher Cl/Br group comprising EN3, EN3a, The Dog Pond and EN2. The low Cl/Br had ratios ranging from 170 to 239; while the higher Cl/Br ratio group had ratios ranging from 348 to 426 and were comparable to groundwater.

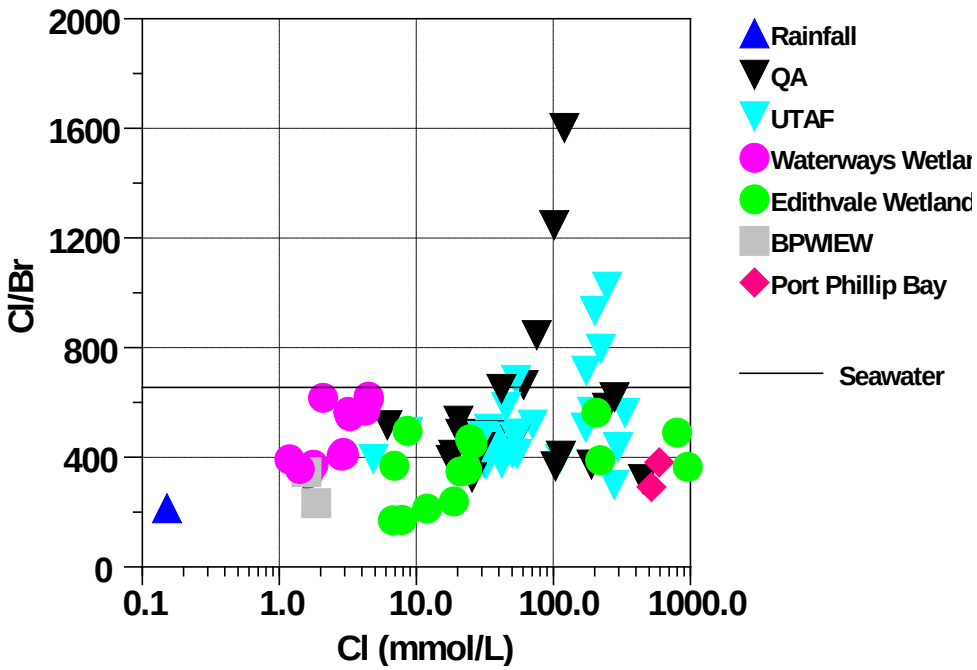


Figure 5.19 Cl/Br versus Cl for groundwater and surface water

5.8.3.3 STABLE ISOTOPE ANALYSIS

Stable isotope ($\delta^{18}O$ and $\delta^{2}H$) values for groundwater and surface waters are compared to the Global Meteoric Water Line (GMWL) ($\delta^{2}H = 8.2\ \delta^{18}O + 10.8$) (Craig, 1961) in Figure 5.20 and chloride in Figure 5.21. The GMWL provides an important key to the interpretation of oxygen-18 and deuterium data. It is a line that defines the relationship between oxygen-18 (^{18}O) and deuterium (^{2}H) in fresh surface waters and precipitation from numerous global reference sites. Water with an isotopic composition that lies on the meteoric water line is assumed to have originated from the atmosphere and to be unaffected by other isotopic processes. Shifts from the meteoric water line result from isotopic processes other than the typical water cycle processes or mixing with various water sources. The isotopic values for the groundwater samples are also compared to the Local Meteoric Water Line ($\delta^{2}H = 7.5\ \delta^{18}O + 9.8$) (Crosbie et al. 2012). This line defines the relationship between ^{18}O and ^{2}H for rainfall in the Melbourne region.

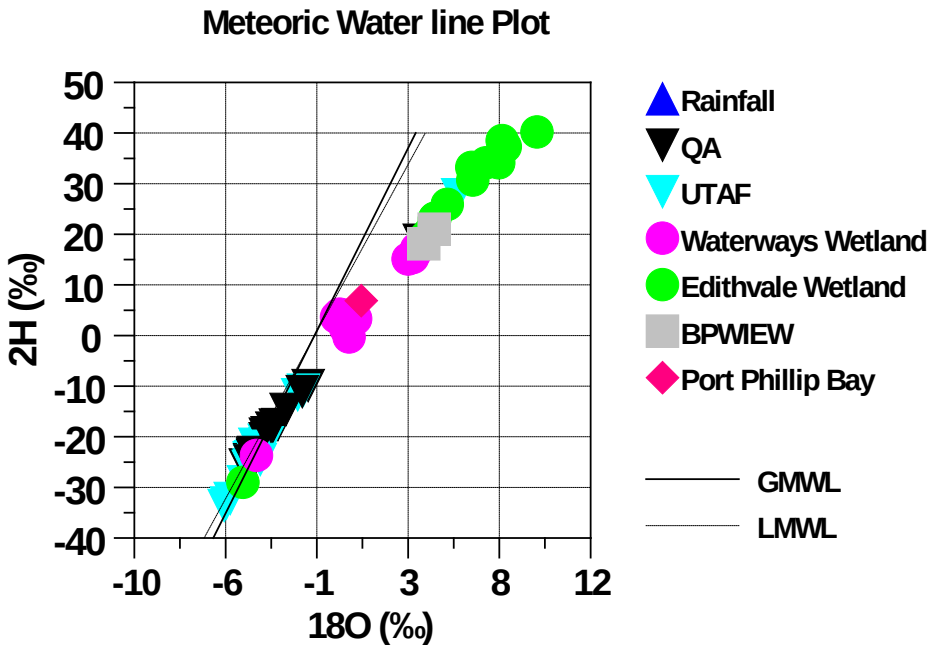


Figure 5.20 Stable isotope ($\delta^{18}O$ and $\delta^{2}H$) values for groundwaters and surface waters compared to the GMWL and LMWL for Melbourne

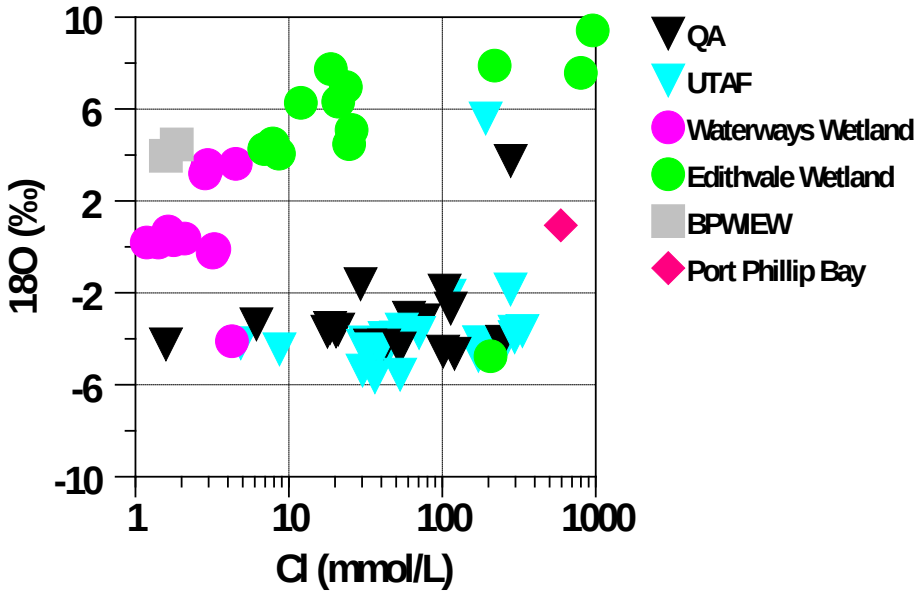


Figure 5.21 Stable isotope ($\delta^{18}O$) values for groundwaters and surface waters compared to Cl

Groundwater samples from the QA had $\delta^{18}O$ values ranging from -4.65‰ to 3.74‰, and deuterium values ranging from -25.7‰ to 18.8.‰. Although there was a large range of isotope values, the majority of samples plotted on the GMWL, indicating meteoric origin of water. One groundwater sample from the Quaternary aquifer, QA, with high salinity (GW17-26-08) had an enriched signature that was likely to due to evaporation in the unsaturated zone.

Groundwater samples from the UTAF plotted on or close to the GMWL (excluding one outlier) and had $\delta^{18}O$ values ranging from -5.67‰ to 5.59‰, and deuterium values ranging from -33.6‰ to -27.8‰, indicating groundwater is primarily of meteoric origin. The average stable isotope values ($\delta^{18}O$ = -3.82‰ and $\delta^{2}H$ = -21.9‰) for the UTAF is similar to the beach sample collected from Port Phillip Bay ($\delta^{18}O$ = -3.93‰ and $\delta^{2}H$ = -24.5‰), which together with EC, Cl/Br ratios supports hydraulic data indicating reversal of hydraulic gradients and seawater intrusion via the UTAF.

The Waterway Wetlands had a highly variable stable isotope composition, with $\delta^{18}O$ values ranging from -5.67‰ to 5.59‰ and $\delta^{2}H$ values ranging from -33.6‰ to 27.8‰. Many samples had isotopic signatures that were enriched in $\delta^{18}O$

and δ^2H values compared to the GMWL and LMWL, indicating evaporation is a key process affecting water samples in the wetlands. As wetland water evaporates, the relative proportions of deuterium and ^{18}O shift away from the meteoric water line because of differences in the vapour pressures of the isotopes (Clark and Fritz, 1997). The further along the evaporation trend line a water sample plots away from the meteoric water line, the more extensive the evaporation is relative to the water body volume.

The stable isotope composition of the Edithvale Wetlands is highly variable, with $\delta^{18}O$ values ranging from -4.76‰ to 9.42‰ and δ^2H values ranging from -29.0‰ to 40.2‰. EN2 had a stable isotope signature similar to the UTAF ($\delta^{18}O$ = -4.76‰ and δ^2H = -29.0‰) in the November 2017 GME which confirms the hydraulic connection between the aquifer and the wetland cell. The sample collected from EN2 in February 2018 GME was highly evaporated, and had an enriched isotopic signature ($\delta^{18}O$ = 7.89‰ and δ^2H = 37.3‰).

All other wetland cells in the Edithvale Wetlands plotted to the right of the GMWL and LMWL and had isotopic signatures that are highly affected by evaporation. Drawdown and drying occurs in ES1, The Dog Pond, and EN3 during summer due to low rainfall/high evaporation rates, and drying can occur EN1 although groundwater leakage can sustain a moist area in EN1 (Victorian Government of Sustainability and Environment, 2011). The stable isotope values in the February 2018 GME were more enriched than the November 2018 GME which is consistent with low rainfall/high evaporation over the summer.

5.8.3.4 ASSESSMENT OF RECHARGE SOURCES TO EDITHVALE WETLANDS

Wetland cell EN2 of the Edithvale Wetlands was excavated into the underlying Brighton Group aquifer in 1987-1988. Stable isotope data ($\delta^{18}O$ and δ^2H), major ion chemistry, boron concentrations, salinity and Cl/Br ratios support that this wetland cell is in hydraulic connection with the UTAF. Ecology Australia (2016) report that the most northern cells (EN2, EN3 and EN3a) generally reach deep into the peat layer and sandy substrate and have differing inputs of groundwater. Geochemical signatures, Cl/Br ratios and EC values also suggest EN3, EN3a and the Dog Pond have groundwater input, although stable isotope signatures are highly enriched due to evaporative effects.

The Edithvale South Wetlands (ES1) is likely to receive significant amounts of surface water input via three stormwater drains which overflow into EN1 in Edithvale North Wetlands; however stable isotope data indicate that evaporation is a key process occurring either on input waters or surface waters from the wetland cell during spring/summer.

5.9 SENSITIVE RECEPTORS

As mentioned in Section 1, the EES requirements include the following key matters for the EES, in terms of groundwater impacts, to examine are:

- Potential effects on biodiversity values, including through direct or indirect loss, degradation or fragmentation of habitat or through other causes including road-kill, as well as related ecological effects
- Potential effects on water environments and related beneficial uses, including as a result of changes to hydrology and groundwater.

On this basis, the key environmental values, pertinent to this EES, are discussed in the following text:

5.9.1 GROUNDWATER USERS

Registered groundwater bores located within a 2 km radius of the project site were identified using WMIS and information provided by Lotsearch. A total of 402 registered groundwater bores located within a 2 km radius of the Mordialloc Bypass project site. The location of the groundwater bores are shown on Figure 5.22.

Of these 402 bores, 111 have beneficial uses of groundwater that are broken down in the following way:

- 681 stock and domestic
- 30 irrigation.

The remaining 291 bores are used for groundwater monitoring (193) or have no information available (98).

Of the 111 groundwater bores with beneficial uses, 21 are located within 500 m of the project site and are detailed in Table 5.9.

Table 5.9 Groundwater bore details (within 500 m of site boundary)

BORE ID	DISTANCE FROM SITE (m)	BENEFICIAL USE	DEPTH (m)	GEOLOGY	DATE INSTALLED
WRK039072	0	Stock and domestic	24.38	Sand	9/01/1986
76479	20	Stock and domestic	24.38	Sand	11/01/1986
WRK055858	61	Irrigation	Unknown	Unknown	Unknown
81729	87	Stock and domestic	49.38	Sand	23/12/1982
76306	136	Stock and domestic	24.38	Sand	13/01/1986
81737	152	Stock and domestic	86.00	Mudstone	2/12/1983
76456	226	Stock and domestic	22.25	Sand	23/11/1983
81716	241	Stock and domestic	10.00	Sand	12/06/1983
81710	251	Irrigation	152.50	Clay	12/01/1979
76514	275	Stock and domestic	20.00	Sand	27/02/1990
WRK071605	306	Irrigation	122.00	Unknown	2/10/2012
WRK039215	319	Irrigation	40.02	Sand	20/02/1990
81736	363	Stock and domestic	24.38	Clay	10/08/1983
WRK963362	370	Stock and domestic	5.50	Unknown	7/11/2005
WRK986702	371	Stock and domestic	10.80	Sand	17/06/2008
76462	392	Stock and domestic	21.34	Sand	27/12/1982
76497	396	Stock and domestic	3.00	Sand	31/12/1984
76473	403	Stock and domestic	6.10	Sand	7/08/1983
81662	431	Stock and domestic	24.30	Unknown	31/12/1970
WRK057334	457	Stock and domestic	68.00	Siltstone	2/06/2010
WRK032660	483	Irrigation	56.00	Sandstone	8/07/1998

5.9.2 GROUNDWATER DEPENDENT ECOSYSTEMS

Groundwater dependent ecosystems (GDE) are communities of plants, animals and other organisms that depend on groundwater for survival (Department of Land and Water Conservation, 2002). A GDE may be either entirely dependent on groundwater for survival, or may use groundwater opportunistically or for a supplementary source of water (Hatton and Evans, 1998).

GDEs include wetlands, vegetation, mound springs, river base flows, cave ecosystems, playa lakes and saline discharges, springs, mangroves, river pools, billabongs and hanging swamps and near-shore marine ecosystems. The GDE Atlas (BOM, 2017b) categorises GDEs into three classes:

- Ecosystems that rely on the surface expression of groundwater – this includes all the surface water ecosystems which may have a groundwater component, such as rivers, wetlands and springs.
- Ecosystems that rely on the subsurface presence of groundwater – this includes all vegetation ecosystems.
- Subterranean ecosystems – this includes cave and aquifer ecosystems.

Groundwater discharge can be important in maintaining baseflow in rivers and streams, and ecosystems associated with these discharge areas may have a high dependency on groundwater for their water requirements. It should be noted however that some of these ecosystems rely on perched aquifer systems that are shallow, surficial and are largely not connected to the deep regional groundwater system, and, as such, will not be additionally interfered with by construction works (beyond that impacted by typical urban development disturbance). That is, these ecosystems are largely sustained by recharge-in/recharge-out processes associated with rainfall infiltration which typically characterise the behaviour of shallow perched water systems.

All identified GDEs within the vicinity of the Mordialloc Bypass project site are identified on Figure 5.23. Within a 2 km buffer of the project site, nine ecosystems have been identified that rely on the subsurface presence of groundwater. The following GDEs have been identified:

- Coast Banksia Woodland
- Coastal Dune Scrub
- Creek line Grassy Woodland
- Damp Sand Herb-rich Woodland; Grassy Woodland
- Heathy Woodland
- Plains Grassy Wetland
- Plains Grassy Woodland
- Swap Scrub (mosaic).

These GDEs have a moderate to high potential for groundwater interaction.

A search of the GDE atlas also identified five GDEs within the 2 km buffer of the Mordialloc Bypass project site that rely on the surface expression of groundwater:

- Clayton South Drain
- Edithvale Wetlands (Ramsar Convention)
- Mordialloc Creek
- Mordialloc Settlement Drain; and
- Wannarkladdin Wetlands were identified GDEs that rely on the surface expression of groundwater.

All the five GDEs have a high potential for groundwater interaction.

5.9.3 REGIONAL GROUNDWATER CONDITIONS – WETLANDS

All wetlands previously identified in Section 5.4 are sensitive receptors to any potential changes to regional groundwater conditions. Whilst all wetlands assist in the natural control of flooding only Edithvale – Seaford have Ramsar criteria. Ecosystem services are resources and processes provided by the natural environment to the benefits to humans through the transformation of resources (including land, water, vegetation) into the flow of essential goods and services e.g. clean air, water, etc (Department of the Environment Water Heritage and the Arts 2010). Ecosystem services have been defined for Edithvale Wetlands (Table 5.10) and have been used as a measuring tool to evaluate potential incremental impact of the proposed roadway on the Edithvale Wetlands.

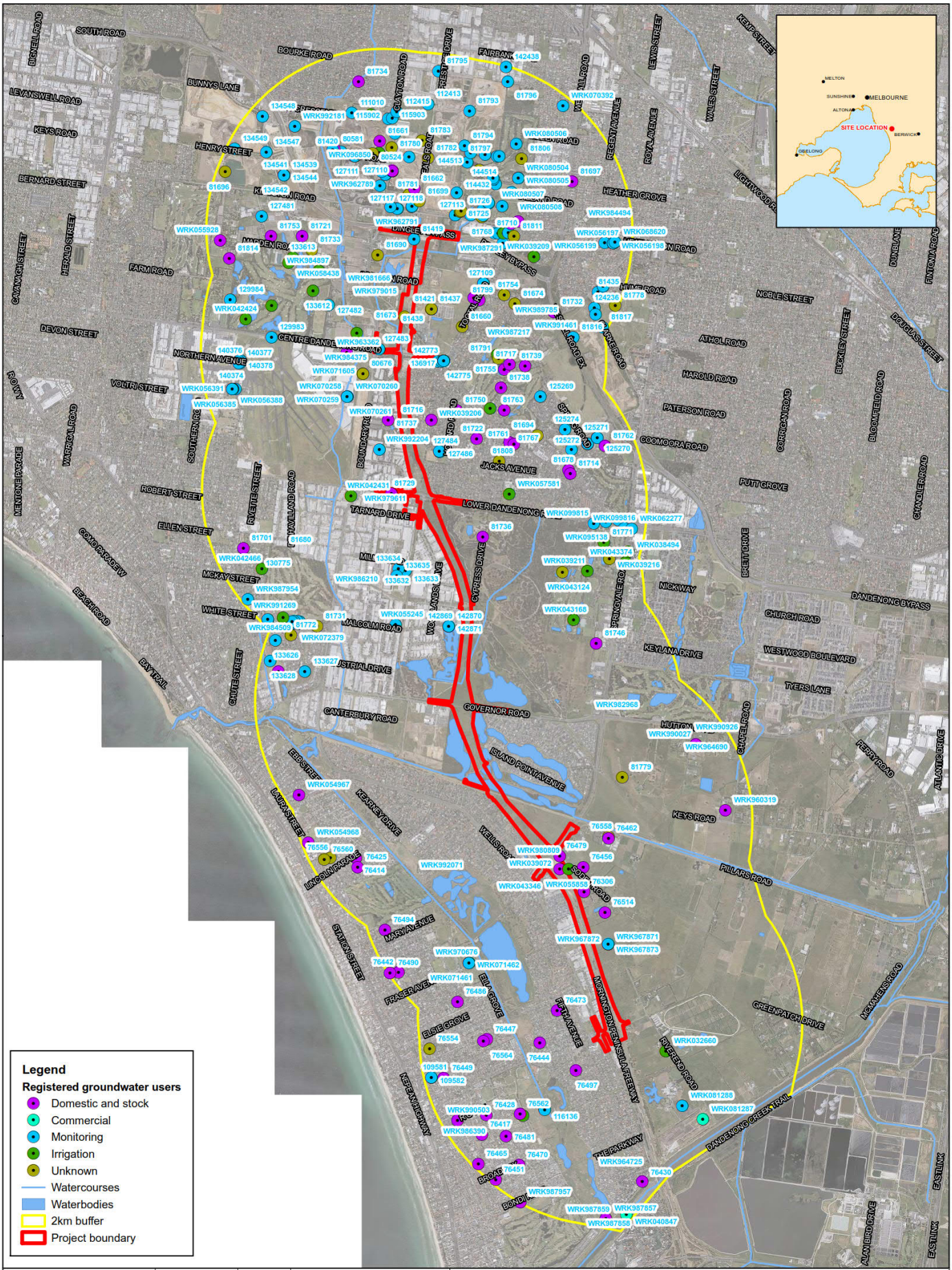
The approach to this assessment entailed a review of the ecological services of the Edithvale-Seaford Wetlands that were used to nominate the wetlands for Ramsar listing (Department of Sustainability and Environment Melbourne, 2012).

Table 5.10 Ecosystem services used for the ecological character description (after Victorian Government Department of Sustainability and Environment Melbourne, November 2012)

ECOSYSTEM SERVICES THAT RELATE TO THE RAMSAR CRITERIA FOR LISTING EDITHVALE – SEAFORD AS A RAMSAR SITE	RAMSAR CRITERIA
Last remaining representative example of the Carrum Carrum Swamp. Representative of the depleted shallow freshwater wetland type in the Gippsland Plain Bioregion.	1
Assists in the natural control of flooding	1
Supports threatened species, particularly the Australasian Bittern	2
Regularly supports 1% of the East Asian-Australasian Flyway population for Sharptailed Sandpipers	6
The wetlands support threatened ecological vegetation community's characteristic of the Gippsland Plains Bioregion	3*

*Criterion 3 was added after the site was listed in 2001.

Existing groundwater conditions information was gathered from public and other sources, and reviewed to establish the current groundwater setting down-gradient of the project alignment, with particular focus on the Waterways Wetlands and Edithvale Wetlands areas. The key data sources included Water Measurement Information System (WMIS) bore database, Bureau of Meteorology (BOM) groundwater dependent ecosystems database, VicRoads (SiteMap), Melbourne Water, South East Water (SEW) and previous reports.


Legend
Registered groundwater users
Domestic and stock
Commercial
Monitoring
Irrigation
Unknown
Watercourses
Waterbodies
2km buffer
Project boundary
SITE LOCATION
MELTON
SUNSHINE
MELBOURNE
ALTONA
BERWICK
GEELONG
BOURKE ROAD
SOUTH ROAD
BUNNYS LANE
KEYS ROAD
HENRY STREET
BERNARD STREET
FARM ROAD
DEVON STREET
NORTHERN AVENUE
VOLTRI STREET
SOUTHERN RD
ROBERT STREET
ELLEN STREET
MCKAY STREET
WHITE STREET
CHUTE STREET
BAY TRAIL
BEACH ROAD
COMO PARADE W
MENTONE PARADE
WARRIGAL ROAD
RIVETTE STREET
HAVILLAND ROAD
BOUNDARY RD
TARNARD DRIVE
MALCOLM ROAD
INDUSTRIAL DRIVE
CANTERBURY ROAD
LOWER DANDENONG RD
CYPRESS DRIVE
WOODLANDS AVE
MILL
CLAYTON ROAD
FOREST DRIVE
FAIRBANK
WELLS ROAD
REGENT AVENUE
ROYAL AVENUE
WALES STREET
LEWIS STREET
KEMP STREET
HEATHER GROVE
NOBLE STREET
HUME ROAD
ATHOL ROAD
HAROLD ROAD
PATERSON ROAD
COOMOORA ROAD
JACKS AVENUE
PUTTI GROVE
NICKWAY
SPRINGVALE RD
BRETT DRIVE
DANDENONG BYPASS
CHURCH ROAD
KEYLANA DRIVE
WESTWOOD BOULEVARD
TYERS LANE
CHAPEL ROAD
PERRY ROAD
ATLANTIC DRIVE
ISLAND POINT AVENUE
GOVERNOR ROAD
HUTTON
KEARNEY DRIVE
LAURA STREET
EBB STREET
LINCOLN PARADE
STATION STREET
MARY AVENUE
FRASER AVE
ELSIE GROVE
EDU GROVE
FIFTH AVENUE
MORNINGTON PENINSULA FREEWAY
PILLARS ROAD
GREENPATCH DRIVE
MCMAHENS ROAD
RIVERSEND ROAD
DANDENONG CREEK TRAIL
THE PARKWAY
BROAD
BONDI
EASTLINK
ALANBIRD DRIVE
DUNBLANE
FINTONA ROAD
CORRIGAN ROAD
BLOOMFIELD ROAD
BUCKLEY STREET
DOUGLAS STREET
GAVANAGH STREET
HERALD STREET
LEVANSWELL ROAD
BIGNELL ROAD
KEYS ROAD
ROWAY
WRK055928
WRK042424
WRK042466
WRK042431
WRK056391
WRK056385
WRK056388
WRK058438
WRK070258
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WRK963382
WRK981666
WRK979015
WRK992204
WRK979611
WRK057581
WRK099815
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WRK062277
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WRK038494
WRK043374
WRK039216
WRK039211
WRK043124
WRK043168
WRK055245
WRK055858
WRK043346
WRK039209
WRK056197
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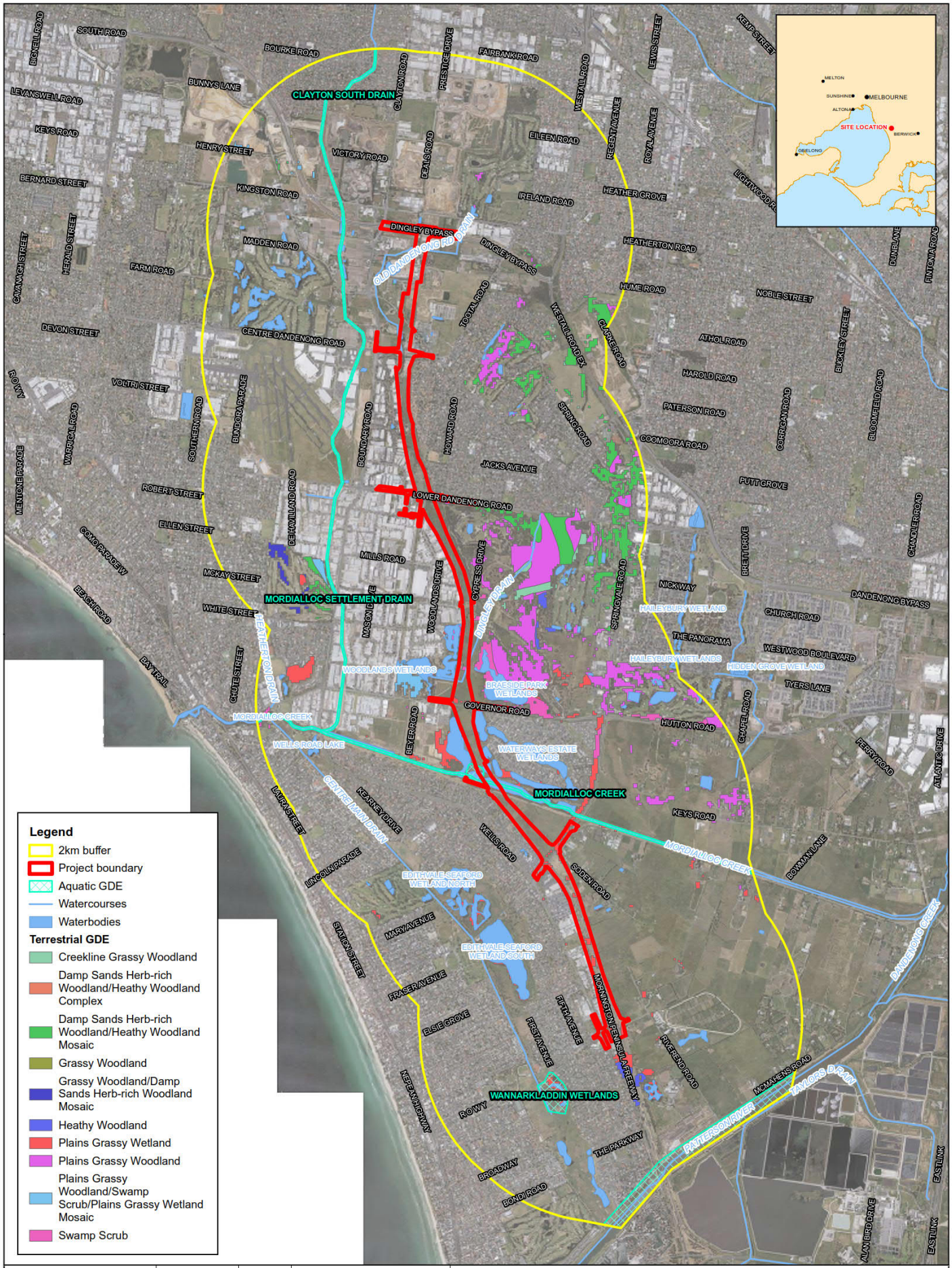
WRK990926
WRK964690
WRK982968
WRK960319
WRK032660
WRK081288
WRK081287
Map: 2135645A_GIS_954_A
Author: MB
Date: 4/09/2018
Approved by: AS
0 400 800 m
1:40,000
Coordinate system: GDA 1994 MGA Zone 55
Scale ratio correct when printed at A3
Data source: VicRoads.
Copyright © The State of Victoria, Department of Environment, Land, Water & Planning 2018
MAJOR ROAD PROJECTS AUTHORITY
VICTORIA State Government
wsp
Engineering and Technical Services for Mordialloc Bypass Upgrade
Figure 5.22
Registered groundwater users within 2km of Mordialloc Bypass
VicRoads
www.wsp.com



Legend

- 2km buffer
- Project boundary
- Aquatic GDE
- Watercourses
- Waterbodies

Terrestrial GDE

- Creekline Grassy Woodland
- Damp Sands Herb-rich Woodland/Heathy Woodland Complex
- Damp Sands Herb-rich Woodland/Heathy Woodland Mosaic
- Grassy Woodland
- Grassy Woodland/Damp Sands Herb-rich Woodland Mosaic
- Heathy Woodland
- Plains Grassy Wetland
- Plains Grassy Woodland
- Plains Grassy Woodland/Swamp Scrub/Plains Grassy Wetland Mosaic
- Swamp Scrub

Map: 2135645A_GIS_951_A	Author: MB
Date: 4/09/2018	Approved by: AS

0 400 800 m

1:40,000

Coordinate system: GDA 1994 MGA Zone 55

Scale ratio correct when printed at A3

Data source: VicRoads.
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MAJOR ROAD PROJECTS AUTHORITY

VICTORIA State Government

wsp

Engineering and Technical Services for Mordialloc Bypass EES

Figure 5.23

Groundwater dependent ecosystems within 2km of Mordialloc Bypass

5.10 CONCEPTUAL HYDROGEOLOGICAL MODEL

Information obtained to inform the existing conditions description of this report can be integrated to develop a conceptual hydrogeological model of the Study Area. Conceptual models are a useful tool that captures the existing environmental condition primarily hydrological and hydrogeological aspects and illustrating the interaction and functions between the two. The following section summarises the conceptual aspects of groundwater within the study area and its interactions with both natural and anthropogenic elements.

5.10.1 TOPOGRAPHY AND DRAINAGE

The study area is largely flat with elevations close to or below sea level. The greatest elevation is to the North East with elevation dropping towards the south with elevations below sea level at Edithvale Wetlands. A coastal dune system is present to the west, parallel to Port Phillip Bay.

The southern portion of the study area, approximately south of Governor Road, is within the former Carrum Carrum Swamp that was drained and cleared for agricultural settlement in the late 1800's by European settlers. Several waterways were cut or modified to drain the swamp such as Patterson River and the channelizing of Mordialloc Creek. The low lying area of the former Carrum Carrum Swamp experienced natural water logging. To alleviate this, several drains and wetlands have been constructed and to provide flood mitigation and storage. Woodlands Industrial Estate Wetland, Braeside Park Wetlands, Waterways Estate Wetlands and Edithvale Wetlands are all anthropogenically altered water bodies.

Wetland cells in Edithvale were known to be deepened in 1987–1988 leading to a direct connection between the wetlands and the UTAF. This has resulted the wetlands becoming a local groundwater sink with a decrease in water quality as the UTAF discharges into the groundwater cells to replace losses through evaporation.

5.10.2 HYDROGEOLOGY

There are two primary HSU aquifers within the study area being the QA and the UTAF aquifers. The UTAF is present across the entire project area and is unconfined in the northern portion of the study area, approximately north of Governor Road, where the UTAF sediments outcrops. In the southern portion of the study area largely within the former Carrum Swamp, the QA overlies the UTAF which becomes semi-confined.

The UTAF consists of Tertiary Brighton Group Sediments as is mostly fluvial deposited clayey sands and sandy clays with sand lenses. The QA sediments consists of swamp deposits and Aeolian sands deposited in dunes running parallel to the coast. A layer of Pleistocene clay forms the basal layer of the QA.

Groundwater levels across the study area are relatively close to surface levels with water levels mirroring topography. Groundwater levels are greatest in the north with elevation of 4.99 mAHD and are below sea level in the south and close to the topographic low of the Edithvale Wetlands. Groundwater levels experience seasonal variability with groundwater levels falling during dryer summer months and increase in ET and recovering during the wetter winter period. Groundwater levels in the south, adjacent to Springvale road are anthropogenically altered due to the presence of a registered pumping bore which has created a drawdown depression in the southern portion of the alignment.

Groundwater flow direction in the QA and UTAF aquifer is complex, largely resulting from topographic effects, land-use, intimate connection with water bodies, groundwater use, proximity of Port Phillip Bay and, the influence of the built environment and associated urban run-off management. The monitoring data collected suggests that the groundwater within the QA aquifers appears to move towards the south to southwest (Section 0, Figure 5.14). Groundwater flow within the deeper semi-confined UTAF is in a south south-easterly direction (Figure 5.15), towards discharge features such as Port Phillip Bay, Patterson River and Edithvale Wetlands. Local effects induced by groundwater extraction locally influence groundwater flow (Figure 5.15, registered extraction bore (WRK039072) influences groundwater flow near Springvale Road directed in a southerly direction towards the extraction bore). Pumping from surface water bodies to maintain wetland cells during drier months can influence groundwater flow (Figure 5.11).

Groundwater connection to the Edithvale Wetlands has resulted in local groundwater flow of the UTAF being directed towards the wetlands where groundwater replaces losses to the wetland through evaporation. This has resulted in a decline of wetland water quality in some of the wetland cells. This alteration in groundwater flow has potentially lead to saline intrusion of groundwater from Port Phillip Bay.

Nested groundwater monitoring bores have indicated that both positive and negative hydraulic gradient exist between the QA and UTAF within the study area. The influence from the pumping bore has distort the natural groundwater regime with water level response to pumping noticed at several nested groundwater sites.

Recharge to the QA and UTAF is predominantly by rainfall and to a smaller degree by watercourses and potentially built environment. The groundwater flow within the QA is complex and likely consists of numerous flow systems locally influenced by topography and surface water features. Regional groundwater flow within the UTAF is topographically driven with groundwater flow to from the north east to the south west where it discharges into Port Phillip Bay. At a local scale the Edithvale Wetlands act as an evaporative sink where the is direct connection between some of the wetland cells and the UTAF.

5.10.3 WATER QUALITY

Groundwater quality in both the QA and UTAF is highly variable with salinity is marginal to saline. Groundwater salinity within the UTAF is highest where the UTAF is unconfined in the north and where it is in close proximity to Port Phillip Bay. Salinity within the QA is higher than that of the surface water features with the exception of wetland cells EN2 and the Dog Pond, which are in hydraulic connection with the UTAF.

The pH concentrations in the QA vary from slightly acidic to alkaline with pH ranging from 5.23 (GW17-26-08) to 7.77 (GW17-26-14S), Acid sulfate materials have been identified within the footprint of the former Carrum Carrum Swamp and acidic conditions can occur where sediments have oxidised by fluctuating seasonal water levels. The pH levels in the UTAF are near-neutral to alkaline with values ranging from 6.34 (GW18-26-22s) to 8.44 (GW18-26-10D).

Whilst boron is ubiquitous in both aquifers, the elevated concentrations were recorded in both groundwater and surface water samples adjacent and within the Edithvale Wetlands. Elevation boron concentrations in wetland cells EN2 and Dog Pond are associated with saline intrusion of sea water supporting the conceptual understanding of the Edithvale Wetlands.

5.10.4 GROUNDWATER DEPENDENCE

The potential for groundwater-surface water interaction within the study area is likely due to the low-lying topography and geomorphology within the former Carrum Carrum Swamp.

Edithvale Wetlands have been the primary focus for groundwater-surface water interaction within the study area however other potential GDEs have been mapped. Drainage features such as the Centre Main Drain, Mordialloc Creek and Patterson River have been identified as GDEs that depend on the surface expression of groundwater. As well as several terrestrial GDEs located adjacent to wetlands and within Braeside Park.

Water quality sampling including isotopic analysis indicates that several wetland cells within Edithvale Wetlands (EN2, EN3, EN3a and Dog Pond) are in hydraulic connection with the QA and the underlying UTAF. This is largely to do with the excavation and deepening of the wetlands in 1987-88 that penetrated through the basal Pleistocene clay layer of the QA forming a hydraulic connection with the UTAF. This connection supports conceptual understanding of the Edithvale acting as evaporative groundwater sink.

Edithvale also receives stormwater contributions that can alter the amount of groundwater contributions to the wetlands. Edithvale South wetlands (ES1) and Edithvale North wetland cell (EN1) appear to be entirely dependent on surface water with wetland cell EN1 behaving as an ephemeral water body and capable of drying out completely. Water levels in ES1 can be supported by pumping from the Centre Main Drain during drier periods.

Geochemical analysis indicated that the Woodlands Industrial Estate Wetlands, Braeside Park Wetlands, Waterway Estate Wetlands and Mordialloc Creek have chemically distinct water signatures from the QA, UTAF and certain

wetland cells at Edithvale Wetlands (ES1, EN1) samples indicating that these water bodies are not groundwater dependant.

5.10.4.1 EDITHVALE WETLANDS WATER BALANCE

Developed from the existing LXRA water balance model for the Edithvale Wetlands, a SOURCE water balance model was completed to include changes to runoff caused by the Mordialloc Bypass. The resulting project water balance model for Edithvale Wetlands model impacts to water levels within the wetlands due to changes in in surface water and groundwater contributions (Appendix C).

A sensitivity analysis of the projected the impact to water levels within the individual wetland cells based on 10% reduction to groundwater contributions. The resulting simulations indicated that there was little sensitivity to water levels within the wetlands with potential reduction of groundwater baseflow into the wetland cells.

5.10.5 CONCEPTUAL CROSS SECTIONS

The conceptual understanding of hydrogeological conditions within the existing environment are presented in the following cross sections. Figure 5.24 displays the north-south cross section through the alignment and a west-east cross section from Port Phillip Bay to the alignment.

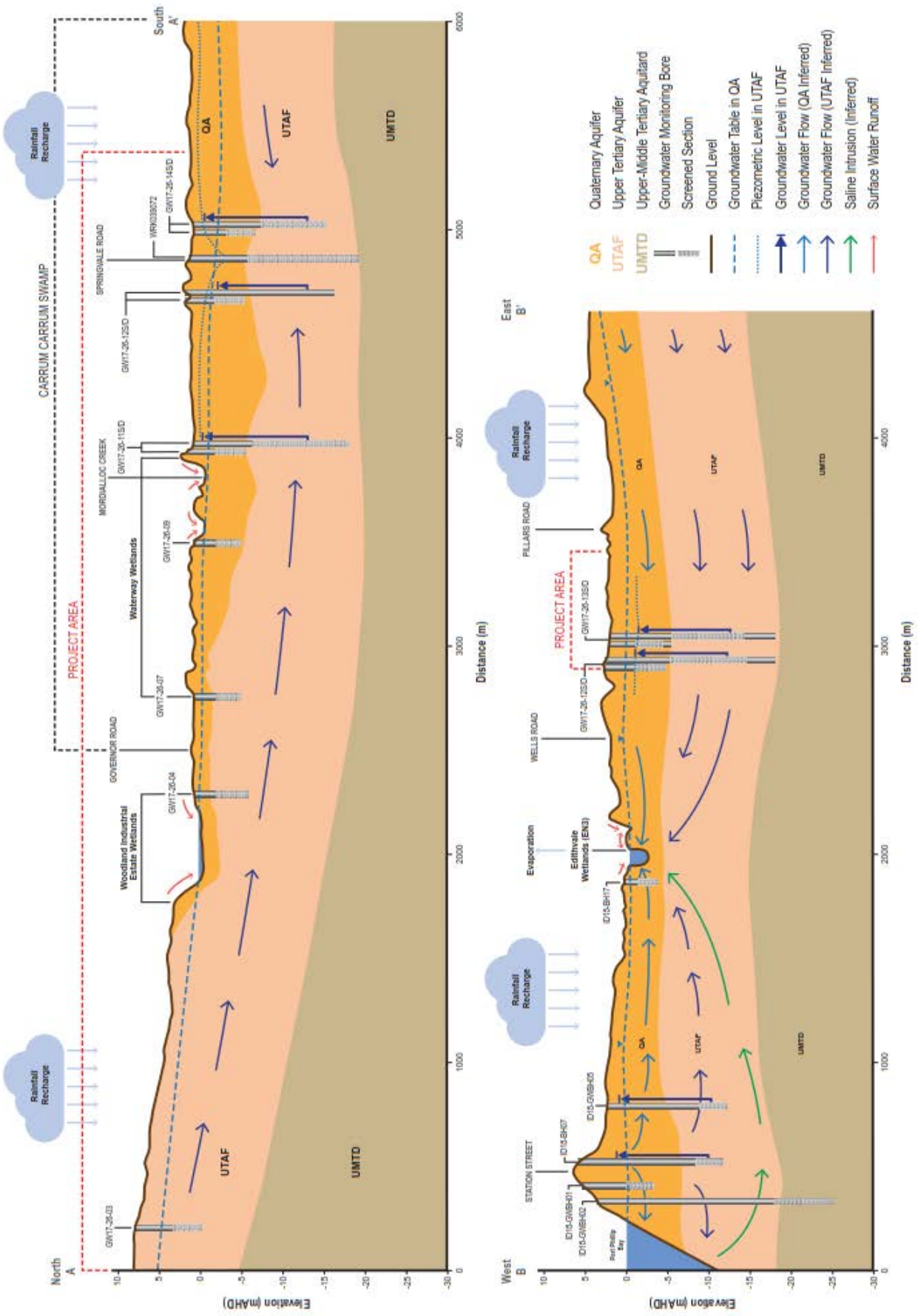


Figure 5.24 Conceptual model of regional groundwater flow setting between the project alignment and Edithvale wetlands (note high vertical exaggeration)

6 RISK ASSESSMENT

The risk assessment for the project was undertaken as using the source-path-receptor pathway and assessment framework based on AS/NZS ISO31000:2009 previously described in Section 4.4.

A series of multidisciplinary semi-quantitative environmental risk assessments and workshops have been undertaken in relation to the assessment of potential environmental impacts due to the proposed project.

The risk assessment process identified potential construction and operational hazards, impact pathways, consequences of contaminated land and spoil management and likelihood of impacts. Risk to environmental assets and values were determined as the combination of consequence and likelihood. Where possible, mitigation measures and additional EPRs were recommended to lower the residual risk.

6.1 PROJECT PHASES AND ASSOCIATED RISKS

As indicated in Section 1, a key factor instrumental in the assessment of impacts from the project arose out of the initial PGIA, and the potential of groundwater impacts being highlighted in a risk assessment (RA) process. The RA process has evaluated the project based on the concept designs for the project, a draft construction methodology and the existing conditions of the study area. The project phases to be assessed are as follows:

- *Initial phase.*
- *Construction phase.*
- *Operations and maintenance phase.*

To effectively and comprehensively recognise all potential risks to the project, it is necessary to identify impact pathways for the project. A risk is considered possible only when an impact pathway is present. An impact pathway is the cause and effect pathway or relationship that exists between a project activity and an aspect of the environment.

The project phases assessed for risks, including design, construction and operation phases, are described in Table 6.1.

Table 6.1 Assessed Project phases

PROJECT PHASES	MAIN ACTIVITIES FOR EACH PHASE	EXAMPLES OF ASPECTS IN EACH ACTIVITY
Initial Phase	Current project activities including: Project scoping, design stages (from initial to detailed), feasibility studies, design option analysis, baseline assessments, planning and approvals, material selection etc.	Site investigations (impacts from geotechnical assessments including pre-construction drilling, ecology assessments etc., gaps in baseline data, quality control). Design (water sensitive urban design, design to minimise environmental impact etc.). Approvals (what approvals are required and what are the environmental implications to ensure protection of environmental assets).
Construction Phase	Construction and Manufacturing	Transport of materials to site, impacts on environment/social values, earthworks, environmental changes (weather), laydown areas, schedule delays.
Operations and Maintenance Phase	Road and infrastructure maintenance and operation.	Weed control, grass cutting, re-laying road surface, drainage, long term environmental/social impacts, emergency preparedness/response, traffic.

6.1.1 IMPACT PATHWAYS

Potential impacts to the groundwater environment can occur at different stages of the proposed development and have been described in Section 4.4.

Impacts have been classified in a temporal sense with the two temporal phases of the project consisting as:

- The *construction phases*, where impacts are likely to be short term and localised, e.g. spills and contamination or groundwater extraction for trenching and excavation.
- *Ongoing phases*, where impacts can arise as a result of the construction activities or ongoing road operation, e.g. reduction of permeability due to embankment structures and groundwater deprivation downgradient of excavations.

Developed from previous groundwater studies, Table 6.2 describes the potential impacts identified with the Mordialloc Bypass (GHD 2012). Risks have been identified using a *source – pathway – impact* criteria where the source is activities relating to construction and operation, the pathway is the mechanism that would result in an impact, and impact being the description of change to the groundwater environment.

Table 6.2 Groundwater impact pathways

CATEGORY	EVENT	DEVELOPMENT ACTIVITY	PATHWAY		RECEPTOR / IMPACT
Groundwater availability	Changes in groundwater recharge	Excavations expose aquifer	Changes to surface infiltration, changes to evaporation or evapotranspiration	Increased recharge resulting in water table rise leading to potential mobilisation of salts and or water logging OR Decreased recharge resulting in water table decline and reduction water supply	Changes to groundwater availability to groundwater users and potential change to groundwater quality
		Placement and compaction of fill material over recharge zone	Decrease to recharge		
		Onsite construction drainage line intersects water table	Increase to recharge		
	Compression of aquifer material	Surcharging of aquifer material	Compaction of unconsolidated alluvial material reduces permeability altering the groundwater flow path		Changes to groundwater flow paths can increase / decrease groundwater levels up and down gradient of surcharging causes in reduction in availability down gradient
	Changes to groundwater flow	Alteration of condition at waterway crossings, earthworks restricting surface water flow	Alteration of groundwater surface water interaction		Changes to flow regimes between groundwater and surface water systems

CATEGORY	EVENT	DEVELOPMENT ACTIVITY	PATHWAY	RECEPTOR / IMPACT
Groundwater quality	Groundwater contamination	Spills, runoff of storm water, stock pile run off, work areas	Leakage into aquifer through infiltration	Reduction in groundwater quality for groundwater users. Reduction in groundwater quality may impact health of receptors that rely on groundwater e.g. GDE's
		Disposal of groundwater extracted from construction	Leakage from surface ponds to underlying aquifer through infiltration	
		Handling and storage of hazardous materials for construction	Leakage from storage areas to underlying aquifer through infiltration	
	Activation, mobilisation of acid sulphates	Existing actual or potential acid sulphate soils are exposed during construction or excavation	Reduction of water levels exposing acid generating materials to oxidation. Mobilisation of metals and acid	
	Changes to groundwater quality through use	Construction dewatering or extraction for construction water supply	Change in water quality through interception, mixing or dislocation of saline waters	

6.2 KEY FINDINGS

Impacts to groundwater resources can be simplified into two categories: impacts to *groundwater quality* and impacts to groundwater levels (*groundwater quantity*). The risks to groundwater resources have the potential to impact on existing groundwater users and groundwater dependent ecosystems (GDE):

- Potential impacts to groundwater quality associated with the project include chemical spills, cross-connection of aquifers through activities such as drilling, excavation and fill placement.
- Potential impacts to groundwater levels associated with the project include drawdown and/or mounding where embankments alter flow paths due to the compaction and consolidation of sediments, and the consequential changes in hydraulic conductivity of underlying unconsolidated sediments.

The primary environmental risks identified for groundwater is provided in Table 6.3. The initial risk ratings presented below for both project and cumulative impacts consider standard inherent controls as listed in the Environmental Risk Assessment Report (WSP 2018c). The additional controls listed in the tables below are those recommended to further mitigate and minimise the primary environmental risks which were risk rated as medium or above. Primary environmental risks which were scored as low did not require additional controls to be applied.

Also included in the table below are any identified on-site project related cumulative risks, including: secondary risks (resulting from the implementation of a risk response in mitigating a primary environmental risk) and on-site aggregate cumulative risks (the aggregate/combined primary environmental risks resulting from diverse project activities having an impact on the same environmental asset).

It is important to note that Risk number GW2 and GW7 were originally assessed as moderate risks during the preliminary impact assessment (WSP 2017a). The impact assessment methodology for the EES was developed to further investigate moderate to high risk items. Importantly, the risk assessment process allows for continual revision of the environmental risk of the project as more information becomes available adjusting the initial risks ranking. The development of the numerical groundwater model as part of the impact assessment predicted negligible impacts and as such the initial risk for GW2 and GW7 were reassessed and reduced to a low risk of causing environmental impact.

Table 6.3 Groundwater environmental risk assessment register

RISK ID	IMPACT PATHWAY	RISK DESCRIPTION	INITIAL RISK			ADDITIONAL MITIGATION/CONTROLS	EPR	RESIDUAL RISK		
			Consequence	Likelihood	Rating			Consequence	Likelihood	Rating
R-GW1	Initial investigation impacts on groundwater quality.	Geotechnical investigations impact ground water quality	Minor	Unlikely	Low	Not required	N/A	Minor	Unlikely	Low
R-GW2	Initial design impacts on groundwater quality.	Compression of shallow unconsolidated aquifers from the loading weight of embankment structures changing groundwater levels and flow regime (choking off of groundwater flow). This potentially can affect existing users/sensitive receptors (beneficial groundwater users such registered and unregistered groundwater bores, GDEs including Ramsar wetland, and surface waters systems) by diverting or throttling groundwater flow, and thereby potentially depriving existing users and/or GDE's of sustaining groundwater resources.	Moderate	Rare	Low	Not required	N/A	Moderate	Rare	Low

RISK ID	IMPACT PATHWAY	RISK DESCRIPTION	INITIAL RISK			ADDITIONAL MITIGATION/CONTROLS	EPR	RESIDUAL RISK		
			Consequence	Likelihood	Rating			Consequence	Likelihood	Rating
R-GW3	Construction impacts on groundwater quality. Construction impacts on groundwater availability.	Contaminants entering groundwater from machinery during construction.	Minor	Unlikely	Low	Not required	N/A	Minor	Unlikely	Low
R-GW4	Construction impacts on groundwater quality.	Disturbance of existing soils with elevated levels of contamination (e.g. from pre-existing landfill) during construction resulting in mobilisation of contaminants into groundwater.	Minor	Unlikely	Low	Not required	N/A	Minor	Unlikely	Low
R-GW5	Construction impacts on groundwater quality.	Inflow of contaminated groundwater presenting OH&S and ongoing environmental compliance issues	Minor	Possible	Low	Not required	N/A	Minor	Possible	Low
R-GW6	Construction impacts on groundwater quality.	Construction works impacting water quality of groundwater in wetlands and existing users.	Minor	Possible	Low	Not required	N/A	Minor	Possible	Low

RISK ID	IMPACT PATHWAY	RISK DESCRIPTION	INITIAL RISK			ADDITIONAL MITIGATION/CONTROLS	EPR	RESIDUAL RISK		
			Consequence	Likelihood	Rating			Consequence	Likelihood	Rating
R-GW7	Construction impacts on groundwater quality	Compression of shallow unconsolidated aquifers from the loading weight of embankment structures changing groundwater levels and flow regime (choking off of groundwater flow). This potentially can affect existing users/sensitive receptors (beneficial groundwater users such registered and unregistered groundwater bores, GDEs including Ramsar wetland, and surface waters systems) by diverting or throttling groundwater flow, and thereby potentially depriving existing users and/or GDE's of sustaining groundwater resources.	Minor	Possible	Low	Not required	N/A	Minor	Possible	Low
R-GW8	Operational impacts on groundwater quality.	Traffic accidents and resultant fuel spills and chemical (from firefighting activities) contaminate groundwater	Minor	Rare	Negligible	Not required	N/A	Minor	Rare	Negligible
R-GW9	Operational impacts on groundwater quality.	Traffic accidents and resultant fuel spills and chemical (from firefighting activities) contaminate groundwater.	Minor	Rare	Negligible	Not required	N/A	Minor	Rare	Negligible

RISK ID	IMPACT PATHWAY	RISK DESCRIPTION	INITIAL RISK			ADDITIONAL MITIGATION/CONTROLS	EPR	RESIDUAL RISK		
			Consequence	Likelihood	Rating			Consequence	Likelihood	Rating
R-GW10	Operational impacts on groundwater quality	Water quality impacts during operation of road	Minor	Unlikely	Low	Not required	N/A	Minor	Unlikely	Low
Cumulative Impacts – On-Site Aggregate										
GW11	Aggregate Cumulative Effect	Design does not mitigate hydrogeology impacts resulting from multiple project activities such as alteration of surface water recharge, compaction altering flow rates and drawdown	Minor	Unlikely	Low	Not Required	N/A	Minor	Unlikely	Low
GW12	Aggregate Cumulative Effect	Groundwater quality impacted by exposure of ASS, spills and leaks, landfill contamination, during construction and operation and maintenance	Minor	Unlikely	Low	Not Required	N/A	Minor	Unlikely	Low

The assessment of cumulative impacts was competed in two stages, namely the assessment of aggregate project impacts and the assessment of the cumulative impact of multiple off-site projects in addition to the Mordialloc Bypass project for Groundwater. The cumulative environmental risks identified for Groundwater is provided in the Table 6.4.

Table 6.4 Groundwater cumulative effects environmental risk assessment

RISK ID	IMPACT PATHWAY	PROJECTS CONSIDERED	CUMULATIVE RISK DESCRIPTION	ADDITIONAL MITIGATION / CONTROLS	EPR	RESIDUAL RISK		
						Consequence	Likelihood	Rating
R-GW7	Compression of shallow unconsolidated aquifers from the loading weight of embankment structures changing groundwater levels and flow regime (choking off of groundwater flow). This potentially can affect existing users/sensitive receptors (beneficial groundwater users such registered and unregistered groundwater bores, GDEs including Ramsar wetland, and surface waters systems) by diverting or throttling groundwater flow, and thereby potentially depriving existing users and/or GDE's of sustaining groundwater resources.	LXRA Edithvale and Bonbeach level crossing removal projects.	Excavation of the LXRA rail under road construction and final structures have the potential to alter the regional hydrogeological regime. These structures can create flow barriers altering the water levels both up and down gradient of the structure including the Edithvale-Seaford Wetlands. The change in the water levels close to Port Phillip Bay can also influence saline intrusion inland. LXRA have conducted extensive peer reviewed groundwater impact assessment of the proposed development, this including a numerical groundwater model. LXRA model predictions influenced design mitigation considerations to mitigate the impact to existing hydrogeological regime. The results of which have been presented in LXRA's Edithvale and BonBeach Level Crossing Removal Projects EES documents. LXRA assessed that they would have minimal impact on groundwater as such cumulative impacts remain low.	N/A	N/A	Minor	Possible	Low

7 IMPACT ASSESSMENT AND MITIGATION

7.1 IDENTIFIED POTENTIAL IMPACTS

Through the processes described in Section 4 and 6, the potential impacts to groundwater can be simplified into two groupings, impacts that impact on groundwater quality and impacts to groundwater availability. Both the construction and operation phases of the project has the potential to impact on both groundwater levels (availability) and groundwater quality.

7.2 IMPACT ASSESSMENT

7.2.1 GROUNDWATER IMPACT ASSESSMENT METHOD

A regional finite difference numerical model has been developed to calculate predicted impacts to groundwater identified during the preliminary groundwater impact assessments and risk assessment process (Section 1.2). The model used MODFLOW USG and the Groundwater Vistas Version 7 graphic user interface.

Section 4.5 summarises the methodology used in the development of the numerical groundwater model.

The following sections summarise the results of the numerical groundwater model.

A detailed description of the development, calibration, and predictions are located the separate groundwater modelling report (Appendix D).

7.2.2 BASIS OF IMPACT ASSESSMENT

The Australian groundwater modelling guidelines (Barnett et al, 2012) provide guiding principles and minimum standards of numerical groundwater models. The guidelines recommend that the overall reliability, complexity and confidence level of the model should be assessed and agreed to by all parties prior to construction of the model, and if possible reassessed at a later stage in the modelling process.

The confidence level classification defined within the guidelines comprises three classes; class 1, class 2 and class 3, in order of increasing confidence level. The level of confidence typically depends on the available data, calibration procedures, consistency between the calibration conditions and predictive analysis scenario, and the level or severity of stresses being simulated. A table of quantifiable indicators with which to assess a model's confidence level based on those attributes is included in the modelling guidelines.

The impact assessment model undertaken for the project is a semi-regional model of appropriate complexity and commensurate with the anticipated impacts (anticipated to be negligible to low arising from non-intrusive nature of the proposed roadway design). This model is therefore a class 2 model and is appropriate for assessing impacts of low-risk developments.

The LXRA groundwater impacts have assessed using a similar model development method (AECOM GHD JV, 2018) however the model is a class 2 model as the development is considered to be appropriate for medium risk developments since that project involved excavation into the local aquifers (primarily the UTAF aquifer) and the construction of permanent buried structures, intrusive into aquifers (material barriers to groundwater flow).

7.2.3 IMPACT PREDICTIONS

7.2.3.1 IMPACT PREDICTION METHODOLOGY

The predictive model runs were carried out under steady state and transient conditions to assess average and seasonal impacts respectively.

For impact scenarios, the effects of the embankments were imposed on aquifer conditions according to the various embankment heights as shown in Figure 7.1, and as further described below. Predictive runs were undertaken with and without the proposed embankments and the impact determined as the difference between the two runs for each stress period. This approach ensured that modelled impact estimates were solely due to the embankment and not small changes in rainfall and evapotranspiration over time (transient disequilibrium effects).

The reduction in hydraulic conductivity due to compaction effects from the proposed embankments was assessed by conservative geotechnical modelling (assuming compressive clay bearing lithology), as described in Section 1.2 and Appendix C. A hydraulic conductivity reduction factor was applied to the areas below the embankment in model layer 1 and 2 for the predictive run. The permeability reduction factors were scaled according to the height of the embankment for each segment.

The Time-Variant Materials (TVM) package was used to change the hydraulic conductivity (Kh and Kv) by the calculated reduction factor for the future stress periods in the impact scenarios. Recharge (RCH) and EVT were reduced to zero beneath the embankment. It is assumed that the surface will be sealed and impervious.

7.2.3.2 PREDICTED WATER LEVEL CHANGES DUE TO EMBANKMENTS

The predicted groundwater table changes due to the embankments for the steady state scenario are shown in Section 4.2 of the numerical groundwater modelling report (Appendix D). The maximum drawdown is 6 cm at the southern embankment section and a maximum water level rise of 11 cm is observed at the northernmost embankment. The change only occurs beneath the embankment itself and there is negligible drawdown outside of the embankment footprint.

The predicted groundwater table changes due to the embankments for the transient scenario are shown Section 4.2 of the numerical groundwater modelling report (Appendix D). In June 2020, the maximum drawdown is 3.6 cm at the southern embankment section and a maximum water level rise of 5.1 cm is observed at the northernmost embankment. The modelled change only occurs beneath the embankment itself.

In December 2020, the maximum drawdown is 11 cm at the southern embankment section and a maximum water level rise of 13 cm is observed at the northernmost embankment. Most of the drawdown occurs beneath the embankment itself and is <5 cm immediately adjacent to the embankment reducing to 1 cm, 485 m to the west of the embankment towards Edithvale Wetlands.

The modelled drawdown effects will be virtually undetectable given that:

- The observed seasonal groundwater level variations are much larger by comparison (~0.5 to 1 m)
- Changes to drainage and hardstand in the area are likely to have a larger influence on groundwater levels (although still negligible)
- In the short-term loading of the aquifer by the embankment may cause a temporary rise in groundwater levels adjacent to embankment due to compression of the aquifer matrix. That effect should be managed by existing drainage and will dissipate over a short period.

7.2.3.3 PREDICTED CHANGES TO GROUNDWATER INFLOWS AT EDITHVALE WETLANDS

The groundwater model was also used to predict changes in the groundwater component of the Edithvale wetlands. This was done using Hydro-Stratigraphic Unit (HSU) zones for the wetland areas in layer 1 and 2 and summarising the inflows and outflows. A separate water balance model has been created by surface water experts in which the modelled groundwater component is used as verification.

The modelled monthly recharge (R) and evapotranspiration (ET) fluxes were collated for a one year period for a model scenario with and without embankments. The fluxes were converted from a volume (m^3/day) to a rate (mm/day) by dividing the flux by the surface area of each wetland pond. The average rates for R and ET from the six different wetland ponds are summarised in Table 7.1. For each wetland cell, it is assumed that the net loss due to EVT (minus recharge) is balanced by, and equal to, the groundwater discharge component ('Net ET' in Table 4.1). Note that net ET is negative for the months April, July and August when rainfall exceeds EVT. The difference in groundwater discharge to the wetlands (= Net ET) as a result of changes in hydraulic gradient near the embankments is negligible ($<10^{-3}$ mm/d) compared with other water balance components (surface water input, rainfall, and EVT).

Table 7.1 Modelled recharge and evapotranspiration and calculated net evapotranspiration at Edithvale Wetlands for modelling scenario with and without embankments for the period March 2020 – February 2021

SCENARIO	WITH EMBANKMENTS			WITHOUT EMBANKMENTS			CHANGE
Month	**Recharge (mm/d)**	**ET (mm/d)**	**Net ET (mm/d)**	**Recharge (mm/d)**	**ET (mm/d)**	**Net ET (mm/d)**	**Net ET (mm/d)**
Mar-20	0.95	2.95	2.00	0.95	2.95	2.00	-0.0014
Apr-20	3.03	1.76	-1.28	3.03	1.76	-1.28	-0.0004
May-20	1.02	1.03	0.01	1.02	1.03	0.01	-0.0002
Jun-20	0.50	0.73	0.23	0.50	0.73	0.23	-0.0002
Jul-20	1.22	1.09	-0.13	1.22	1.09	-0.13	-0.0002
Aug-20	1.96	1.38	-0.58	1.96	1.38	-0.58	-0.0002
Sep-20	1.24	2.08	0.83	1.24	2.08	0.83	-0.0005
Oct-20	1.55	3.16	1.61	1.55	3.17	1.61	-0.0009
Nov-20	0.99	3.82	2.82	0.99	3.82	2.83	-0.0018
Dec-20	4.31	4.72	0.41	4.31	4.72	0.41	-0.0011
Jan-21	2.05	4.59	2.54	2.05	4.59	2.54	-0.0018
Feb-21	0.04	3.46	3.42	0.04	3.47	3.42	-0.0020

7.2.3.4 UNCERTAINTY IN PREDICTION AREA OF GROUNDWATER IMPACT

The *sensitivity analysis* indicated the calibration was most sensitive to:

- Decreased horizontal and vertical hydraulic conductivity of the quaternary aquifer (zone 11) of layer 1
- Decreased horizontal and vertical hydraulic conductivity of layer 2
- Increased recharge.

Predictive *uncertainty analysis* was undertaken for these parameters for the predictive run. The following uncertainty runs were undertaken:

- Decreased horizontal hydraulic and vertical conductivity of zone 11 of layer 1 by a factor of 0.1 (Kh = 0.01 m/day)
- Decreased horizontal and vertical hydraulic conductivity of layer 2 by a factor of 0.1 (Kh = 0.07 m/day and Kv = 0.007 m/day).

The results show that predicted groundwater impacts (in terms of water level and flow effects) are similar (negligible) for all uncertainty runs, providing additional confidence in the prediction under calibrated conditions.

The results also imply that groundwater impact to the Edithvale Wetland as a result of the embankments is unlikely to be significant under the currently accepted climate change scenarios.

7.2.3.5 SUMMARY OF MODEL PREDICTION

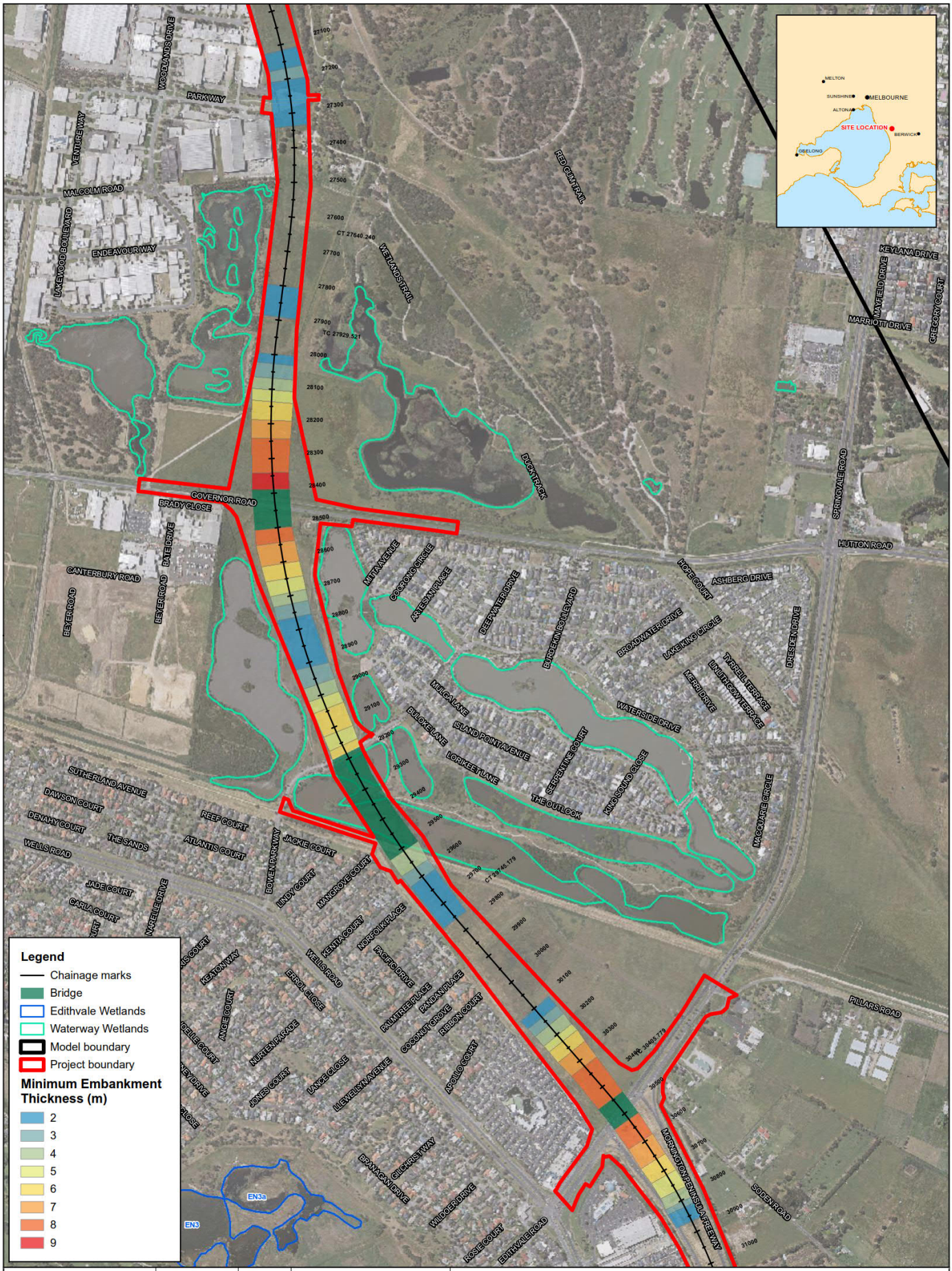
The following conclusions can be drawn from the groundwater modelling investigation:

- The modelled water table implies that the Edithvale Wetlands are a net groundwater discharge point via EVT, which is consistent with chemical and isotopic data.
- Construction of bypass embankments will result in compaction loading of the aquifer and a decrease in permeability of the underlying aquifers. The numerical model was used to assess the groundwater effects near the Edithvale Wetland as a result of the change in permeability beneath the embankments.
- Modelling results indicate that the aquifer loading will result in a very small change in groundwater level (in the order of 10 to 15 cm maximum) in close proximity of the alignment embankment footprint. The changes range from a small decrease in groundwater level beneath the southern embankment to a small rise in groundwater level beneath the northern embankment. Most of the change is restricted to within the embankment footprint with negligible groundwater level changes outside the embankments.
- Therefore, construction of the embankments and bypass is highly unlikely to have any measurable effect on groundwater levels adjacent to the Edithvale Wetland, nor groundwater flow contributions to the wetland water balance.
- As a result of the outcomes of the groundwater modelling, the initial risk rating of risk GW2 and GW7 have been lowered to a low risk.

The modelled drawdown effects will be virtually undetectable given that:

- The observed seasonal groundwater level variations are much larger by comparison (~0.5 to 1 m)
- Changes to drainage and hardstand in the area are likely to have a larger influence on groundwater levels (although still negligible).

In the short-term, loading of the aquifer by the embankment may cause a temporary rise in groundwater levels adjacent to embankment due to compression of the aquifer matrix. That effect should be mitigated by existing drainage and will dissipate over a short period.



Map: 2135645A_GIS_1428_A	Author: VD
Date: 4/09/2018	Approved by: AS

0 100 200 m

1:10,000

Coordinate system: GDA 1994 MGA Zone 55

Scale ratio correct when printed at A3

Data source: VicRoads.

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MAJOR ROAD PROJECTS AUTHORITY

VICTORIA State Government

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Engineering and Technical Services for Mordialloc Bypass Upgrade

Figure 7.1

Embankment thickness - Freeway

7.3 CUMULATIVE IMPACTS

Groundwater related impacts of a project can be assessed by comparing the post project situation to a baseline that was acquired pre-development. Where projects can be considered in isolation of other influences then this method is suitable. However, when located within an area with other developments that have the potential to impact on baseline conditions it is important to consider the cumulative effects of the development.

In relation to groundwater, cumulative impacts are assessed at a regional scale with consideration given to projects located within the same hydrostratigraphic unit (HSUs) that have the ability to impact groundwater availability, groundwater quality or both. Such as extractive industries such as quarries, significant groundwater users, etc. or physical barriers such as tunnels or trench structures that can act as barriers to groundwater flow.

In consideration of this, the spatial boundary adopted to consider cumulative impacts ranges from Port Phillip Bay in the west, Patterson River in the south and Dandenong Creek in the east, both of which forms a hydraulic boundary, and Heatherton Road to the north, which is sufficiently up gradient from the contact between the QA and UTAF HSUs.

The only project with the potential to impact the regional hydrogeological regime is the LXRA level crossing removal for Edithvale and Bonbeach stations. However, modelling results for Mordialloc Bypass shows that the slight changes to the groundwater level do not reach beyond the embankments themselves and will not significantly impact groundwater levels adjacent to the wetland, nor will they significantly change the rate of groundwater discharge to the wetlands. The LXRA report findings indicate that changes to the water table elevation as a result of that project will not extend as far as the Edithvale Wetlands, nor the proposed Mordialloc Bypass project.

As such, no cumulative impacts to the wetland are expected as a result of both the OSAR and LXRA projects.

8 ENVIRONMENTAL PERFORMANCE REQUIREMENTS

This section describes the approaches to manage performance as part of the wider EMF to be drafted for the project. The objective is to identify EPRs that would reduce the residual risk to low where the impact assessment identified that unacceptable impacts need to be managed.

Whilst no groundwater specific EPR was identified during the impact assessment a project specific a Water Management and Monitoring Plan (WMMP) was identified as a EPR W5 in the Water Impact Assessment. The WMMP plan incorporates both surface and groundwater monitoring requirements for water quality and contamination. The WMMP incorporates the baseline data collected to data and includes:

- Detail of the monitoring parameters, including the frequency and location of surface water monitoring points and groundwater monitoring bores.
- Specific trigger levels (water quality in surface water bodies and groundwater bores) and details of contingency plans in the case trigger levels are exceeded.
- Detailed reporting requirements.

Details of the WMMP are outlined in the *Surface Water Impact Assessment* (WSPb 2018).

9 CONCLUSIONS

The groundwater impact assessment has been completed for the Mordialloc Bypass to determine the impacts of the project on the existing groundwater regime, identify management and mitigation requirements to reduce the potential risks from the project, and address the EES objectives outlined in the EES Scoping Requirements. The following sections provide a summary of the key sections of this report.

9.1 EXISTING CONDITIONS

The study area consists of a relatively flat landscape with elevation dipping from the north east towards the south with elevation below sea level at Edithvale Wetlands. There are several natural and anthropogenic drainage features and water courses within the study area including Patterson River, Mordialloc Creek, Woodlands Industrial Estate Wetlands, Braeside Park Wetlands, Waterways Estate Wetlands and the Edithvale Wetlands.

The primary hydrostratigraphic units within the study area are:

- Quaternary Aquifer (QA): This aquifer is largely associated with the former Carrum Swamp and consists of a shallow unconfined aquifer with depths of approximately <10 m.
- Upper Tertiary Aquifer (UTAF): This aquifer is located across the entire Project area and within the Brighton Group sediments. Where the Brighton Group outcrops, the UTAF consists of an unconfined aquifer. Where the Brighton Group sediments are overlain by the Quaternary alluvial, the UTAF becomes semi-confined. Depths of the UTAF within the study area are approximately in excess of 20 meters.

Groundwater quality is highly variable in both the QA and UTAF. TDS concentrations within the remaining QA ranges from 632 mg/L to 18,000 mg/L (Segments A2, B, C & D), with the remaining UTAF bores ranging from 865 mg/L to 26,325 mg/L (Segments A2, B, C & D). Whilst the majority of the monitored data is Segment C, EPA Victoria adopts a conservative approach to classification of groundwater, Segment A2. This variability within the study area indicates that beneficial uses vary across the study area and cannot be applied in a consistent relevance in either the QA or UTAF.

Hydraulic conductivity within the QA and UTAF is similar in both aquifers with average value of 0.2 m/d and 0.3 m/d respectively.

Groundwater flow within the QA is complex and influence by topography, land use and water courses. Regional groundwater flow in the UTAF is generally topographically driven with water groundwater flows from the north east towards the south-east discharge features such Port Phillip Bay, Patterson River and Edithvale Wetlands.

Groundwater levels vary within each aquifer depending on numerous factors including topography, seasonal variability and extraction from registered pumping bores. Groundwater levels are typically closer to surface during the wetter winter months and lower during the summer months that are typically drier and experience greater losses to evapotranspiration. Towards the southern portion of the alignment water levels are close to or below sea level. For locations close to Edithvale Wetlands this is conceptually correct with the wetlands acting as a discharge point for groundwater. The presence of a licenced extraction bore close to Springvale road has also altered groundwater levels with several groundwater bores influenced through groundwater extraction.

9.2 RISK AND IMPACT ASSESSMENT

Numerical groundwater modelling was conducting to assess the impact to groundwater levels that could occur as a result of the embankment structures, and the reduction of permeability to underlying unconsolidated sediments. The embankment structures were identified as a potential risk causing groundwater to increase on the up gradient side and decrease down gradient causing a ‘groundwater shadow’ downgradient. The reduction of groundwater levels could reduce groundwater contributions to adjacent groundwater dependant ecosystems, include the Edithvale Wetlands.

Whilst the construction of the embankment structures would result in a decrease of permeability of the underlying aquifer, the numerical groundwater model indicated that impacts to groundwater would be minimal. Modelling results indicated that very small changes in groundwater level would occur (in the order of 10 to 15 cm maximum) in close proximity of the alignment embankment footprint. Minor groundwater level increases would occur beneath the embankment north of Governor Road adjacent the Braeside Park Wetlands and a small decrease beneath the Springvale Road embankment. The impact to water levels are predicted to occur within the project footprint underneath the embankment structures themselves with negligible changes to groundwater levels outside the embankments.

Considering the observed seasonal groundwater variation are much larger by comparison (~0.5 to 1 m). These minimal impacts to groundwater levels is highly unlikely to have any measurable effects on groundwater levels adjacent the sensitive wetlands nor on groundwater flow contributions to the wetland water balances.

Based on modelling prediction a risk assessment was undertaken in accordance with AS/NZS ISO 31000:2009 Risk Management Process. The following risks were assessed for the construction and operation phases of the project:

- Interference to groundwater availability (groundwater levels/flow)
- Impacts to groundwater quality
- Impact to the beneficial use of groundwater
- Water logging at surface.

The risks caused by changes to groundwater levels or quality from the project are considered sufficiently low that mitigation methods beyond the project design phase would not be required. A Water Management and Monitoring Plan to validate and monitor predicted impacts to groundwater would be the only recommended Environmental Performance Requirement of the project.

Cumulative Impacts from the LXRA Edithvale and Bonbeach projects were considered in this assessment. Predicted impacts from the as potential LXRA do not extend to the Edithvale Wetlands nor do they overlap with any predictions from the project's own numerical modelling. As such, it is considered that there are no cumulative impacts arising from the LXRA project.

9.3 ENVIRONMENTAL PERFORMANCE REQUIREMENTS

To validate, monitoring and manage predicted impacts the development of a Water Management and Monitoring Plan (WMMP) is recommended for the project. To be implemented prior to construction, the WMMP allows for the monitoring and verification of predicted impacts to both surface and groundwater resources.

The WMMP incorporates baseline data acquired through the pre-development monitoring allowing the development site specific trigger levels for both water quality of surface water bodies and groundwater bores. The WMMP also details what parameters are to be monitored including the frequency, location and duration.

9.4 CONCLUSION

The identified risks to groundwater as a result of the Mordialloc Bypass project has been assessed within this groundwater impact assessment. The numerical modelling has shown that the impact to groundwater caused by the embankment structures is minimal with changes to water levels occurring beneath the embankment structures and within the natural variability within each aquifer, and negligible impacts outside the embankment footprints. With minimal impacts to regional groundwater flow or levels, no impact to groundwater contributions to the Edithvale Wetlands, or is expected.

As such, impacts to groundwater beneficial uses, the mobilisation of contaminants, or the degradation of groundwater dependant ecosystems is considered low to negligible.

The development of a WMMP to EPA Victoria standard is required as a EPR to validate, monitor predictive impacts prior to the commencement of construction. The WMMP incorporates baseline data collected to date, and determines trigger levels, monitoring requirements and mitigation plans in the event of trigger level exceedances are detected.

BIBLIOGRAPHY

- AECOM-GHD JV (2018). Edithvale and Bonbeach Level Crossing Removal Projects Environment Effects Statement EES Technical Report A, Groundwater Impact Assessment.
- Alcalá, F. J., & Custodio, E. (2008). Using the Cl/Br ratio as a tracer to identify the origin of salinity in aquifers in Spain and Portugal. Journal of Hydrology, 359(1-2), 189-207.
- ANZECC/ARMCANZ (2000). Australian and New Zealand Guidelines for Fresh and Marine Water Quality Volumes 3 and 4. Australian and New Zealand Environment Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra.
- Aquatic Systems Management Pty, Ltd (2007). Kananook Creek Corridor Management Plan, Waterways Geomorphology, Flow Management, Water Quality and Habitat Issues.
- Barnett et al, 2012, Australian groundwater modelling guidelines, Waterlines report, National Water Commission, Canberra.
- Bureau of Meteorology (BOM) (2017a). Climate data online, accessed 01/03/17, http://www.bom.gov.au/climate/data/
- Bureau of Meteorology (BOM) (2017b). Groundwater dependent ecosystems atlas, accessed 01/03/17, http://www.bom.gov.au/water/groundwater/gde/index.shtml
- City of Kingston 2018, viewed 16 March 2018, <http://localhistory.kingston.vic.gov.au/htm/article/287.htm>.
- Clark, I., and Fritz, P. 1997. Environmental Isotopes in Hydrogeology. CRC Press LLC, Bocca Raton, New York, 328pp.
- Crosbie, R., Morrow, D., Cresswell, R., Leaney, F., Lamontagne, S., & Lefournour, M. (2012). New insights to the chemical and isotopic composition of rainfall across Australia. CSIRO Water for a Healthy Country Flagship, Australia. Department of Economic Development, Jobs, Transport and Resources (2010). Victoria GIS Data Geological units 250k.
- Department of Environment, Land Water and Planning (DELWP) (2017). Groundwater resource reports, accessed 5/2/17, http://www.depi.vic.gov.au/water/groundwater/groundwater-resource-reports
- Department of Environment, Land Water and Planning (DELWP) (2018). Scoping Requirements for Mordialloc Bypass Environment Effects Statement Melbourne.
- Department of the Environment, Water, Heritage and the Arts, 2010. Ecosystem Serivces: Key Concepts and Applications. Department of the Environment, Water, Heritage and the Arts, Canberra.
- Department of Land and Water Conservation (2002). The NSW State Groundwater Dependent Ecosystem Policy, Department of Land and Water Conservation, Sydney. Policy, Department of Land and Water Conservation, Sydney.
- Department of Sustainability and Environment (2006). Ministerial guidelines for assessment of environmental effects under the Environment Effects Act 1978. Department of Sustainability and Environment Melbourne.
- Department of Sustainability and Environment (2012). Description of Ecological Character of the Edithvale-Seaford Wetlands Ramsar Site. Department of Sustainability and Environment, Melbourne.
- EPA Victoria (2003), State Environment Protection Policy (SEPP) (Waters of Victoria), Publication 905.
- GHD (2005). Edithvale – Seaford Wetland review of Wetland Operations. GHD Victoria.
- Geoscience Australia (2018). Australian Stratigraphic Units Database. Geoscience Australia Canberra.

- Government of Victoria (2002). State Environment Protection Policy (SEPP) (Groundwaters of Victoria), Government of Victoria.
- Hatton, T. & Evans, R. (1998), Dependence of ecosystems on groundwater and its significance to Australia, Land and Water Resources Research and Development Corporation, Canberra.
- National Water Quality Management Strategy (NHMRC) (2011). Australian Drinking Water Guidelines 6, Version 3.3 updated November 2016.
- National Uniform Drillers Licensing Committee 2011, Minimum construction requirements for water bores in Australia 3rd edition.
- Southern Rural Water/DEPI (2014). East Phillip Bay Groundwater Catchment Statement.
- Southern Rural Water (2017). Groundwater licencing information. Available at: http://www.srw.com.au/customers/forms/. Accessed 9 January 2017.
- Visualising Victoria's Groundwater, The Victorian Water Measurement Information System (WMIS), viewed 16 March 2018, < http://www.vvg.org.au/>.
- VRGS, 2016. Mordialloc Bypass Proposed Alignment - Potential Acid Sulfate Soil Investigation. Unpublished.
- WSP, 2017a. Mordialloc Bypass - Preliminary Groundwater Impact Assessment. Report number 2135645A-SE-26-WAT-REP-0002 RevB, June 2017.
- WSP, 2017b. Mordialloc Bypass - Groundwater Impacts to Edithvale Wetlands - Assessment and Mitigations Report. Report number 2135645A-SE-26-WAT-REP-0003 Rev02, October 2017.
- WSP, 2018. Mordialloc Bypass – Technical Impact Assessment Report (Contaminated Land and Acid Sulfate Soil). Report number 2135645A-SE-26-CLM-0012 RevA. May 2018.
- WSP, 2018b. Mordialloc Bypass – Technical Impact Assessment Report (Surface Water). Report number 2135645A-SE-26-WAT-REP-0005 RevC May (Draft), 2018.
- WSP, 2018c. Mordialloc Bypass – Environmental Risk Assessment. Report Number. Report number 2135645A-SE-26-ENV-REP-0013 RevA (Draft), May 2018.

APPENDIX A

GROUNDWATER MONITORING BORE NETWORK

BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-01

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**8-9-18**
Project:	**Mordialloc Bypass**	Date Completed:	**8-9-17**
Borehole Location:	**Landfill**	Recorded By:	**JL**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**29.59 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334659.71 N 5796555.71**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST / FB VL L MD D VD H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal	29					FILL: Sandy GRAVEL; grey, fine to coarse grained with brick fragments	D		FILL
				0.70					FILL: Gravelly SAND; fine grained, dark grey-brown, some fine to medium grained gravel			
			Bentonite Plug	1								
				1.10					FILL: SAND; fine grained, brown-grey brown.	M		
				28								
				2.00 2				CI	Sandy CLAY; medium plasticity, red brown, orange brown, fine to coarse grained sand.	MC~PL		TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
				27								
				3						MC<PL		
			Sand (course grained)	26								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE ENVIRONMENTAL LOG

BOREHOLE NO. **GW17-26-01**

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**8-9-18**
Project:	**Mordialloc Bypass**	Date Completed:	**8-9-17**
Borehole Location:	**Landfill**	Recorded By:	**JL**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**29.59 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334659.71 N 5796555.71**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB		▼	Machine slotted HDPE with filter socks	25				CI	Sandy CLAY; medium plasticity, red brown, orange brown, fine to coarse grained sand. *(continued)*	MC<PL		
				4.50				CI	Clayey SAND; fine grained, orange brown.	W		
				24								
				23								
				22								
				5								
				6								
				7								
				7.30					END OF BOREHOLE AT 7.30 m			

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-02

SHEET 1 OF 3

Client:	**VicRoads**	Date Commenced:	**30-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**31-8-17**
Borehole Location:	**Nursery**	Recorded By:	**JL**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**21.15 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334603.626 N 5796353.996**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal	21					FILL: Sandy GRAVEL; fine to coarse grained, brown grey, yellow brown, fine to coarse grained sand.			
				0.30					FILL: Gravelly SAND; fine grained, black, organic odour			
			Bentonite Plug	0.50				SP	SAND; fine grained, pale brown, grey, with organic odour.			INFERRED QUATERNARY ALLUVIUM
				0.70				SC	Clayey SAND; fine to medium grained, red brown, orange brown, pale grey-brown, low to medium plasticity clay.			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
				1								
				20								
				2								
				19								
				2.70				SP	SAND; fine to medium grained, orange brown, pale brown, with some clay.			
				3								
				18								
			Sand (course grained)									

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-02

SHEET 2 OF 3

Client:	VicRoads	Date Commenced:	30-8-17
Project:	Mordialloc Bypass	Date Completed:	31-8-17
Borehole Location:	Nursery	Recorded By:	JL
Project Number:	2135645A	Log Checked By:	JC

Drill Model/Mounting:	Comacchio Geo 305	Driller:	Earthcore	Surface RL:	21.15 m
Borehole Diameter:	100 mm	Driller Lic No:	0738	Co-ords:	E 334603.626 N 5796353.996

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB		▼	Machine slotted HDPE with filter socks	17 / 0 16 / 5 15 / 6 14 / 7				SP	SAND; fine to medium grained, orange brown, pale brown, with some clay. *(continued)* 4.2m becoming orange brown, red brown, pale brown 4.5m becoming pale brown, white, orange-brown			
				7.20				SP	SAND; fine to medium grained, dark brown-grey, trace clay.			TERTIARY BRIGHTON GROUP (BEAUMARIS SANDSTONE)

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-02

SHEET 3 OF 3

Client:	**VicRoads**	Date Commenced:	**30-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**31-8-17**
Borehole Location:	**Nursery**	Recorded By:	**JL**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**21.15 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334603.626 N 5796353.996**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				13				SP	SAND; fine to medium grained, dark brown-grey, trace clay. *(continued)*			
WB				9					8.8m becoming dark grey, with some clay pockets			
				12								
				10.00 10					END OF BOREHOLE AT 10.00 m			
				11								
				10								

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-03

SHEET 1 OF 7

Client:	**VicRoads**	Date Commenced:	**9-6-17**
Project:	**Mordialloc Bypass**	Date Completed:	**9-6-17**
Borehole Location:	**Lower Dandenong Road**	Recorded By:	**JL**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**8.12 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334703.908 N 5793927.098**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST / FB VL L MD D VD H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS			Cement Seal; Bentonite Plug; Sand (course grained)	8 / 0.15				CH	TOPSOIL; Sandy CLAY; moderate to high plasticity, brown, dark brown, fine to moderate grained sand, with silt and trace of organics (rootlets)	M		
								CH	Sllty CLAY; high plasticity, dark grey, mottled brown, trace fine grained sand, trace of organics (rootlets)	MC>PL		QUATERNARY ALLUVIUM
				7 / 1					1.0m becoming grey-brown, with fine to moderate grained sand			
				6 / 2								
				2.50				CH	Silty CLAY; high plasticity, orange-brown, trace fine grained sand			
				5 / 3.00 / 3				CH	Silty CLAY; high plasticity, grey. grey-brown, mottled orange, fine grain sand, trace silt			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-03

SHEET 2 OF 7

Client:	**VicRoads**	Date Commenced:	**9-6-17**
Project:	**Mordialloc Bypass**	Date Completed:	**9-6-17**
Borehole Location:	**Lower Dandenong Road**	Recorded By:	**JL**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**8.12 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334703.908 N 5793927.098**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS		▼		4.00				CH	Silty CLAY; high plasticity, orange brown, trace fine grained sand	MC>PL		
				4.30				CI-CH	Sandy CLAY; moderate to high plasticity, orange brown, mottled pale grey, with fine to course grain sand, trace fine grain gravel			
			Machine slotted HDPE with filter socks	5.00				CI-SC	Sandy CLAY/Clayey SAND; medium plasticity, fine to course grained sand, orange/brown, pale grey			
WB				7.90				CL				

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-03

SHEET 3 OF 7

Client:	**VicRoads**	Date Commenced:	**9-6-17**
Project:	**Mordialloc Bypass**	Date Completed:	**9-6-17**
Borehole Location:	**Lower Dandenong Road**	Recorded By:	**JL**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**8.12 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334703.908 N 5793927.098**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Bentonite Plug	0 9 -1 10 -2 11.00 11 -3				CL	Silty CLAY; low to medium plasticity, orange brown, pale brown, grey, some bands of fine to medium grained sand *(continued)*	MC>PL		
									10.1m some cemented materials			
								ML-CI	Silty CLAY/Clayey SILT; low to medium plasticity, brown			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-03

SHEET 4 OF 7

Client:	VicRoads	Date Commenced:	9-6-17
Project:	Mordialloc Bypass	Date Completed:	9-6-17
Borehole Location:	Lower Dandenong Road	Recorded By:	JL
Project Number:	2135645A	Log Checked By:	JC

Drill Model/Mounting:	Comacchio Geo 305	Driller:	Earthcore	Surface RL:	8.12 m
Borehole Diameter:	100 mm	Driller Lic No:	0738	Co-ords:	E 334703.908 N 5793927.098

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				-4 / 13				ML-CI	Silty CLAY/Clayey SILT; low to medium plasticity, brown *(continued)*	MC>PL		
				-5 / 13.10				ML-CI	Silty CLAY/Clayey SILT; low to medium plasticity, brown, dark green			TERTIARY BRIGHTON GROUP (BEAUMARIS SANDSTONE)
				-6 / 14								
				14.40				ML-CI	Clayey SILT/Silty CLAY; low to medium plasticity, green grey, trace of marine shells			TERTIARY GELLIBRAND MARL (FORMERLY FYANSFORD FORMATION)
				-7 / 15								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-03

Client:	**VicRoads**	Date Commenced:	**9-6-17**
Project:	**Mordialloc Bypass**	Date Completed:	**9-6-17**
Borehole Location:	**Lower Dandenong Road**	Recorded By:	**JL**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**8.12 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334703.908 N 5793927.098**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				-8 / 17 -9 -10 / 18 -11 / 19				ML-CI	Clayey SILT/Silty CLAY; low to medium plasticity, green grey, trace of marine shells *(continued)*	MC>PL		

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-03

Client:	**VicRoads**	Date Commenced:	**9-6-17**
Project:	**Mordialloc Bypass**	Date Completed:	**9-6-17**
Borehole Location:	**Lower Dandenong Road**	Recorded By:	**JL**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**8.12 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334703.908 N 5793927.098**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				12 / 21 13 14 / 22 15 / 23				ML-CI	Clayey SILT/Silty CLAY; low to medium plasticity, green grey, trace of marine shells *(continued)*	MC>PL		

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-03

SHEET 7 OF 7

Client:	**VicRoads**	Date Commenced:	**9-6-17**
Project:	**Mordialloc Bypass**	Date Completed:	**9-6-17**
Borehole Location:	**Lower Dandenong Road**	Recorded By:	**JL**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**8.12 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334703.908 N 5793927.098**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				16				ML-CI	Clayey SILT/Silty CLAY; low to medium plasticity, green grey, trace of marine shells *(continued)*	MC>PL		
				25								
				17								
				25.55					END OF BOREHOLE AT 25.55 m			
				26								
				18								
				27								
				19								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-04

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**4-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**4-8-17**
Borehole Location:	**Braeside**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.14 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335117.9 N 5791871.31**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (FB VL L MD D VD / VS S F ST VST H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal	2				CH	Silty CLAY; high plasticity, dark grey.	MC>PL		QUATERNARY ALLUVIUM
			Bentonite Plug	1					0.6m becoming pale grey			
				0								
			Sand (course grained)	-1								
				3.30				CH	Silty CLAY; high plasticity, blue green grey, orange bands, trace fine grained sand.			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
			Machine slotted HDPE with filter socks									

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-04

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**4-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**4-8-17**
Borehole Location:	**Braeside**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.14 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335117.9 N 5791871.31**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				-2 / 5				CH	Silty CLAY; high plasticity, blue green grey, orange bands, trace fine grained sand. *(continued)*	MC>PL		
				-3 / 5.80				CH	Sandy CLAY; high plasticity, pale grey, dark yellow, orange, fine to coarse grained sand.			
				-4 / 6								
				-5 / 7					END OF BOREHOLE AT 7.20 m			
				7.20								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-05

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**11-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**11-8-17**
Borehole Location:	**Braeside**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.33 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335220 N 5791848**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal	2				CH	Silty CLAY; high plasticity, dark grey.			QUATERNARY ALLUVIUM
			Bentonite Plug	1								
				0								
			Sand (course grained)	2.50				CH	Sandy CLAY; high plasticity, pale grey, fine to coarse grained sand.			
				-1								
			Machine slotted HDPE with filter socks	3.20				CH	Sandy CLAY; high plasticity, pale grey, dark yellow, pale brown.			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-05

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**11-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**11-8-17**
Borehole Location:	**Braeside**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.33 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335220 N 5791848**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB		▼		-2				CH	Sandy CLAY; high plasticity, pale grey, dark yellow, pale brown. *(continued)*			
				5								
				-3								
				6.00 6				SC	Clayey SAND; fine to coarse grained, pale grey, dark yellow-brown, trace angular, white gravel.			
				-4								
				7.00 7					END OF BOREHOLE AT 7.00 m			
				-5								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-06

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**2-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**2-8-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.74 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335116.82 N 5791316.15**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST FB VL L MD D VD H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS		▼	Cement Seal	1				CH	Silty CLAY; high plasticity, dark grey.			QUATERNARY ALLUVIUM
			Bentonite Plug	0								
			Sand (course grained)	2								
			Machine slotted HDPE with filter socks	2.50				SC	Clayey SAND; fine to coarse grained, pale grey-brown.			
				-1								
				2.90				CH	Sandy CLAY; high plasticity, pale grey.			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
				3								
				-2								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-06

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**2-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**2-8-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.74 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335116.82 N 5791316.15**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST / FB VL L MD D VD H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS				-3 / 5				CH	Sandy CLAY; high plasticity, pale grey. *(continued)*			
				-4 / 6.00 6					END OF BOREHOLE AT 6.00 m			
				-5 / 7								
				-6								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-07

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**31-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**31-7-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.74 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335273.84 N 5791347.05**

Borehole Information | **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) / DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
AS		▼	Cement Seal; Bentonite Plug; Sand (course grained); Machine slotted HDPE with filter socks	RL 1, 0, -1, -2; DEPTH 1, 2, 3				CH	Silty CLAY; high plasticity, dark grey.			QUATERNARY ALLUVIUM
				2.20				SC	Clayey SAND; fine to coarse grained, pale grey-brown.			
				2.60				CH	Sandy CLAY; high plasticity, pale grey, brown-yellow, fine grained sand.			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-07

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**31-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**31-7-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.74 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335273.84 N 5791347.05**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS				-3 / 5				CH	Sandy CLAY; high plasticity, pale grey, brown-yellow, fine grained sand. *(continued)*			
				-4 / 6.00 6					END OF BOREHOLE AT 6.00 m			
				-5 / 7								
				-6								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-08

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**31-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**31-7-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.75 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335302.29 N 5790812.37**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS		▼	Cement Seal	1					Topsoil: Sandy CLAY; high plasticity, dark grey-brown, trace fine grained gravel, with roots.			
				0.20				CH	Silty CLAY; high plasticity, dark grey, trace fine grained sand.			QUATERNARY ALLUVIUM
			Bentonite Plug	0								
				1								
			Gravel	2								
				2.40				CH	Sandy CLAY; high plasticity, pale grey, fine to coarse grained sand.			
			Machine slotted HDPE with filter socks	-1								
				3								
				-2								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-08

Client:	**VicRoads**	Date Commenced:	**31-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**31-7-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.75 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335302.29 N 5790812.37**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST / FB VL L MD D VD H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS				-3 / 5				CH	Sandy CLAY; high plasticity, pale grey, fine to coarse grained sand. *(continued)*			
				-4					5.2m becoming pale green-blue grey wih trace fine grained angular gravel (white)			
				6.00 / 6					END OF BOREHOLE AT 6.00 m			
				-5 / 7								
				-6								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-09

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**31-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**31-7-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.09 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335395.19 N 5790841.37**

Borehole Information | **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) / DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
AS		▼	Cement Seal	2 / 0.20				CH	Topsoil: Sandy CLAY; high plasticity, dark grey-brown, trace fine grained gravel, with roots.			
								CH	Silty CLAY; high plasticity, dark grey, trace fine grained sand.			QUATERNARY ALLUVIUM
			Bentonite Plug	1								
				1								
			Gravel	2								
				0								
		▼		2.40				CH	Sandy CLAY; high plasticity, pale grey, fine to coarse grained sand.			
			Machine slotted HDPE with filter socks	3								
				-1								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-09

Client:	**VicRoads**	Date Commenced:	**31-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**31-7-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.09 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335395.19 N 5790841.37**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS				-2 / 5				CH	Sandy CLAY; high plasticity, pale grey, fine to coarse grained sand. *(continued)*			
				-3 / 5.20				CH	Sandy CLAY; high plasticity, pale green-blue, grey, trace fine grained angular gravel (white).			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
				-4 / 6.00 6					END OF BOREHOLE AT 6.00 m			
				-5 / 7								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-10D

SHEET 1 OF 6

Client:	**VicRoads**	Date Commenced:	**12-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**12-7-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.28 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335508.51 N 5790434.72**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal	2					FILL: Silty SAND; fine grained, brown grey, some clay, trace gravel.			FILL
			Bentonite Plug	0.50				CI	Silty CLAY; medium plasticity, dark grey, some fine grained sand.			QUATERNARY ALLUVIUM
				1								
				1								
				2								
				0								
			Machine slotted HDPE with filter socks	2.70				CI	Sandy CLAY; medium plasticity, grey, fine grained sand.			
				3								
				-1								
				3.70				SW	SAND; fine grained, brown, grey.			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-10D

Client:	**VicRoads**	Date Commenced:	**12-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**12-7-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.28 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335508.51 N 5790434.72**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				-2				SW	SAND; fine grained, brown, grey. *(continued)*			
				5								
				5.20				CI-CH	Silty CLAY; medium to high plasticity, pale grey, some fine grained sand.			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
WB				-3								
				6								
				-4								
			Sand (course grained)	7					7.0m some fine to medium grained sand			
				7.20				CH	Silty CLAY; high plasticity, pale grey, yellow, brown, some fine to medium grained sand.			
				-5								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-10D

Client:	**VicRoads**	Date Commenced:	**12-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**12-7-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.28 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335508.51 N 5790434.72**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				-6 / 9				CH	Silty CLAY; high plasticity, pale grey, yellow, brown, some fine to medium grained sand. *(continued)*			
				-7 / 10								
				-8								
				10.90				SC	Clayey SAND; fine grained, pale grey, yellow brown, medium plasiticity clay.			
				-9 / 11								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-10D

Client:	**VicRoads**	Date Commenced:	**12-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**12-7-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.28 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335508.51 N 5790434.72**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				10				SC	Clayey SAND; fine grained, pale grey, yellow brown, medium plasticity clay. *(continued)*			
				12.90				SP	SAND; fine to coarse grained, pale grey, some clay layers.			
WB				10 / 11 / 12 / 13 / 14 / 15								

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-10D

Client:	**VicRoads**	Date Commenced:	**12-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**12-7-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.28 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335508.51 N 5790434.72**

Borehole Information							Field Material Description					
	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H / FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
									SP	SAND; fine to coarse grained, pale grey, some clay layers. *(continued)*			
			Natural Pack Sand	-14									
					17								
				-15									
WB					18								
				-16									
					19								
				-17									

END OF BOREHOLE AT 20.00 m

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-10D

Client:	**VicRoads**	Date Commenced:	**12-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**12-7-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.28 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335508.51 N 5790434.72**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H / FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
				20.00								
				-18								
				21								
				-19								
				22								
				-20								
				23								
				-21								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-10S

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**2-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**2-8-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.10 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335508.51 N 5790434.72**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal	2				CI	Silty CLAY; medium plasticity, dark grey, with some fine grained sand.			QUATERNARY ALLUVIUM
			Bentonite Plug	1					1.4m becoming brown orange grey			
				1.80				CH	Sandy CLAY; high plasticity, dark grey.			
				0								
			Sand (course grained)	3.00				SC	Clayey SAND; fine to medium grained, pale grey.			
			Machine slotted HDPE with filter socks	-1								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-10S

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**2-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**2-8-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.10 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335508.51 N 5790434.72**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				-2 / 5				SC	Clayey SAND; fine to medium grained, pale grey. *(continued)*			
				-3 / 5.40				CH	Silty CLAY; high plasticity, pale grey, trace fine grained sand.			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
WB				-4 / 6					6.0m becoming sandy			
				-5 / 7.00 7					END OF BOREHOLE AT 7.00 m			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-11D

SHEET 1 OF 6

Client:	**VicRoads**	Date Commenced:	**11-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**11-7-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.61 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335655.48 N 5790407.63**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal; Bentonite Plug	2; 1; 0; -1; 1.00; 2.50; 3.30					FILL: Clayey SAND; fine to medium grained, brown, grey.			FILL
								CH	Silty CLAY; high plasticity, dark grey, some fine to medium grained sand.			QUATERNARY ALLUVIUM
								CI	Sandy CLAY; medium plasticity, grey, fine grained sand.			
								SP	SAND; fine grained, brown grey.	W		

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-11D

Client:	**VicRoads**	Date Commenced:	**11-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**11-7-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.61 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335655.48 N 5790407.63**

Borehole Information | **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m)	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Sand (course grained)	-2	5				SP	SAND; fine grained, brown grey. *(continued)*	W		
				-3	5.70 6				CI-CH	Silty CLAY; medium to high plasticity, pale grey, some fine grained sand.			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
				-4	7.00 7				CH	Silty CLAY; high plasticity, yellow brown.			
			Machine slotted HDPE with filter	-5									

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-11D

Client:	**VicRoads**	Date Commenced:	**11-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**11-7-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.61 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335655.48 N 5790407.63**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			socks	-6 / 9 -7 / 10 -8 / 11 -9				CH	Silty CLAY; high plasticity, yellow brown. *(continued)*	W		

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-11D

Client:	**VicRoads**	Date Commenced:	**11-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**11-7-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.61 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335655.48 N 5790407.63**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				10				CH	Silty CLAY; high plasticity, yellow brown. *(continued)*	W		
				12.90				CI	Sandy CLAY/Clayey SAND; medium plasticity, pale grey brown, fine grained sand.			
				13.70				SP	SAND; fine grained, pale grey brown.			
				14.40				CI	Silty CLAY; medium plasticity, grey brown, some bands of sand.			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-11D

Client:	**VicRoads**	Date Commenced:	**11-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**11-7-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.61 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335655.48 N 5790407.63**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			HDPE sump	14 15 16 17 17 18 18.50 19				CI	Silty CLAY; medium plasticity, grey brown, some bands of sand. *(continued)*	W		
								SP	SAND; fine grained, brown, some clay bands. 19.7m becoming red brown			

END OF BOREHOLE AT 20.00 m

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-11D

Client:	**VicRoads**	Date Commenced:	**11-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**11-7-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.61 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335655.48 N 5790407.63**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H / FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
				20.00								
				-18								
				21								
				-19								
				22								
				-20								
				23								
				-21								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-11S

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**2-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**2-8-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.62 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335655.48 N 5790407.63**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
			Cement Seal						FILL: Silty Sandy CLAY			FILL
				0.40				CH	Silty CLAY; high plasticity, dark grey, some fine grained sand.			QUATERNARY ALLUVIUM
			Bentonite Plug	2								
				1								
				1.10				CH	Sandy CLAY; high plasticity, dark grey, fine to coarse grained sand.			
				1								
WB				2								
		▼		2.50				SC	Clayey SAND; fine to medium grained, pale grey.			
				0								
			Sand (course grained)	3								
			Machine slotted HDPE with filter socks	-1					3.5m becoming stained brown, dark yellow			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-11S

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**2-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**2-8-17**
Borehole Location:	**Waterways**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.62 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335655.48 N 5790407.63**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				4.00				SC	Clayey SAND; fine to medium grained, stained brown, dark yellow.			
WB				5.40				CH	Silty CLAY; high plasticity, pale grey, trace fine to coarse grained sand.			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
				7.00					END OF BOREHOLE AT 7.00 m			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-12D

SHEET 1 OF 6

Client:	**VicRoads**	Date Commenced:	**3-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**3-7-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.31 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336042.61 N 5789766.11**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal; Bentonite Plug	2; 1; 0; -1; 3				CH	Silty CLAY; medium to high plasticity, grey to dark grey.			QUATERNARY ALLUVIUM
				1.50				CI	Sandy CLAY; medium plasticity, grey, fine grained sand.			
				2.20				SC	Clayey SAND; fine grained, grey.			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-12D

SHEET 2 OF 6

Client:	**VicRoads**	Date Commenced:	**3-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**3-7-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.31 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336042.61 N 5789766.11**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				-2				SC	Clayey SAND; fine grained, grey. *(continued)*			
				4.50				CI-CH	Silty CLAY; medium to high plasticity, dark brown, some sand.			
WB				5								
				-3								
				6								
				-4								
			Sand (course grained)	7								
				7.30 -5				CI-CH	Silty CLAY; medium to high plasticity, grey, mottled orange brown.			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
			Machine slotted HDPE with filter									

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-12D

Client:	**VicRoads**	Date Commenced:	**3-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**3-7-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.31 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336042.61 N 5789766.11**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			socks	-6				CI-CH	Silty CLAY; medium to high plasticity, grey, mottled orange brown. *(continued)*			
				8.50 -7				CI-CH	Silty CLAY; medium to high plasticity, orange brown, grey, trace sand.			
				9 -8								
				10 -9								
				11								11.8m hard cemented layer

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-12D

Client:	**VicRoads**	Date Commenced:	**3-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**3-7-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.31 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336042.61 N 5789766.11**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				10 12.30				CI-CH	Silty CLAY; medium to high plasticity, orange brown, grey, trace sand. *(continued)*			
								SW	SAND; fine grained, pale grey brown.			
				13								
				11								
				14								
				12								
				15								
				13								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-12D

Client:	**VicRoads**	Date Commenced:	**3-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**3-7-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.31 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336042.61 N 5789766.11**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
								SW	SAND; fine grained, pale grey brown. *(continued)*			
			HDPE sump	14								
				17.00 / 17				SC	Clayey SAND; fine to medium grained, brown.			
				15								
WB				18								
				16								
				19								
				17								

END OF BOREHOLE AT 20.00 m

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-12D

Client:	**VicRoads**	Date Commenced:	**3-7-17**
Project:	**Mordialloc Bypass**	Date Completed:	**3-7-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.31 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336042.61 N 5789766.11**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H / FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
				20.00								
				-18								
				21								
				-19								
				22								
				-20								
				23								
				-21								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-12S

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**3-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**3-8-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.27 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336042.61 N 5789766.11**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal; Bentonite Plug; Sand (course grained); Machine slotted HDPE with filter socks	2; 1; 1.50; 2; 2.20; 0; 3; -1				CH	Silty CLAY; high plasticity, dark grey.			QUATERNARY ALLUVIUM
								CI-CH	Sandy CLAY; medium to high plasticity, grey, trace fine grained sand.			
								SC	Clayey SAND; fine grained, grey.			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-12S

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**3-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**3-8-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.27 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336042.61 N 5789766.11**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				-2				SC	Clayey SAND; fine grained, grey. *(continued)*			
				4.50				CI	Silty CLAY; medium plasticity, dark brown, some sand.			
				5.00 5 -3				CH	Silty CLAY; high plasticity, grey brown, orange.			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
				6 -4								
				7.00 7 -5					END OF BOREHOLE AT 7.00 m			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-13D

SHEET 1 OF 6

Client:	VicRoads	Date Commenced:	4-2-17
Project:	Mordialloc Bypass	Date Completed:	4-2-17
Borehole Location:	Springvale Road	Recorded By:	PP
Project Number:	2135645A	Log Checked By:	JC

Drill Model/Mounting:	Comacchio Geo 305	Driller:	Earthcore	Surface RL:	2.13 m
Borehole Diameter:	100 mm	Driller Lic No:	0738	Co-ords:	E 336182.42 N 5789837.65

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal; Bentonite Plug	2 / 1 / 0 / -1 / DEPTH 1 / 2 / 3				CH	Silty CLAY; high plasticity, dark grey to grey.			QUATERNARY ALLUVIUM
				3.00				CI-CH	Sandy CLAY; medium to high plasticity, brown.			
				3.50				CI-CH	Silty CLAY; medium to high plasticity, pale grey to mottled orange brown.			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-13D

Client:	**VicRoads**	Date Commenced:	**4-2-17**
Project:	**Mordialloc Bypass**	Date Completed:	**4-2-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.13 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336182.42 N 5789837.65**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				-2				CI-CH	Silty CLAY; medium to high plasticity, pale grey to mottled orange brown. *(continued)*			
				5.00 5				CI	Sandy CLAY; medium plasticity, pale grey brown.			
WB				-3								
				6								
				-4								
				7								
			Sand (course grained)	-5								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-13D

Client:	**VicRoads**	Date Commenced:	**4-2-17**
Project:	**Mordialloc Bypass**	Date Completed:	**4-2-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.13 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336182.42 N 5789837.65**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Machine slotted HDPE with filter socks	8.00 / -6 / 9 / -7				CI	Sandy CLAY; medium plasticity, brown, fine to medium grained sand.			
				9.50 / 10 / -8 / 11 / -9				SC	Clayey SAND; fine grained, orange brown, pale grey.			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-13D

Client:	**VicRoads**	Date Commenced:	**4-2-17**
Project:	**Mordialloc Bypass**	Date Completed:	**4-2-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.13 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336182.42 N 5789837.65**

Borehole Information							Field Material Description					
	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H / FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
				10					SC	Clayey SAND; fine grained, orange brown, pale grey. *(continued)*			
					13								
				11									
WB					14					14m becoming medium to fine grained sand , brown			
				12									
					15								
				13									

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-13D

Client:	**VicRoads**	Date Commenced:	**4-2-17**
Project:	**Mordialloc Bypass**	Date Completed:	**4-2-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.13 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336182.42 N 5789837.65**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST / FB VL L MD D VD H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				14				SC	Clayey SAND; fine grained, orange brown, pale grey. *(continued)*			
			HDPE sump	17.00 / 17				SP	SAND; fine to medium grained, brown.			
WB				15								
				18 / 16								
				19 / 17								

END OF BOREHOLE AT 20.00 m

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-13D

Client:	**VicRoads**	Date Commenced:	**4-2-17**
Project:	**Mordialloc Bypass**	Date Completed:	**4-2-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.13 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336182.42 N 5789837.65**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				20.00 18 21 19 22 20 23 21								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-13S

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**3-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**3-8-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.08 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336182.42 N 5789837.65**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal	2				CI-CH	Silty CLAY; medium to high plasticity, dark grey.			QUATERNARY ALLUVIUM
			Bentonite Plug	1								
				0								
			Sand (course grained)	3.00 -1				CI	Sandy CLAY; medium plasticity, brown.			
			Machine slotted HDPE with filter socks	3.50				CH	Silty CLAY; high plasticity, pale grey, brown, orange.			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-13S

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**3-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**3-8-17**
Borehole Location:	**Springvale Road**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.08 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336182.42 N 5789837.65**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				-2				CH	Silty CLAY; high plasticity, pale grey, brown, orange. *(continued)*			
				-3 (5.00 / 5)				CH	Sandy CLAY; high plasticity, pale grey, brown, fine grained sand.			
				-4 (6)								
				-5 (7.00 / 7)					END OF BOREHOLE AT 7.00 m			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-14D

SHEET 1 OF 5

Client:	**VicRoads**	Date Commenced:	**8-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**8-8-17**
Borehole Location:	**Chelsea Heights**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.78 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336219.44 N 5789512.85**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal; Bentonite Plug	1 / 0 / -1 / -2; 1 / 2 / 3				CH	Silty CLAY; high plasticity, dark grey, trace fine to coarse grained sand, trace fine grained gravel.			QUATERNARY ALLUVIUM
				2.20				CH	Sandy CLAY; high plasticity, grey, fine to coarse grained sand.			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-14D

Client:	**VicRoads**	Date Commenced:	**8-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**8-8-17**
Borehole Location:	**Chelsea Heights**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.78 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336219.44 N 5789512.85**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Sand (course grained)	-3 5 -4 6 6.50 -5 7 7.80 -6				CH	Sandy CLAY; high plasticity, grey, fine to coarse grained sand. *(continued)* 5.0m becoming blue green, grey			
								SC	Clayey SAND; fine to coarse grained, trace fine grained gravel.			
									Sandy CLAY; grey mottled orange-brown, fine to coarse grained sand.			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-14D

Client:	**VicRoads**	Date Commenced:	**8-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**8-8-17**
Borehole Location:	**Chelsea Heights**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.78 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336219.44 N 5789512.85**

Borehole Information							Field Material Description					
	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Machine slotted HDPE with filter socks	-7 -8 -9 -10	9 10 11					Sandy CLAY; grey mottled orange-brown, fine to coarse grained sand. *(continued)*			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-14D

Client:	**VicRoads**	Date Commenced:	**8-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**8-8-17**
Borehole Location:	**Chelsea Heights**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.78 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336219.44 N 5789512.85**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				11 / 13					Sandy CLAY; grey mottled orange-brown, fine to coarse grained sand. *(continued)*			
WB			HDPE sump	12 / 13.80 / 14 / 13 / 15 / 14				SC	Clayey SAND; fine to coarse grained, grey mottled orange-brown, medium plasticity clay.			

END OF BOREHOLE AT 16.00 m

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-14D

SHEET 5 OF 5

Client:	**VicRoads**	Date Commenced:	**8-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**8-8-17**
Borehole Location:	**Chelsea Heights**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.78 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336219.44 N 5789512.85**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (FB VL L MD D VD / VS S F ST VST H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				16.00								
				15 / 17								
				16 / 18								
				17 / 19								
				18								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-14S

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**8-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**8-8-17**
Borehole Location:	**Chelsea Heights**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.89 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336218.27 N 5789512.78**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal; Bentonite Plug; Sand (course grained); Machine slotted HDPE with filter socks	1 / 0 / -1 / -2; 1 / 2 / 3				CH	Silty CLAY; high plasticity, dark grey, trace fine to coarse grained sand.			QUATERNARY ALLUVIUM
				2.20				CH	Sandy CLAY; high plasticity, grey, fine to coarse grained sand.			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-14S

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**8-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**8-8-17**
Borehole Location:	**Chelsea Heights**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.89 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336218.27 N 5789512.78**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (FB VL L MD D VD / VS S F ST VST H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				-3 / 5				CH	Sandy CLAY; high plasticity, grey, fine to coarse grained sand. *(continued)*			
									5.0m becoming blue green, grey			
				-4 / 6								
				6.50				SC	Clayey SAND; fine to coarse grained, trace fine grained gravel.			
				-5 / 7								
				7.10					END OF BOREHOLE AT 7.10 m			
				-6								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-15D

SHEET 1 OF 5

Client:	**VicRoads**	Date Commenced:	**9-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**9-8-17**
Borehole Location:	**Chelsea Heights**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.51 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336361.34 N 5789585.12**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal; Bentonite Plug	1; 0; -1; -2 / 1; 2; 3				CH	Silty CLAY; high plasticity, dark grey.			QUATERNARY ALLUVIUM
				3.00				CH	Sandy CLAY; high plasticity, grey, fine to coarse grained sand.			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-15D

SHEET 2 OF 5

Client:	**VicRoads**	Date Commenced:	**9-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**9-8-17**
Borehole Location:	**Chelsea Heights**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.51 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336361.34 N 5789585.12**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				-3				CH	Sandy CLAY; high plasticity, grey, fine to coarse grained sand. *(continued)*			
									4.5m mottled dark yellow, brown			
				5								
				-4								
WB				6.00 6				CH	Clayey SAND; fine to coarse grained, pale grey, high plasticity clay.			
				-5								
		▼		6.60				SC	Sandy CLAY; high plasticity, mottled brown orange, dark yellow, with clayey sand lenses.			
				7								
			Sand (course grained)	-6								
				7.60				CH	Clayey SAND; fine to coarse grained, high plasticity clay.			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-15D

Client:	**VicRoads**	Date Commenced:	**9-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**9-8-17**
Borehole Location:	**Chelsea Heights**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.51 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336361.34 N 5789585.12**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Machine slotted HDPE with filter socks	-7 / 9				CH	Clayey SAND; fine to coarse grained, high plasticity clay. *(continued)*			
				-8 / 10								
				-9								
				11.00 / 11				SC	Sandy CLAY; high plasticity, fine to coarse grained sand.			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
				-10								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-15D

Client:	**VicRoads**	Date Commenced:	**9-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**9-8-17**
Borehole Location:	**Chelsea Heights**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.51 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336361.34 N 5789585.12**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				11				SC	Sandy CLAY; high plasticity, fine to coarse grained sand. *(continued)*			
				12								
WB				14.00 13				SC	Sandy CLAY; high plasticity, grey, fine to coarse grained sand.			
				13								
			HDPE sump	15								
				14								

END OF BOREHOLE AT 16.00 m

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-15D

SHEET 5 OF 5

Client:	**VicRoads**	Date Commenced:	**9-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**9-8-17**
Borehole Location:	**Chelsea Heights**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.51 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336361.34 N 5789585.12**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H / FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
				16.00								
				15								
				17								
				16								
				18								
				17								
				19								
				18								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-15S

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**8-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**8-8-17**
Borehole Location:	**Chelsea Heights**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.50 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336355.81 N 5789595.72**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal	1				CH	Silty CLAY; high plasticity, dark grey.			QUATERNARY ALLUVIUM
			Bentonite Plug	0								
				1								
				-1								
			Sand (course grained)	3.00 3				CH	Sandy CLAY; high plasticity, grey, fine to coarse grained sand.			
			Machine slotted HDPE with filter socks	-2								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW17-26-15S

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**8-8-17**
Project:	**Mordialloc Bypass**	Date Completed:	**8-8-17**
Borehole Location:	**Chelsea Heights**	Recorded By:	**PP**
Project Number:	**2135645A**	Log Checked By:	**JC**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**1.50 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336355.81 N 5789595.72**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				-3				CH	Sandy CLAY; high plasticity, grey, fine to coarse grained sand. *(continued)*			
									4.5m mottled dark yellow, brown			
				5								
				-4								
				6								
				-5								
				6.60				SC	Clayey SAND; fine to coarse grained, pale grey, high plasticity clay.			
				7								
				7.10					END OF BOREHOLE AT 7.10 m			
				-6								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-16D

SHEET 1 OF 5

Client:	VicRoads	Date Commenced:	14-2-18
Project:	Mordialloc Bypass	Date Completed:	14-2-18
Borehole Location:	Braeside Park	Recorded By:	MS
Project Number:	2135645A	Log Checked By:	NB

Drill Model/Mounting:	Comacchio Geo 205	Driller:	Earthcore	Surface RL:	3.46 m
Borehole Diameter:	100 mm	Driller Lic No:	0738	Co-ords:	E 335715.01 N 5791857.77

Borehole Information							Field Material Description					
2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS			Cement Seal; Bentonite Plug	3				CH	Sandy CLAY; high plasticity, dark brown, fine grained sand	MC~PL		QUATERNARY ALLUVIUM
				1								
				2								
				2.00 2				SP	SAND; fine grained, grey, cemented layer	M		
				2.30				CH	Sandy CLAY; high plasticity, pale brown, fine grained sand	MC>PL		
				1								
				3					3.0m becoming grey, sand content increasing			
		▼		0						W		

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-16D

Client:	**VicRoads**	Date Commenced:	**14-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**14-2-18**
Borehole Location:	**Braeside Park**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**3.46 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335715.01 N 5791857.77**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Sand (course grained)	4.00				SC	Clayey SAND: fine grained, orange, pale brown, high plasticity clay	W		
				7.80				CH	Sandy CLAY: high plasticity, orange, pale brown, fine to coarse grained sand	MC>PL		TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-16D

SHEET 3 OF 5

Client:	VicRoads	Date Commenced:	14-2-18
Project:	Mordialloc Bypass	Date Completed:	14-2-18
Borehole Location:	Braeside Park	Recorded By:	MS
Project Number:	2135645A	Log Checked By:	NB

Drill Model/Mounting:	Comacchio Geo 205	Driller:	Earthcore	Surface RL:	3.46 m
Borehole Diameter:	100 mm	Driller Lic No:	0738	Co-ords:	E 335715.01 N 5791857.77

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Machine slotted HDPE with filter socks	8.20				CH	Sandy CLAY: high plasticity, orange, pale brown, fine to coarse grained sand *(continued)*	MC>PL		
				-5				SC	Clayey SAND: fine to coarse grained, orange, brown, high plasticity clay	W		
				9.00 9				CH	Sandy CLAY: high plasticity, orange, brown, fine to coarse grained sand	MC>PL		
				-6								
				9.60				SW	SAND: fine to coarse grained, orange, brown, with high plasticity clay	W		
				10								
				-7								
				10.70				SW	SAND: fine to coarse grained, orange, brown			
				11								
				-8								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-16D

Client:	**VicRoads**	Date Commenced:	**14-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**14-2-18**
Borehole Location:	**Braeside Park**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**3.46 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335715.01 N 5791857.77**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				-9				SW	SAND: fine to coarse grained, orange, brown *(continued)*	W		
				13								
				-10								
				13.70				SC	Clayey SAND: fine to coarse grained, pale brown, high plasticity clay			
WB				14								
				-11								
				15								
				-12								

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-16D

SHEET 5 OF 5

Client:	**VicRoads**	Date Commenced:	**14-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**14-2-18**
Borehole Location:	**Braeside Park**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**3.46 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335715.01 N 5791857.77**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			HDPE sump	13 / 17				SC	Clayey SAND: fine to coarse grained, pale brown, high plasticity clay *(continued)*	W		
				14								
				18.00 / 18					END OF BOREHOLE AT 18.00 m			
				15								
				19								
				16								

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-16S

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**14-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**14-2-18**
Borehole Location:	**Braeside Park**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**3.36 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335712.35 N 5791858.64**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS			Cement Seal	3				CH	Sandy CLAY; high plasticity, dark brown, fine grained sand	MC~PL		QUATERNARY ALLUVIUM
			Bentonite Plug	1								
			Sand (course grained)	2.00 2				SP	SAND; fine grained, grey, cemented layer	M		
			Machine slotted HDPE with filter socks	2.40 1				CH	Sandy CLAY; high plasticity, pale brown, fine grained sand	MC<PL		
				3					3.0m becoming grey, sand content increasing	MC>PL		
				0								

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-16S

Client:	**VicRoads**	Date Commenced:	**14-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**14-2-18**
Borehole Location:	**Braeside Park**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**3.36 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335712.35 N 5791858.64**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS			Sump	4.00				SC	Clayey SAND: fine grained, orange, pale brown, high plasticity clay	W		
				6.50					END OF BOREHOLE AT 6.50 m			

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This borehole log should be read in conjunction with WSP's accompanying standard notes.

BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-17D

SHEET 1 OF 5

Client:	**VicRoads**	Date Commenced:	**19-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**19-2-18**
Borehole Location:	**Waterways**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**1.90 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335466.71 N 5791097.38**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (FB VL L MD VD / VS S F ST VST H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
			Cement Seal						FILL; Sandy CLAY: high plasticity, black, fine to coarse grained sand	D		FILL
			Bentonite Plug	0.50				CH	CLAY: high plasticity, black	MC~PL		QUATERNARY ALLUVIUM
AS				1								
				0								
				1								
				2								
				-1					2.8m becoming grey, trace fine grained sand	MC>PL		
				3								
WB				3.40				CH	Sandy CLAY: high plasticity, grey, pale brown, fine to coarse grained sand			
				-2								

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-17D

Client:	**VicRoads**	Date Commenced:	**19-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**19-2-18**
Borehole Location:	**Waterways**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**1.90 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335466.71 N 5791097.38**

Borehole Information | **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) / DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Sand (course grained)	4.10 / -3 / 5 / 5.60 / -4 / 6 / -5 / 7 / 7.20 / -6				CH				
								SC	Clayey SAND: fine to coarse grained, grey, mottled brown, high plasticity clay	W		
								CH	Sandy CLAY: high plasticity, pale brown, fine to coarse grained sand	MC>PL		TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
									6.4m mottled brown, grey			
								SC	Clayey SAND: fine to coarse grained, mottled brown, red, grey, high plasticity clay	W		

RELATIVE DENSITY /CONSISTENCY: VS S F ST VST H | FB VL L MD D VD

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-17D

Client:	**VicRoads**	Date Commenced:	**19-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**19-2-18**
Borehole Location:	**Waterways**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**1.90 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335466.71 N 5791097.38**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (FB VL L MD D VD / VS S F ST VST H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Machine slotted HDPE with filter socks	8.00 (-7 / 9)				CH	Sandy CLAY: high plasticity, grey, fine grained sand	MC>PL		
				9.60 (-8 / 10)				SC	Clayey SAND: fine to coarse grained, grey, high plasticity clay	W		
									10.2m becoming red, brown, grey			
									10.6m becoming fine grained, grey			
				11.80 (-9 / 11)				SP	SAND: fine grained, grey			
				(-10)								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-17D

Client:	**VicRoads**	Date Commenced:	**19-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**19-2-18**
Borehole Location:	**Waterways**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**1.90 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335466.71 N 5791097.38**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				11 / 13				SP	SAND: fine grained, grey *(continued)*	W		
				13.20				SW	SAND: fine to coarse grained, grey, mottled brown, red, trace high plasticity clay			
				12 / 14								
				14.20				SW	Gravelly SAND: fine to coarse grained, grey, black, mottled brown, fine grained gravel, trace high plasticity clay			
				13 / 15								
				14								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-17D

Client:	**VicRoads**	Date Commenced:	**19-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**19-2-18**
Borehole Location:	**Waterways**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**1.90 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335466.71 N 5791097.38**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			HDPE sump	16.20				SW	Gravelly SAND: fine to coarse grained, grey, black, mottled brown, fine grained gravel, trace high plasticity clay *(continued)*	W		
								SW	SAND: fine to coarse grained, brown, grey			
				15								
				17								
				16								
				18.00 18					END OF BOREHOLE AT 18.00 m			
				17								
				19								
				18								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-17S

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**19-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**20-2-18**
Borehole Location:	**Waterways**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**1.87 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335467.9 N 5791100.38**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (FB VL L MD VD / VS S F ST VST H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
			Cement Seal	1.87					FILL: Sandy CLAY; high plasticity, black, fine to coarse grained sand	D		FILL
			Bentonite Plug	0.50				CH	CLAY; high plasticity, black	MC~PL		QUATERNARY ALLUVIUM
AS				1								
				0								
			Sand (course grained)	2								
		▼	Machine slotted HDPE with filter socks	-1					2.8m grey, trace sand	MC>PL		
WB				3								
				3.40				CH	Sandy CLAY; high plasticity, grey, pale brown, fine to coarse grained sand			
				-2								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-17S

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**19-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**20-2-18**
Borehole Location:	**Waterways**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**1.87 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335467.9 N 5791100.38**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST / FB VL L MD D VD H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
								CH				
WB			Sump	4.10				SC	Clayey SAND; fine to coarse grained sand, mottled brown, grey, high plasticity clay	W		
				-3 5								
				5.60				CH	Sandy CLAY; high plasticity, pale brown, fine to coarse grained sand	MC>PL		TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
				-4 6								
				6.50					END OF BOREHOLE AT 6.50 m			
				-5 7								
				-6								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-18D

SHEET 1 OF 5

Client:	**VicRoads**	Date Commenced:	**20-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**20-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.36 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334926.3 N 5790618.77**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS			Cement Seal	2					FILL; Sandy CLAY: high plasticity, black, organics (small roots), fine grained sand	M		FILL
			Bentonite Plug	1								
				0								
				2.30				SP	SAND: fine grained, grey, organics			QUATERNARY ALLUVIUM
WB				-1								
				3.40				CH	Silty CLAY: high plasticity, dark brown, organics	W		

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-18D

SHEET 2 OF 5

Client:	**VicRoads**	Date Commenced:	**20-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**20-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.36 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334926.3 N 5790618.77**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				-2				CH	Silty CLAY: high plasticity, dark brown, organics *(continued)*	W		
				4.40				SM	Silty SAND: fine grained, grey, dark brown, organics			
				5								
				5.30				CH	Sandy CLAY: high plasticity, grey, fine grained sand, shells	MC>PL		TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
				-3								
				5.80				SP	SAND: fine grained, grey, trace high plasticity clay	W		
WB				6								
				-4								
				7								
			Sand (course grained)	-5								
				7.60				SC	Clayey SAND: fine to coarse grained sand, grey, brown, high plasticity clay			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-18D

Client:	**VicRoads**	Date Commenced:	**20-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**20-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.36 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334926.3 N 5790618.77**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Machine slotted HDPE with filter socks	-6 / 9 / -7 / 10 / -8 / 11 / -9				SC	Clayey SAND: fine to coarse grained sand, grey, brown, high plasticity clay *(continued)*	W		

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-18D

Client:	**VicRoads**	Date Commenced:	**20-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**20-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.36 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334926.3 N 5790618.77**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				10 11 12 13 14 15				SC	Clayey SAND: fine to coarse grained sand, grey, brown, high plasticity clay *(continued)*	W		

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-18D

SHEET 5 OF 5

Client:	**VicRoads**	Date Commenced:	**20-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**20-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.36 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334926.3 N 5790618.77**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (FB VL L MD D VD / VS S F ST VST H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				14				SC	Clayey SAND: fine to coarse grained sand, grey, brown, high plasticity clay *(continued)*	W		
				16.60				SW	SAND: fine to coarse grained, grey, mottled brown			
WB			HDPE sump	17								
				15								
				18.00 18					END OF BOREHOLE AT 18.00 m			
				16								
				19								
				17								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-18S

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**20-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**20-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.37 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334925.48 N 5790615.57**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS			Cement Seal	2					FILL; Sandy CLAY: high plasticity, black, organics (small roots), fine grained sand	M		FILL
			Bentonite Plug	1								
			Sand (course grained)	0								
				2.30				SP	SAND: fine grained, grey, organics			QUATERNARY ALLUVIUM
WB			Machine slotted HDPE with filter socks	-1								
				3.40				CH	Silty CLAY: high plasticity, dark brown, organics	MC>PL		

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-18S

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**20-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**20-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.37 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 334925.48 N 5790615.57**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Sump	-2 / 4.40				CH	Silty CLAY: high plasticity, dark brown, organics *(continued)*	MC>PL		
								SM	Silty SAND: fine grained, grey, dark brown, organics and shells	W		
				-3 / 5.30				CH	Sandy CLAY: high plasticity, grey, fine grained sand	MC>PL		TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
				5.80				SP	SAND: fine grained, grey, trace high plasticity clay	W		
				-4 / 6.50					END OF BOREHOLE AT 6.50 m			
				-5								

5 6 7

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-19D

Client:	**VicRoads**	Date Commenced:	**12-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**12-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.00 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336008.75 N 5790191.86**

Borehole Information | **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m)	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
AS		▼	Cement Seal; Bentonite hole plug	1	1				CH	CLAY: high plasticity, black, with fine grained sand	MC>PL		QUATERNARY ALLUVIUM
					1.50				CH	CLAY: high plasticity, dark brown, trace fine grained sand			
				0	2								
					2.10				CH	Sandy CLAY: high plasticity, light brown, fine grained sand			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
WB				-1	3					3.2m becoming grey			
					3.90				SW	SAND: fine to medium grained, grey	M		

RELATIVE DENSITY /CONSISTENCY: VS S F ST VST H; FB VL L MD D VD

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-19D

Client:	**VicRoads**	Date Commenced:	**12-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**12-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.00 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336008.75 N 5790191.86**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Bentonite PEI plug	-3 5				SW	SAND: fine to medium grained, grey *(continued)*	M		
				-4 6								
				6.10				CH	CLAY: high plasticity, brown	MC>PL		
			Sand (course grained)	-5 7								
				7.20				SP	Clayey SAND: fine grained, pale grey, medium plasticity clay	M		

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-19D

Client:	**VicRoads**	Date Commenced:	**12-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**12-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.00 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336008.75 N 5790191.86**

Borehole Information							Field Material Description					
1	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY	STRUCTURE AND ADDITIONAL OBSERVATIONS
			Machine slotted HDPE with filter socks						SP	Clayey SAND: fine grained, pale grey, medium plasticity clay *(continued)*	M		
				-7	9					9.0m becoming fine to coarse grained			
WB				-8	10								
				-9	11								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-19D

Client:	**VicRoads**	Date Commenced:	**12-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**12-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.00 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336008.75 N 5790191.86**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
								SP	Clayey SAND: fine grained, pale grey, medium plasticity clay *(continued)*	M		
				11 13								
				13.30				SP	SAND: fine grained, brown, possible cemented layer	M		TERTIARY BRIGHTON GROUP (BEAUMARIS SANDSTONE)
				13.50				SP	SAND: fine grained, brown, black	M		
WB				12 14								
				13 15								
									15.7m becoming fine to corase grained			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-19D

Client:	**VicRoads**	Date Commenced:	**12-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**12-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.00 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336008.75 N 5790191.86**

Borehole Information							Field Material Description					
1	2	3	4	5		6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m)	DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY VS S F ST VST H FB VL L MD D VD	STRUCTURE AND ADDITIONAL OBSERVATIONS
									SP	SAND: fine grained, brown, black *(continued)*	M		
WB			HDPE sump	-15	17								
				-16	18.00 18					END OF BOREHOLE AT 18.00 m			
				-17	19								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-19S

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**12-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**12-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.00 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336009.9 N 5790191.14**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST / FB VL L MD D VD H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS			Cement Seal	1 / 1				CH	CLAY: high plasticity, black, trace fine grained sand	MC~PL		QUATERNARY ALLUVIUM
			Bentonite Plug	1.30				CH	CLAY: high plasticity, dark brown, trace fine grained sand			
			Sand (course grained)	0 / 2								
				2.10				CH	Sandy CLAY: high plasticity, light brown, fine grained sand	MC>PL		TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
			Machine slotted HDPE with filter socks	-1 / 3					3.2m becoming grey			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-19S

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**12-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**12-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.00 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336009.9 N 5790191.14**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS		▼	Sump	4.00				SP	SAND: fine to medium grained, dark grey, with high plasticity clay	M		
				-3 5								
				-4 6								
				6.50					END OF BOREHOLE AT 6.50 m			
				-5 7								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-20D

SHEET 1 OF 5

Client:	**VicRoads**	Date Commenced:	**12-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**13-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.31 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335781.39 N 5790084.87**

Borehole Information | **Field Material Description**

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m) / DEPTH(m)	6 FIELD TEST	7 SAMPLE	8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Cement Seal; Bentonite Plug	2 / 1 / 0 / -1				CH	Sandy CLAY: high plasticity, black, fine grained sand	MC~PL	FB VS VL S L F MD ST D VST VD H	QUATERNARY ALLUVIUM
				2.10				SP	SAND: fine grained, dark brown, with high plasticity clay	M		Casing to 2.5m on the 12/02/2018; Casing fell down hole @ 3.3m

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-20D

Client:	**VicRoads**	Date Commenced:	**12-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**13-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.31 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335781.39 N 5790084.87**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (FB VL L MD D VD / VS S F ST VST H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				-2				SP	SAND: fine grained, dark brown, with high plasticity clay *(continued)*	M		
				5								
				-3 5.30				SC	Clayey SAND: fine grained, grey, high plasticity clay			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
WB				6								
				-4								
			Sand (course grained)	7					7.3m becoming fine to coarse grained, brown, grey			
				-5								
				7.90				CH				

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-20D

Client:	**VicRoads**	Date Commenced:	**12-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**13-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.31 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335781.39 N 5790084.87**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Machine slotted HDPE with filter socks	-6				CH	Sandy CLAY: high plasticity, pale brown, fine grained sand *(continued)*	MC>PL		
				9								
				-7 9.30				SC	Clayey SAND: fine to coarse grained, brown, grey, high plasticity clay	M		
				10								
				-8								
				11								
				-9 11.30				CH	Sandy CLAY: high plasticity, mottled brown, grey, fine to medium grained sand	MC>PL		

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-20D

Client:	**VicRoads**	Date Commenced:	**12-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**13-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.31 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335781.39 N 5790084.87**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				10 11 12 13 14 15				CH	Sandy CLAY: high plasticity, mottled brown, grey, fine to medium grained sand *(continued)*	MC>PL		
				14.40				SC	Clayey SAND: fine grained, grey, pale brown, medium plasticity clay	M		

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-20D

SHEET 5 OF 5

Client:	**VicRoads**	Date Commenced:	**12-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**13-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.31 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335781.39 N 5790084.87**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			HDPE sump	14 15 17 16 19 17				SC	Clayey SAND: fine grained, grey, pale brown, medium plasticity clay *(continued)*	M		
				17.60				CH	CLAY: high plasticity, pale brown	MC>PL		TERTIARY BRIGHTON GROUP (BEAUMARIS SANDSTONE)
				18.00 18					END OF BOREHOLE AT 18.00 m			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-20S

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**13-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**13-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.28 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335780.68 N 5790086.13**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST / FB VL L MD D VD H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS			Cement Seal	2				CH	Sandy CLAY: high plasticity, black, fine grained sand	MC~PL		QUATERNARY ALLUVIUM
			Bentonite Plug	1								
		▼		2								
			Sand (course grained)	2.10				SP	SAND: fine grained, dark brown, with high plasticity clay	M		
				0								
WB			Machine slotted HDPE with filter socks	3								
				-1								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-20S

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**13-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**13-2-18**
Borehole Location:	**Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 305**	Driller:	**Earthcore**	Surface RL:	**2.28 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335780.68 N 5790086.13**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Sump	-2 / 5 / -3 / 5.40 / 6 / -4 / 6.50 / 7 / -5				SP	SAND: fine grained, dark brown, with high plasticity clay *(continued)*	M		
								SC	Clayey SAND: fine grained, grey, high plasticity clay			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
									END OF BOREHOLE AT 6.50 m			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-21D

SHEET 1 OF 5

Client:	**VicRoads**	Date Commenced:	**21-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**21-2-18**
Borehole Location:	**Soden Road**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Commaccio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.09 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336979.62 N 5789120.48**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS			Cement Seal; Bentonite Plug	2 / 0 / -1 / 1 / 2 / 3					FILL; Sandy GRAVEL: fine to coarse grained, grey, with medium plasticity clay, trace brick	D		FILL
				0.80 / 1 / 2				CH	Sandy CLAY: high plasticity, dark brown, fine grained sand	MC>PL		QUATERNARY ALLUVIUM
				2.50				CI	Sandy CLAY: medium plasticity, pale brown, fine grained sand			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-21D

Client:	**VicRoads**	Date Commenced:	**21-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**21-2-18**
Borehole Location:	**Soden Road**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Commaccio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.09 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336979.62 N 5789120.48**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Sand (course grained)	-2 5 -3 6 -4 7.00 7 -5				CI	Sandy CLAY: medium plasticity, pale brown, fine grained sand *(continued)*	MC>PL		
								SW	SAND: fine to coarse grained, pale brown, with high plasticity clay	M		

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-21D

Client:	**VicRoads**	Date Commenced:	**21-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**21-2-18**
Borehole Location:	**Soden Road**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Commaccio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.09 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336979.62 N 5789120.48**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Machine slotted HDPE with filter socks	-6 / 9 -7 / 10 -8 / 11 -9				SW	SAND: fine to coarse grained, pale brown, with high plasticity clay *(continued)*	M		

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-21D

Client:	**VicRoads**	Date Commenced:	**21-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**21-2-18**
Borehole Location:	**Soden Road**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Commaccio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.09 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336979.62 N 5789120.48**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				10 11 12 13 14 15				SW	SAND: fine to coarse grained, pale brown, with high plasticity clay *(continued)*	M		cemented seam: 13.0m to 13.4m

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-21D

Client:	**VicRoads**	Date Commenced:	**21-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**21-2-18**
Borehole Location:	**Soden Road**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Commaccio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.09 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336979.62 N 5789120.48**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			HDPE sump	14 15 16 17 18 19 17 18.00				SW	SAND: fine to coarse grained, pale brown, with high plasticity clay *(continued)*	M		
									END OF BOREHOLE AT 18.00 m			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-21S

SHEET 1 OF 2

Client:	**VicRoads**	Date Commenced:	**21-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**21-2-18**
Borehole Location:	**Soden Road**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.12 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336982.68 N 5789118.11**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (FB VL L MD VD / VS S F ST VST H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS			Cement Seal	2					Sandy GRAVEL: fine to coarse grained, grey, with medium plasticity clay	D		FILL
			Bentonite Plug	0.80 / 1				CH	Sandy CLAY: high plasticity, dark brown, fine grained sand	MC>PL		QUATERNARY ALLUVIUM
			Sand (course grained)	0 / 2								
			Machine slotted HDPE with filter socks	2.50 / -1 / 3				CI	Sandy CLAY: medium plasticity, pale brown, fine grained sand			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-21S

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**21-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**21-2-18**
Borehole Location:	**Soden Road**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.12 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336982.68 N 5789118.11**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (FB VL L MD VS S F ST VST D VD H)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS			Sump	-2 / 5 / -3 / 6 / -4 / 6.50 / 7 / -5				CI	Sandy CLAY: medium plasticity, pale brown, fine grained sand *(continued)*	MC>PL		
									END OF BOREHOLE AT 6.50 m			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-22D

SHEET 1 OF 5

Client:	VicRoads	Date Commenced:	16-2-18
Project:	Mordialloc Bypass	Date Completed:	16-2-18
Borehole Location:	Wells Rd, Aspendale Gardens	Recorded By:	MS
Project Number:	2135645A	Log Checked By:	NB

Drill Model/Mounting:	Comacchio Geo 205	Driller:	Earthcore	Surface RL:	2.09 m
Borehole Diameter:	100 mm	Driller Lic No:	0738	Co-ords:	E 336979.62 N 5789120.48

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS			Cement Seal	2 / 0.40					TOPSOIL: Sandy SILT; dark brown, fine grained sand, trace low plasticity clay	M		TOPSOIL
									FILL: Sandy CLAY: medium plasticity, dark brown, fine grained sand, trace medium grained gravel			FILL
			Bentonite Plug	0.90 / 1 / 1				SP	SAND: fine grained, brown, trace medium plasticity clay			QUATERNARY ALLUVIUM
				2.00 / 2 / 0				SP	SAND: fine grained, black, with medium plasticity clay			
WB				3 / -1 / 3.10				SP	SAND: fine grained, trace coarse grained sand, trace organics			
				3.90				SP				

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-22D

Client:	**VicRoads**	Date Commenced:	**16-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**16-2-18**
Borehole Location:	**Wells Rd, Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.09 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336979.62 N 5789120.48**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				-2 / 5				SP	SAND: fine grained, grey, organics throughout *(continued)*	M		
				-3					5.4-5.6m clay seam			
				-4 / 6								
				6.80				SW	SAND: fine to coarse grained, grey, with high plasticity clay, trace organics			
				-5 / 7								
			Sand (course grained)	7.50				SP	SAND: fine grained, grey, trace high plasticity clay, trace medium to coarse grained sand			TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-22D

Client:	**VicRoads**	Date Commenced:	**16-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**16-2-18**
Borehole Location:	**Wells Rd, Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.09 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336979.62 N 5789120.48**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Machine slotted HDPE with filter socks	-6 / 9 -7 / 10 -8 / 11 -9				SP	SAND: fine grained, grey, trace high plasticity clay, trace medium to coarse grained sand *(continued)*	M		

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-22D

Client:	**VicRoads**	Date Commenced:	**16-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**16-2-18**
Borehole Location:	**Wells Rd, Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.09 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336979.62 N 5789120.48**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				10				SP	SAND: fine grained, grey, trace high plasticity clay, trace medium to coarse grained sand *(continued)*	M		
				11								
WB				13								
				12								
				14								
				13								
				15								
				15.50				SP	SAND: fine to coarse grained, grey, trace organics			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-22D

SHEET 5 OF 5

Client:	**VicRoads**	Date Commenced:	**16-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**16-2-18**
Borehole Location:	**Wells Rd, Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.09 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 336979.62 N 5789120.48**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			HDPE sump	-14 / 17				SP	SAND: fine to coarse grained, grey, trace organics *(continued)*	M		
				-15								
				-16 / 18.00 / 18					END OF BOREHOLE AT 18.00 m			
				-17 / 19								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-22S

Client:	**VicRoads**	Date Commenced:	**19-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**19-2-18**
Borehole Location:	**Wells Rd, Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.53 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335793.75 N 5789572.16**

Borehole Information

1 METHOD	2 SUPPORT	3 WATER	4 WELL CONSTRUCTION	5 RL(m)	5 DEPTH(m)	6 FIELD TEST	7 SAMPLE
AS			Cement Seal; Bentonite Plug; Sand (course grained); Machine slotted HDPE with filter socks	2 1 0 -1	0.40 0.80 1 2.00 2 3 3.10		
WB							

Field Material Description

8 GRAPHIC LOG	9 USC SYMBOL	10 SOIL/ROCK MATERIAL FIELD DESCRIPTION	11 MOISTURE	12 RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	13 STRUCTURE AND ADDITIONAL OBSERVATIONS
		TOPSOIL: Sandy SILT; dark brown, fine grained sand, trace low plasticity clay	M		TOPSOIL
		FILL: Sandy CLAY; medium plasticity, dark brown, fine grained sand, trace medium grained gravel			FILL
	SP	SAND: fine grained, brown, trace medium plasticity clay			QUATERNARY ALLUVIUM
	SP	SAND: fine grained, black, with medium plasticity clay			
	SP	SAND: fine grained, grey, trace coarse grained sand, trace organics			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-22S

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**19-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**19-2-18**
Borehole Location:	**Wells Rd, Aspendale Gardens**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Comacchio Geo 205**	Driller:	**Earthcore**	Surface RL:	**2.53 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335793.75 N 5789572.16**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Sump	4.00				SP	SAND: fine grained, grey, organics throughout	M		
									5.4-5.6m clay seam			
				6.50					END OF BOREHOLE AT 6.50 m			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-23D

SHEET 1 OF 5

Client:	**VicRoads**	Date Commenced:	**15-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**15-2-18**
Borehole Location:	**Edithvale Wetlands**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Commaccio Geo 205**	Driller:	**Earthcore**	Surface RL:	**1.21 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335386.75 N 5789497.11**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
AS		▼	Cement Seal	1					TOPSOIL; Clayey SILT: dark brown, organic, roots throughout, low plasticity clay	M		TOPSOIL
				0.40				SP	SAND: fine grained, grey, trace medium plasticity clay			QUATERNARY ALLUVIUM
			Bentonite Plug	0								
				1								
				2.00 2				SP	SAND: fine grained, grey, trace medium plasticity clay, trace coarse grained gravel	W		
				-1								
				3								
WB				-2								
				3.50				ML	Sandy SILT: brown, black, organics, fine grained sand			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-23D

Client:	**VicRoads**	Date Commenced:	**15-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**15-2-18**
Borehole Location:	**Edithvale Wetlands**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Commaccio Geo 205**	Driller:	**Earthcore**	Surface RL:	**1.21 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335386.75 N 5789497.11**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
				-3 / 5				ML	Sandy SILT: brown, black, organics, fine grained sand *(continued)*	W		
				-4 / 5.30				SC	Clayey SAND: fine to coarse grained, grey, high plasticity clay			
WB			Sand (course grained)	5.70 / 6				CH	Sandy CLAY: high plasticity, grey, fine to medium grained sand	MC>PL		TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
				-5					6.4m becoming fine grained sand			
				7								
				-6					7.4m becoming fine to coarse grained sand			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-23D

Client:	**VicRoads**	Date Commenced:	**15-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**15-2-18**
Borehole Location:	**Edithvale Wetlands**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Commaccio Geo 205**	Driller:	**Earthcore**	Surface RL:	**1.21 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335386.75 N 5789497.11**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Machine slotted HDPE with filter socks	-7				CH	Sandy CLAY: high plasticity, grey, fine to medium grained sand *(continued)*	MC>PL		
				9					8.2m becoming fine grained sand, grey, brown			
				-8					9.0m becoming fine to coarse grained sand			
				9.40				SC	Clayey SAND: fine to coarse grained, brown, grey, high plasticity clay	W		
				10								
				-9								
				11								
				-10								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-23D

SHEET 4 OF 5

Client:	**VicRoads**	Date Commenced:	**15-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**15-2-18**
Borehole Location:	**Edithvale Wetlands**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Commaccio Geo 205**	Driller:	**Earthcore**	Surface RL:	**1.21 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335386.75 N 5789497.11**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB				11 12.60 13 12 14 13 14.20 15 14				SC	Clayey SAND: fine to coarse grained, brown, grey, high plasticity clay *(continued)*	W		
								SP	SAND: fine grained, grey, trace high plasticity clay			
								CH	Sandy CLAY: high plasticity, red, grey, fine grained sand	MC>PL		
									15.4m becoming fine to coarse grained sand			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-23D

SHEET 5 OF 5

Client:	**VicRoads**	Date Commenced:	**15-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**15-2-18**
Borehole Location:	**Edithvale Wetlands**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Commaccio Geo 205**	Driller:	**Earthcore**	Surface RL:	**1.21 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335386.75 N 5789497.11**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			HDPE sump	15 16 17 18 19				CH	Sandy CLAY: high plasticity, red, grey, fine grained sand *(continued)*	MC>PL		
				17.50				SW	SAND: fine to coarse grained, brown, grey, trace medium plasticity clay	W		
				18.00					END OF BOREHOLE AT 18.00 m			

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-23S

Client:	**VicRoads**	Date Commenced:	**16-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**16-2-18**
Borehole Location:	**Edithvale Wetlands**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Commaccio Geo 205**	Driller:	**Earthcore**	Surface RL:	**1.17 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335382.52 N 5789500.91**

Borehole Information							Field Material Description					
1	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
			Cement Seal	1					Clayey SILT: dark brown, organic, grass roots, low plasticity clay	M		TOPSOIL
				0.40				SP	SAND: fine grained, grey			QUATERNARY ALLUVIUM
			Bentonite Plug	0								
AS		▼	Sand (course grained)	2 / -1								
			Machine slotted HDPE with filter socks	3 / -2								
				3.40				ML	Sandy SILT: brown, black, organics, fine grained sand	W		

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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BOREHOLE NO.

BOREHOLE ENVIRONMENTAL LOG GW18-26-23S

SHEET 2 OF 2

Client:	**VicRoads**	Date Commenced:	**16-2-18**
Project:	**Mordialloc Bypass**	Date Completed:	**16-2-18**
Borehole Location:	**Edithvale Wetlands**	Recorded By:	**MS**
Project Number:	**2135645A**	Log Checked By:	**NB**

Drill Model/Mounting:	**Commaccio Geo 205**	Driller:	**Earthcore**	Surface RL:	**1.17 m**
Borehole Diameter:	**100 mm**	Driller Lic No:	**0738**	Co-ords:	**E 335382.52 N 5789500.91**

Borehole Information							Field Material Description					
	2	3	4	5	6	7	8	9	10	11	12	13
METHOD	SUPPORT	WATER	WELL CONSTRUCTION	RL(m) / DEPTH(m)	FIELD TEST	SAMPLE	GRAPHIC LOG	USC SYMBOL	SOIL/ROCK MATERIAL FIELD DESCRIPTION	MOISTURE	RELATIVE DENSITY /CONSISTENCY (VS S F ST VST H / FB VL L MD D VD)	STRUCTURE AND ADDITIONAL OBSERVATIONS
WB			Sump	-3 / 5				ML	Sandy SILT: brown, black, organics, fine grained sand *(continued)*	W		
				-4 / 5.30				SC	Clayey SAND: fine to coarse grained, grey, high plasticity clay			
				5.70 / 6				CH	Sandy CLAY: high plasticity, grey, fine to coarse grained sand	MC>PL		TERTIARY BRIGHTON GROUP (RED BLUFF FORMATION)
				-5 / 6.50					END OF BOREHOLE AT 6.50 m			
				7								
				-6								

This borehole log should be read in conjunction with WSP's accompanying standard notes.

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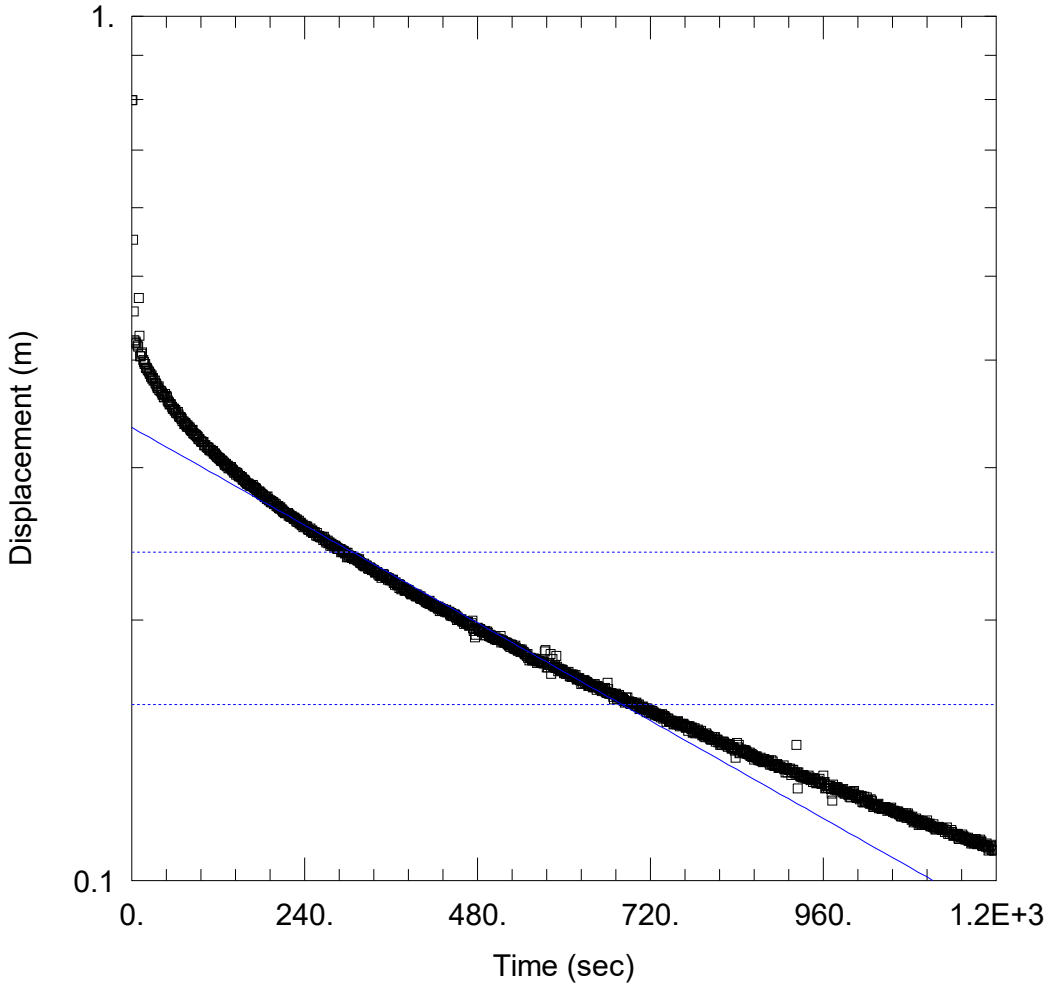
APPENDIX B

GROUNDWATER MONITORING DATA



GW17-26-01 FHT1

Data Set: \...\1_FHT1_v3.aqt
Date: 05/04/18 Time: 14:59:31

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-01
Test Date: 6/10/17

AQUIFER DATA

Saturated Thickness: 4.217 m Anisotropy Ratio (Kz/Kr): 1.

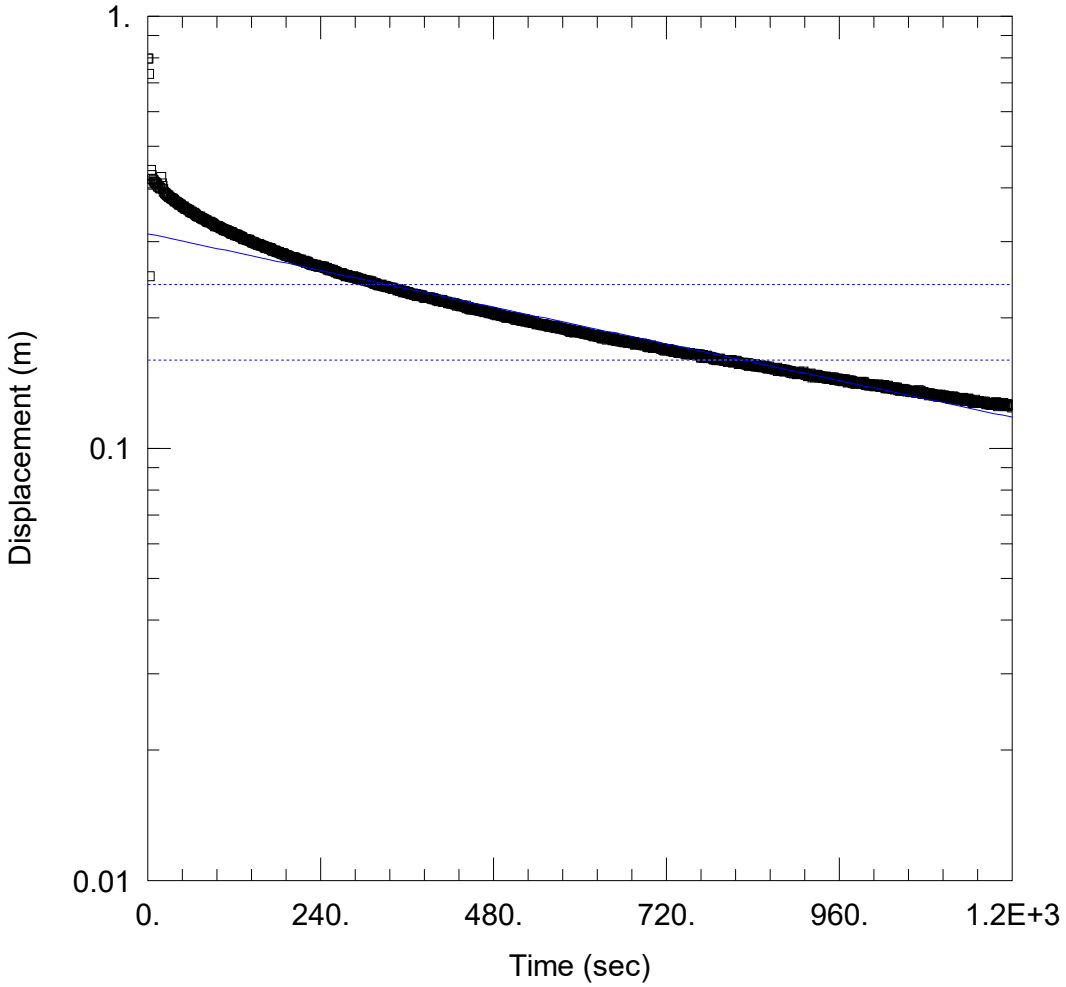
WELL DATA (GW17-26-01)

Initial Displacement: 0.799 m
Total Well Penetration Depth: 4.217 m
Casing Radius: 0.025 m
Static Water Column Height: 4.217 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.03278 m/day
y0 = 0.3342 m



GW17-26-01 FHT2

Data Set: \...\1_FHT2.aqt
Date: 05/04/18 Time: 14:50:16

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-01
Test Date: 6/10/17

AQUIFER DATA

Saturated Thickness: 4.217 m Anisotropy Ratio (Kz/Kr): 1.

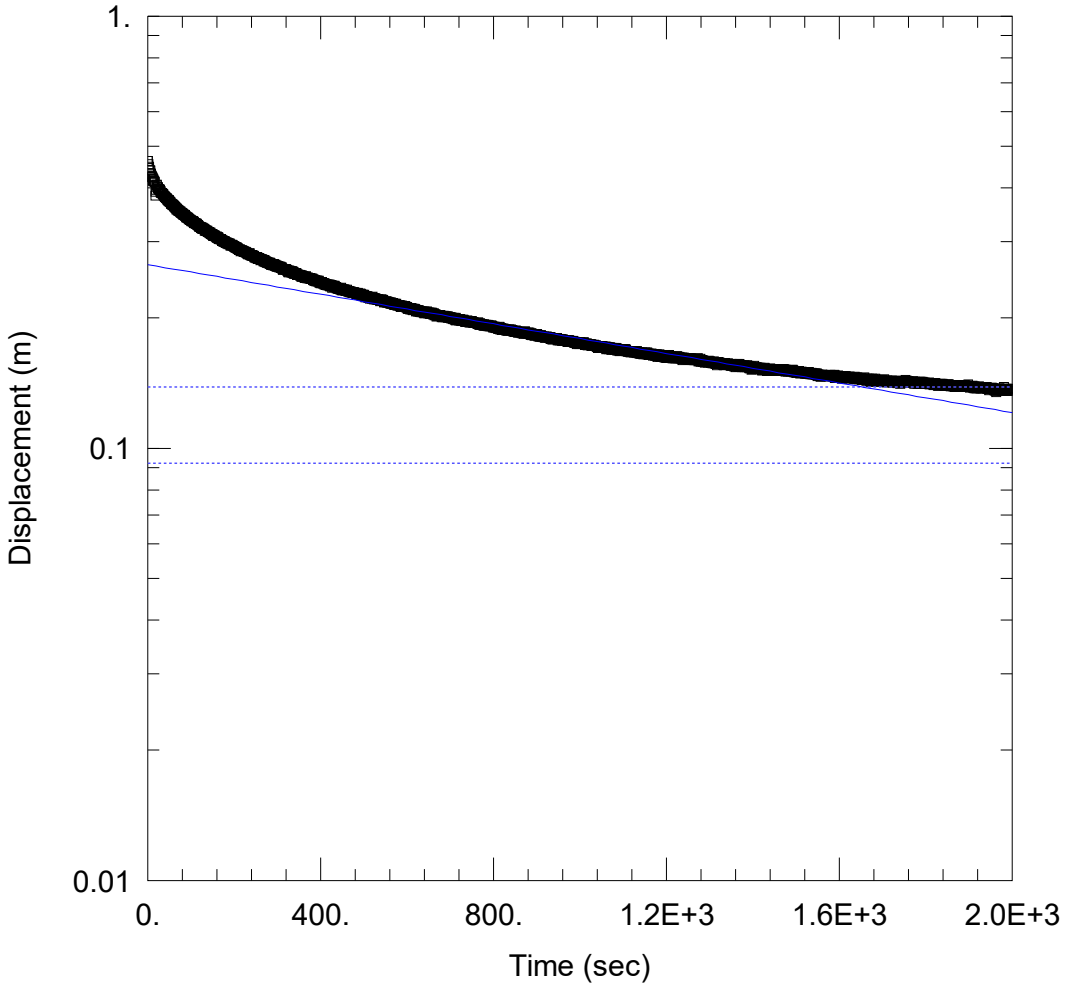
WELL DATA (GW17-26-01)

Initial Displacement: 0.7979 m
Total Well Penetration Depth: 4.217 m
Casing Radius: 0.025 m
Static Water Column Height: 4.217 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.02463 m/day
y0 = 0.3135 m



GW17-26-01 RHT1

Data Set: \...\1_RHT1_v3.aqt
Date: 05/09/18 Time: 12:23:58

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-01
Test Date: 6/10/17

AQUIFER DATA

Saturated Thickness: 4.217 m Anisotropy Ratio (Kz/Kr): 1.

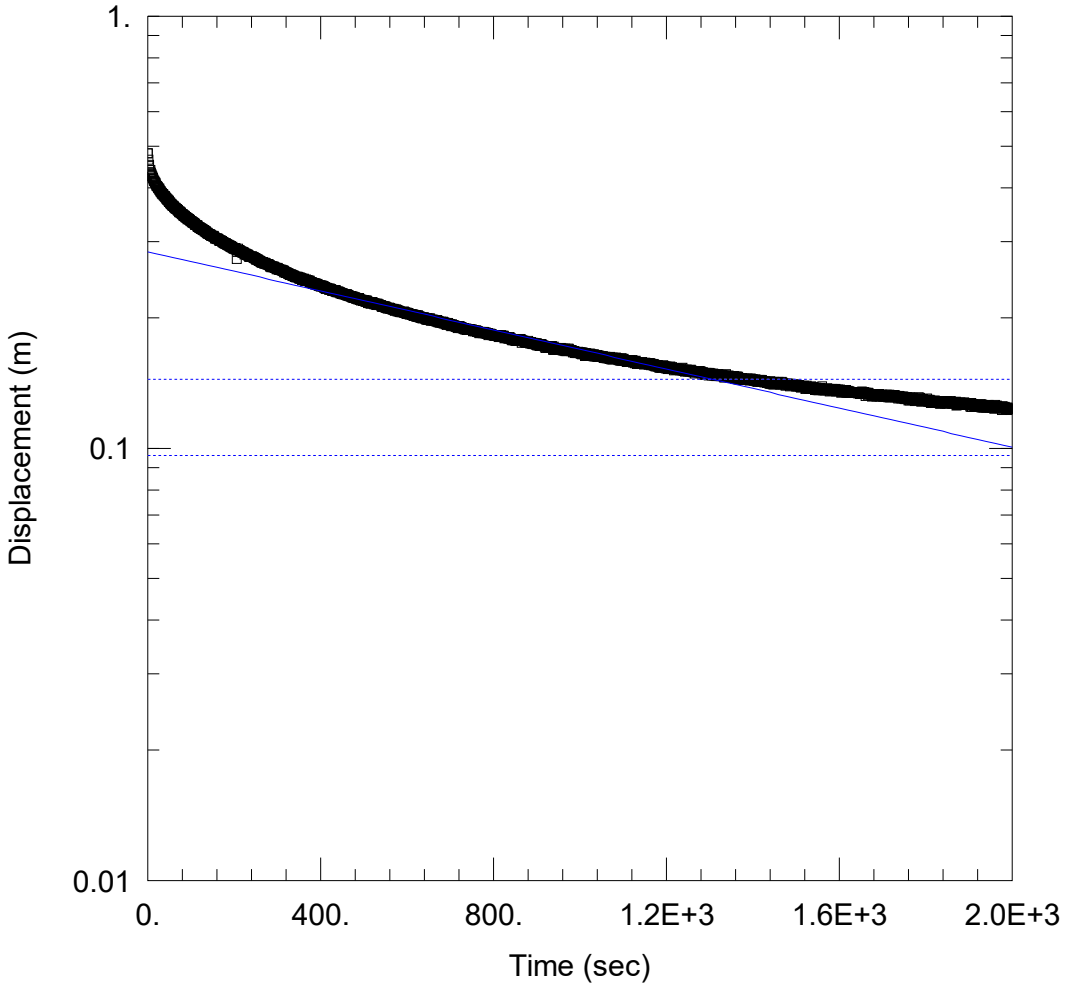
WELL DATA (GW17-26-01)

Initial Displacement: 0.4622 m Static Water Column Height: 4.217 m
Total Well Penetration Depth: 4.217 m Screen Length: 3. m
Casing Radius: 0.025 m Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.01191 m/day y0 = 0.2658 m



GW17-26-01 RHT2

Data Set: \...\1_RHT2_v3.aqt
Date: 05/09/18 Time: 12:29:26

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-01
Test Date: 6/10/17

AQUIFER DATA

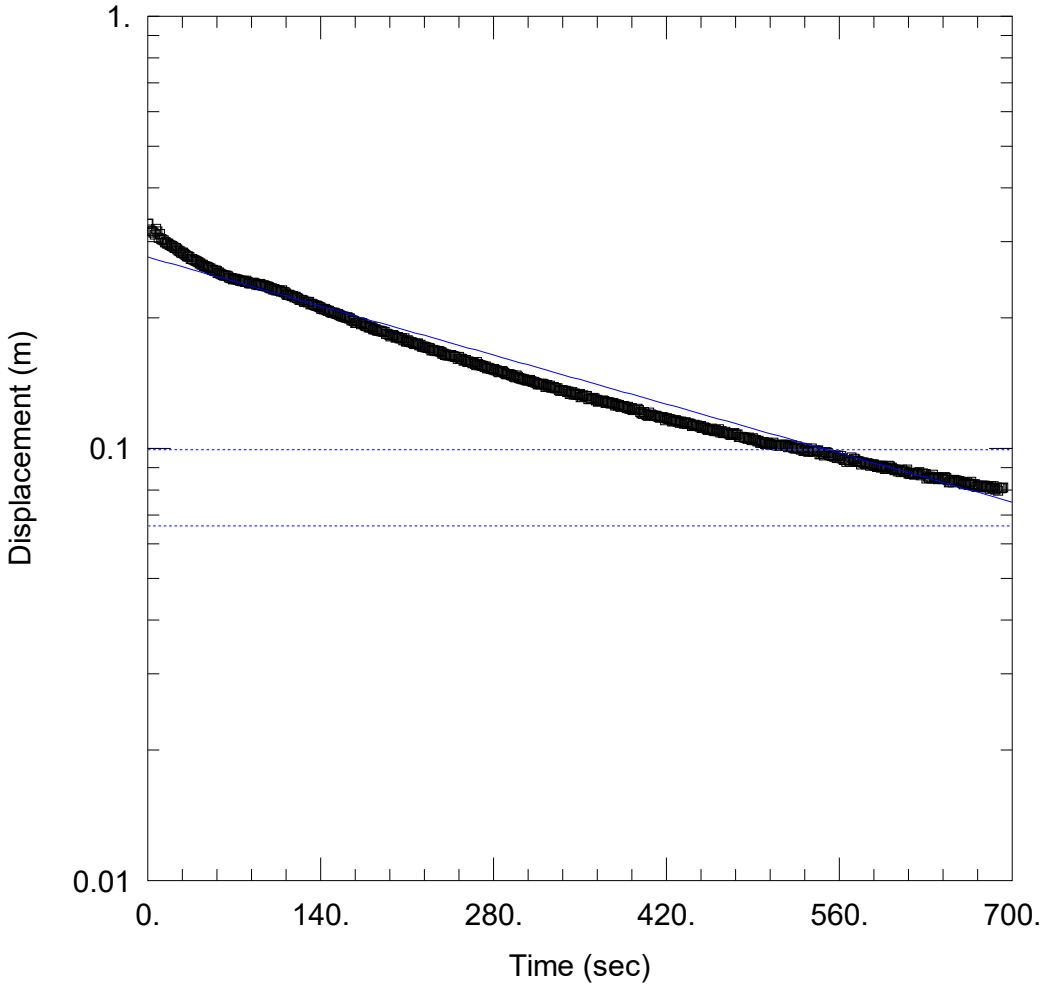
Saturated Thickness: 4.217 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW17-26-01)

Initial Displacement: 0.4805 m
Total Well Penetration Depth: 4.217 m
Casing Radius: 0.025 m
Static Water Column Height: 4.217 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.01572 m/day
y0 = 0.2847 m



GW17-26-02 FHT2

Data Set: \...\2_FHT2.aqt
Date: 05/09/18 Time: 14:04:34

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-02
Test Date: 2/10/17

AQUIFER DATA

Saturated Thickness: 8.929 m Anisotropy Ratio (Kz/Kr): 1.

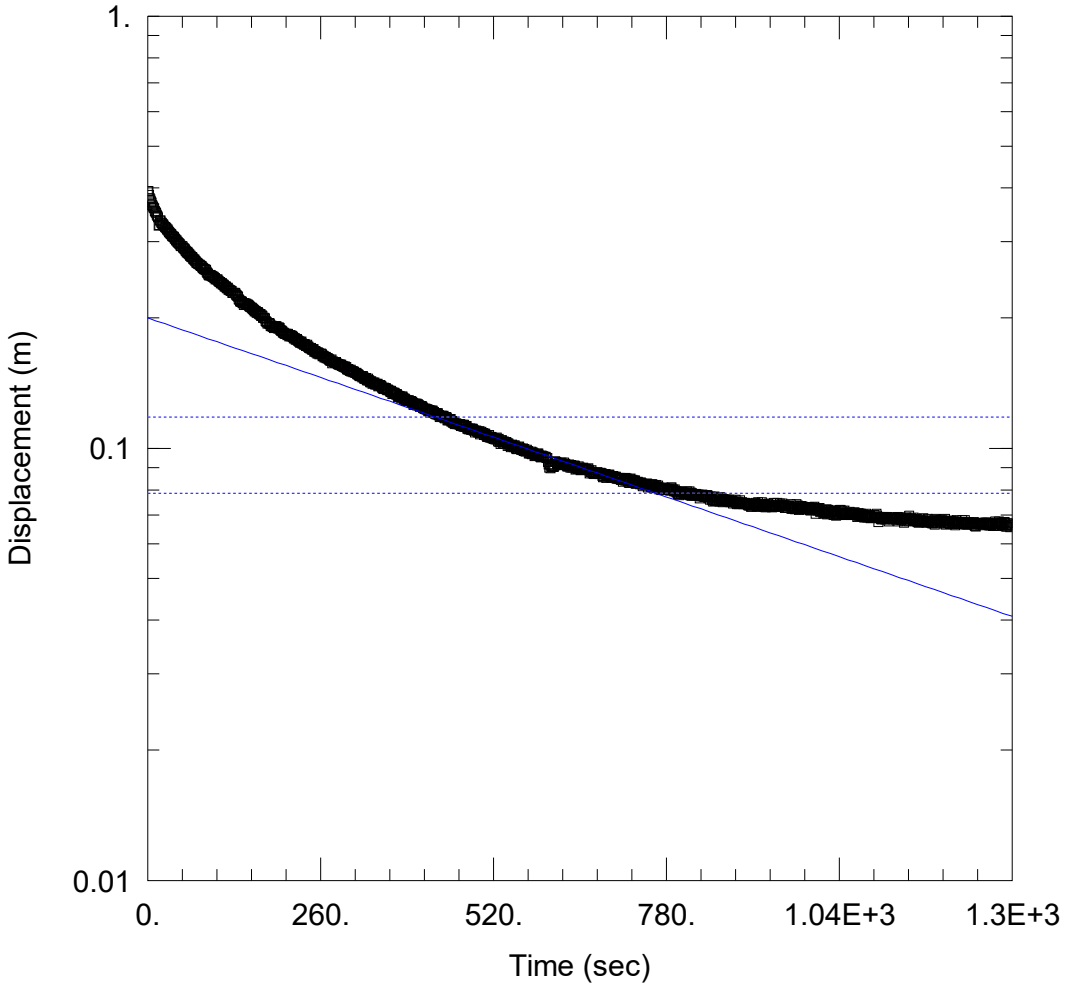
WELL DATA (GW17-26-02)

Initial Displacement: 0.3303 m Static Water Column Height: 8.929 m
Total Well Penetration Depth: 8.929 m Screen Length: 3. m
Casing Radius: 0.025 m Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.06408 m/day y0 = 0.2768 m



GW17-26-02 RHT1

Data Set: \...\2_RHT1.aqt
Date: 05/09/18 Time: 13:35:43

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-02
Test Date: 2/10/17

AQUIFER DATA

Saturated Thickness: 8.929 m Anisotropy Ratio (Kz/Kr): 1.

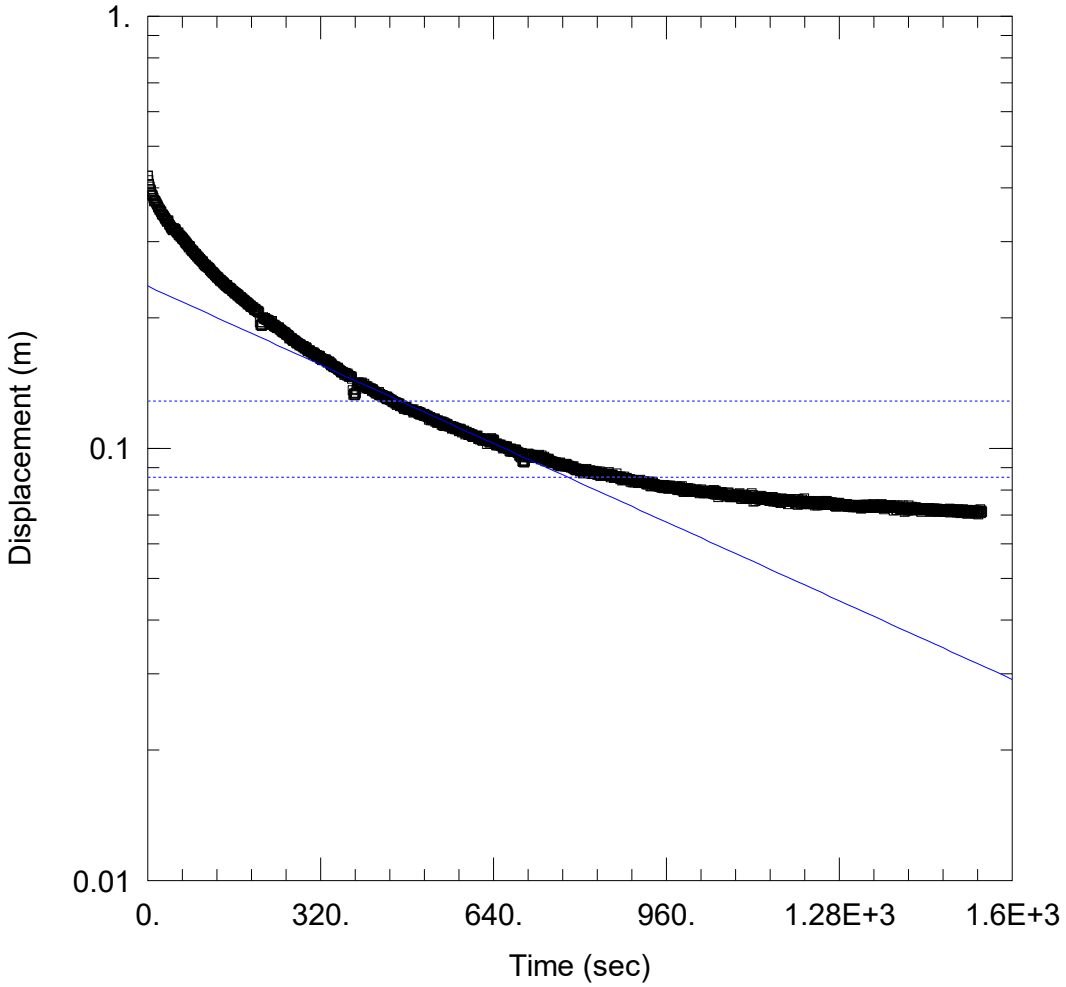
WELL DATA (GW17-26-02)

Initial Displacement: 0.3928 m
Total Well Penetration Depth: 8.929 m
Casing Radius: 0.025 m
Static Water Column Height: 8.929 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.04205 m/day
y0 = 0.2003 m



GW17-26-02 RHT2

Data Set: \...\2_RHT2.aqt
Date: 05/04/18 Time: 15:25:28

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-02
Test Date: 2/10/17

AQUIFER DATA

Saturated Thickness: 8.929 m Anisotropy Ratio (Kz/Kr): 1.

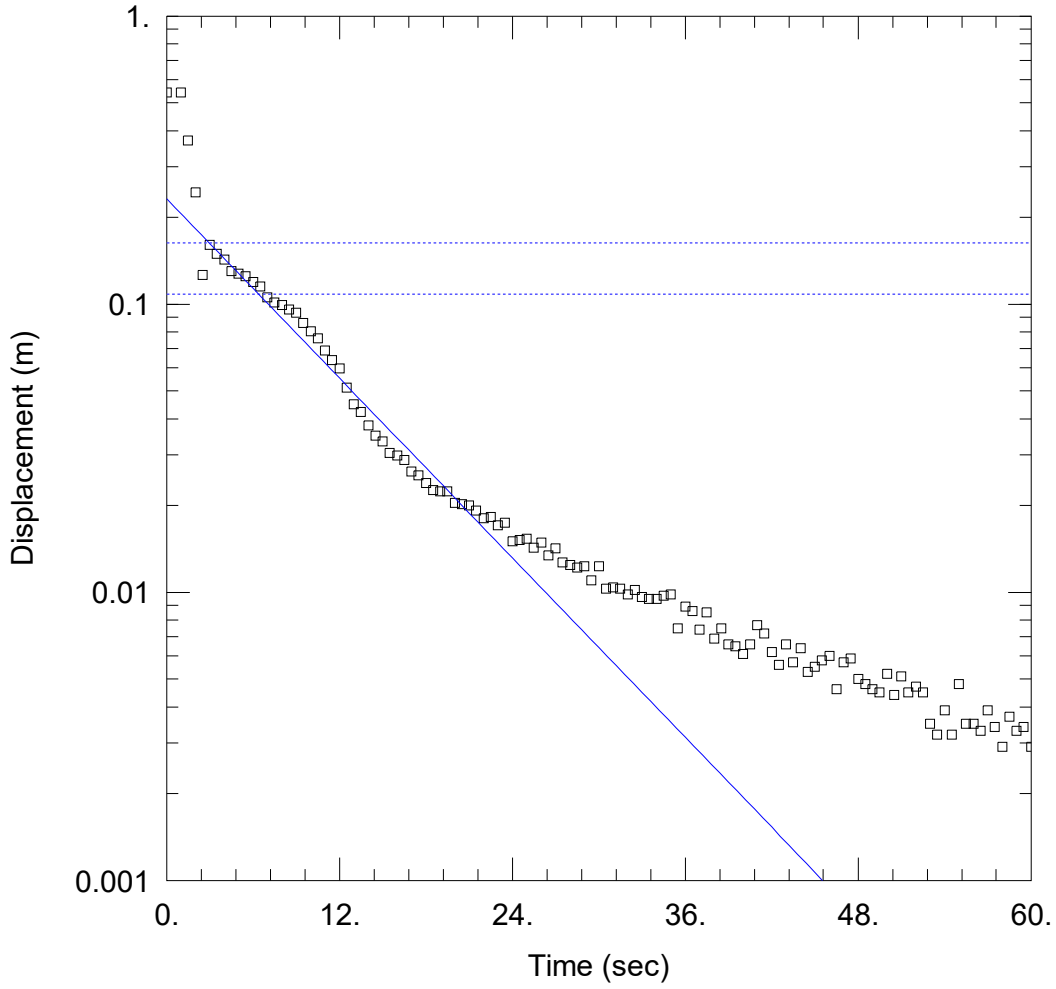
WELL DATA (GW17-26-02)

Initial Displacement: 0.4276 m
Total Well Penetration Depth: 8.929 m
Casing Radius: 0.025 m
Static Water Column Height: 8.929 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.04498 m/day
y0 = 0.2371 m



GW17-26-03 FHT1

Data Set: \...\3_FHT1_B.aqt
Date: 05/09/18 Time: 14:12:25

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-03
Test Date: 23/11/17

AQUIFER DATA

Saturated Thickness: 5.205 m Anisotropy Ratio (Kz/Kr): 1.

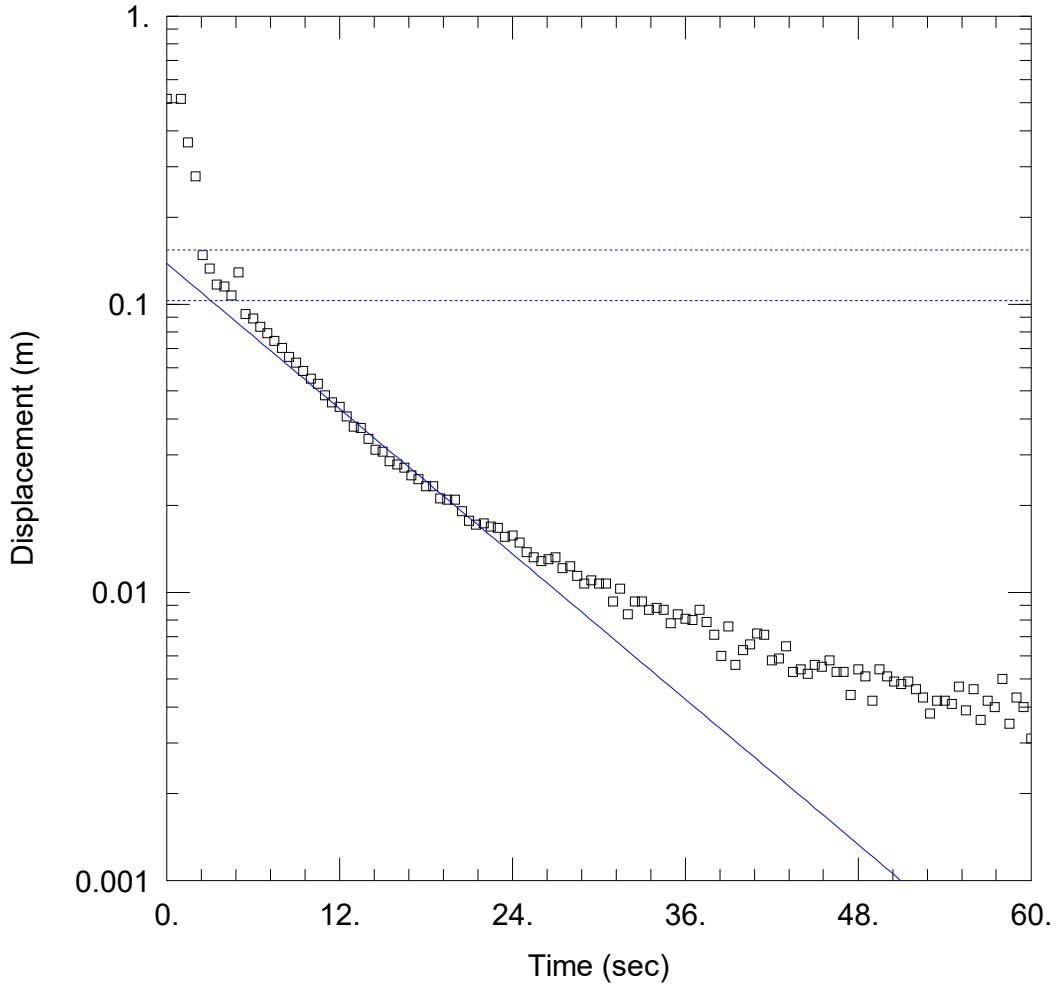
WELL DATA (GW17-26-03)

Initial Displacement: 0.5425 m
Total Well Penetration Depth: 6.8 m
Casing Radius: 0.025 m
Static Water Column Height: 5.205 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 3.933 m/day
y0 = 0.2325 m



GW17-26-03 FHT2

Data Set: \...\3_FHT2_B.aqt
Date: 05/09/18 Time: 14:07:51

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-03
Test Date: 23/11/17

AQUIFER DATA

Saturated Thickness: 5.205 m Anisotropy Ratio (Kz/Kr): 1.

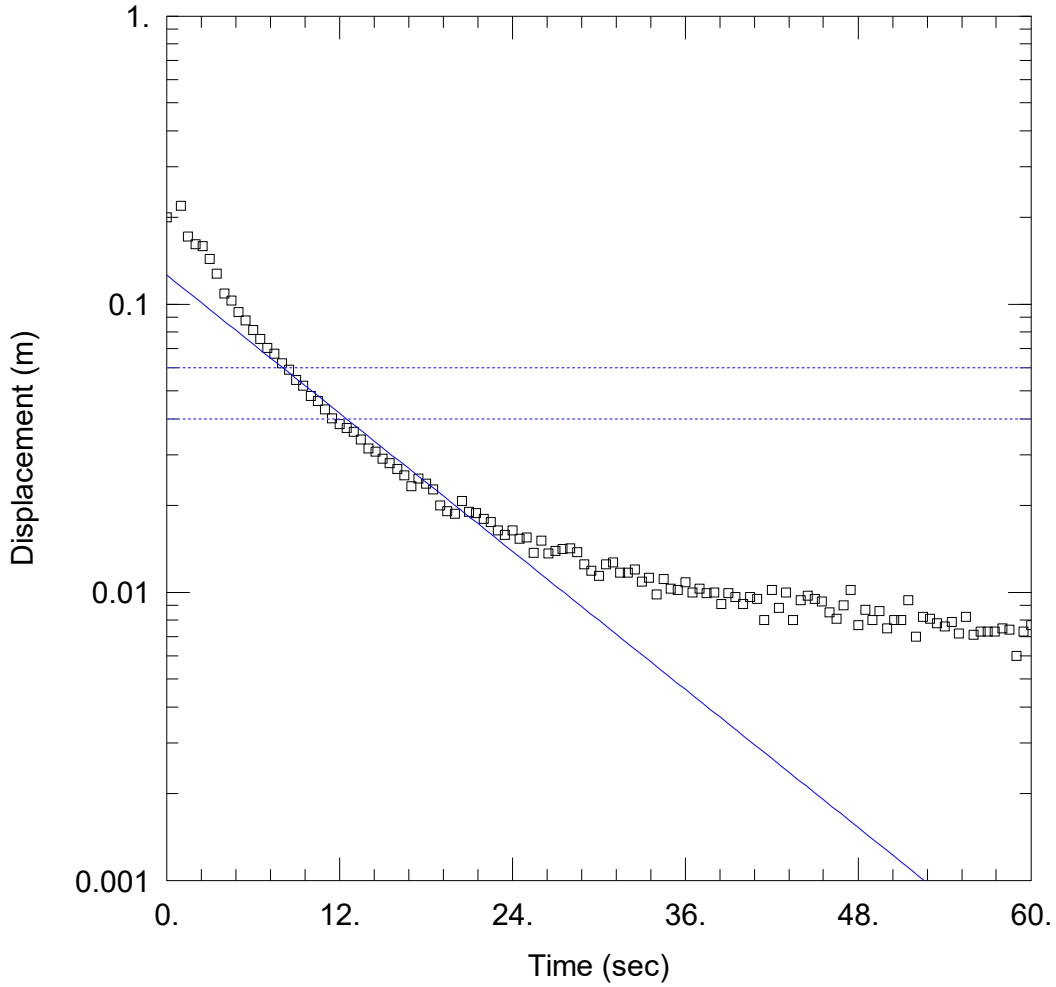
WELL DATA (GW17-26-03)

Initial Displacement: 0.5144 m
Total Well Penetration Depth: 6.8 m
Casing Radius: 0.025 m
Static Water Column Height: 5.205 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 3.181 m/day
y0 = 0.1385 m



GW17-26-03 RHT1

Data Set: \...\3_RHT1_B.aqt
Date: 05/09/18 Time: 14:16:04

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-03
Test Date: 23/11/17

AQUIFER DATA

Saturated Thickness: 5.205 m Anisotropy Ratio (Kz/Kr): 1.

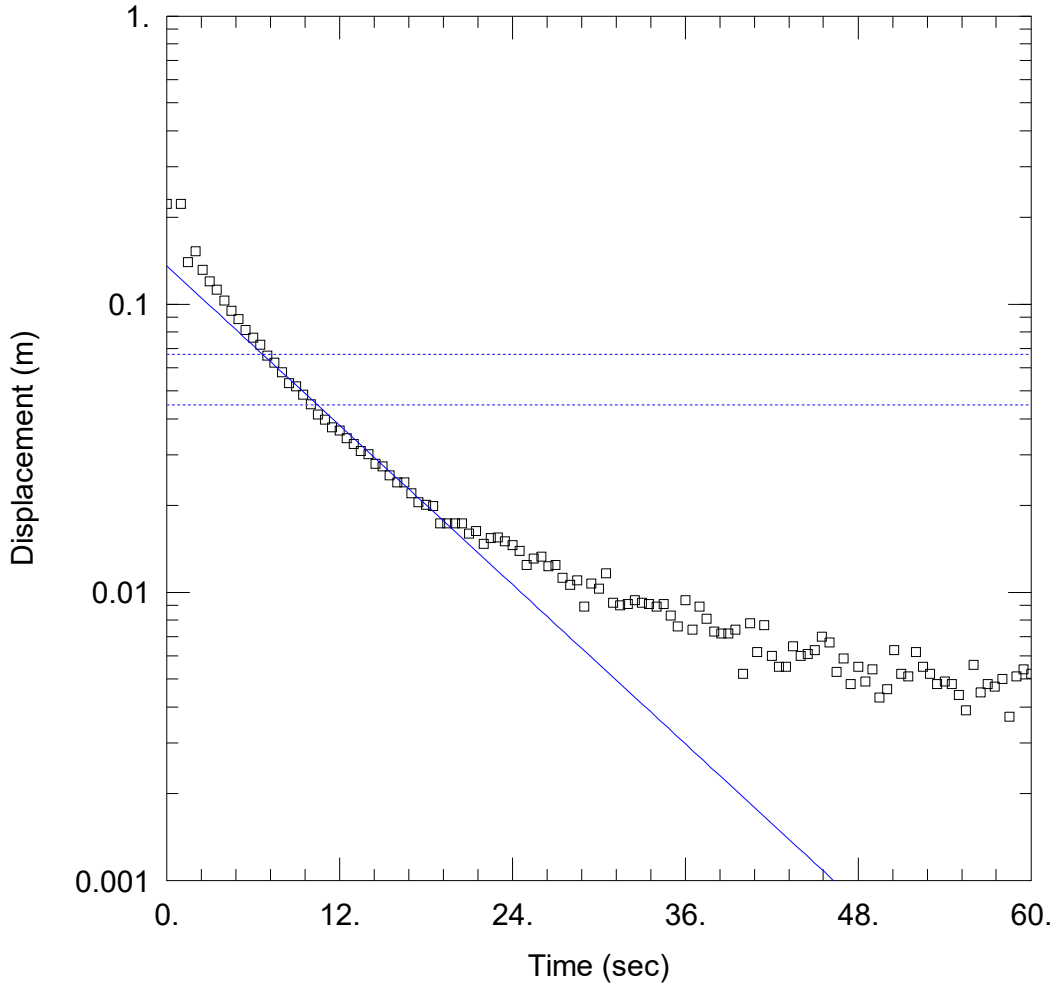
WELL DATA (GW17-26-03)

Initial Displacement: 0.2 m
Total Well Penetration Depth: 6.8 m
Casing Radius: 0.025 m
Static Water Column Height: 5.205 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 3.025 m/day
y0 = 0.1262 m



GW17-26-03 RHT2

Data Set: \...\3_RHT2_B.aqt
Date: 05/09/18 Time: 14:13:32

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-03
Test Date: 23/11/17

AQUIFER DATA

Saturated Thickness: 3.01 m Anisotropy Ratio (Kz/Kr): 1.

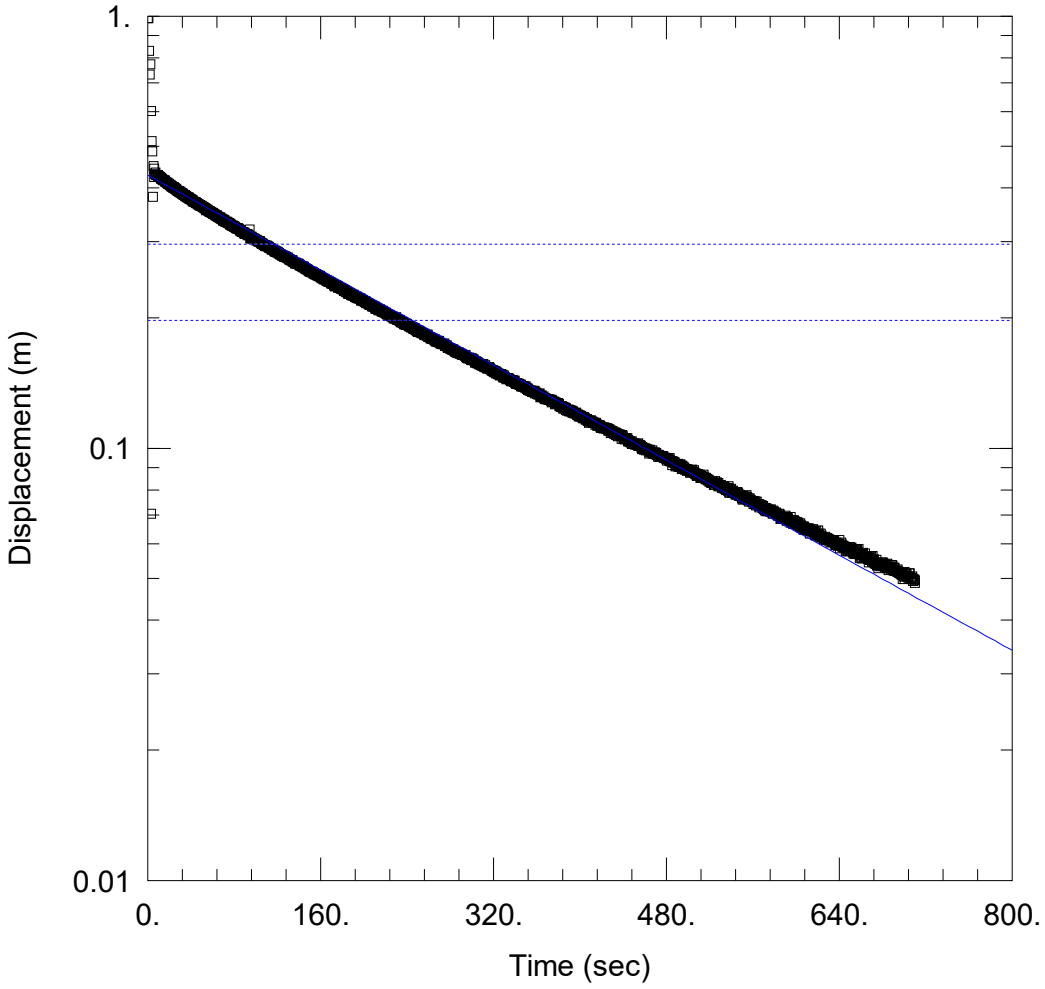
WELL DATA (GW17-26-03)

Initial Displacement: 0.2229 m
Total Well Penetration Depth: 6.8 m
Casing Radius: 0.025 m
Static Water Column Height: 3.01 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 3.489 m/day
y0 = 0.1357 m



GW17-26-04 FHT

Data Set: \...\4_FHT1_B.aqt
Date: 05/04/18 Time: 15:43:16

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-04
Test Date: 31/08/17

AQUIFER DATA

Saturated Thickness: 5.99 m Anisotropy Ratio (Kz/Kr): 1.

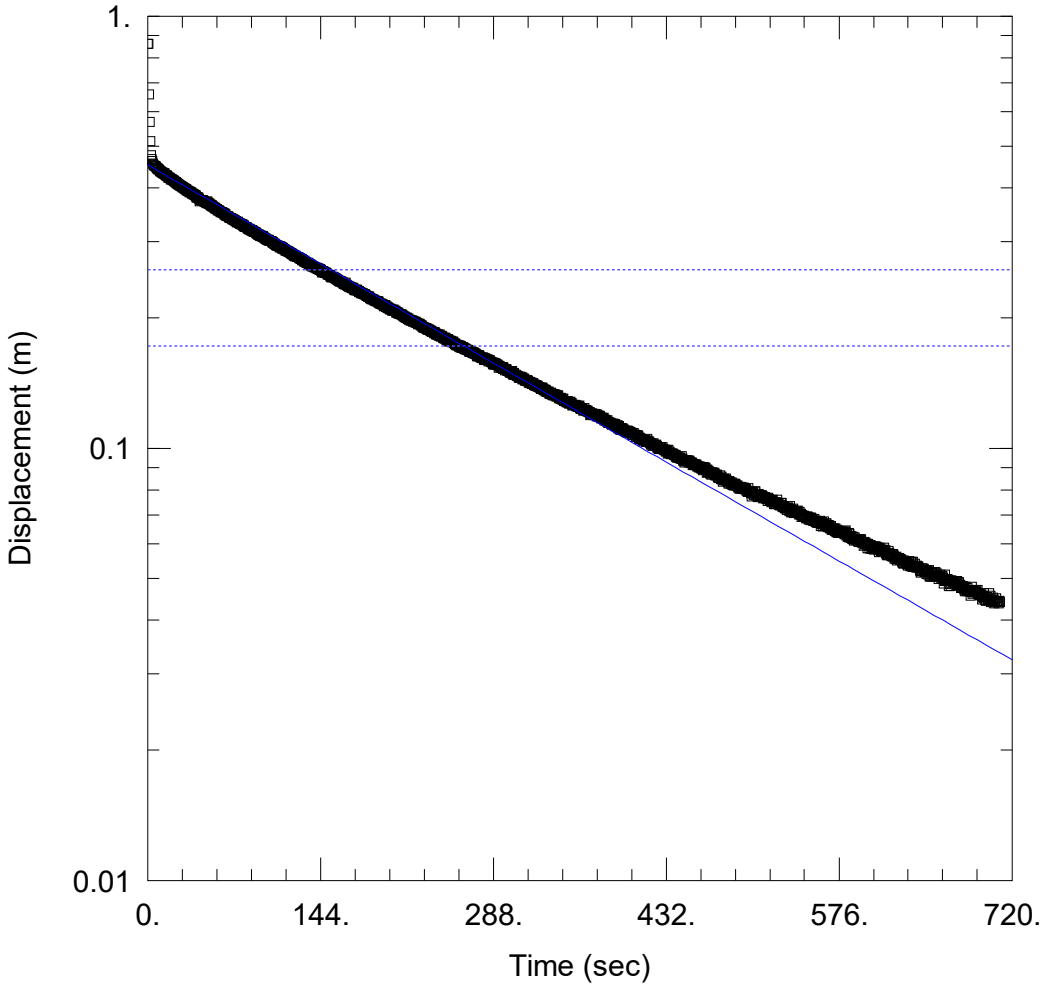
WELL DATA (GW17-26-04)

Initial Displacement: 0.9879 m Static Water Column Height: 5.99 m
Total Well Penetration Depth: 5.485 m Screen Length: 3. m
Casing Radius: 0.025 m Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.09156 m/day y0 = 0.4289 m



GW17-26-04 RHT

Data Set: \...\4_RHT1_B.aqt
Date: 05/04/18 Time: 15:42:54

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-04
Test Date: 31/08/17

AQUIFER DATA

Saturated Thickness: 5.99 m Anisotropy Ratio (Kz/Kr): 1.

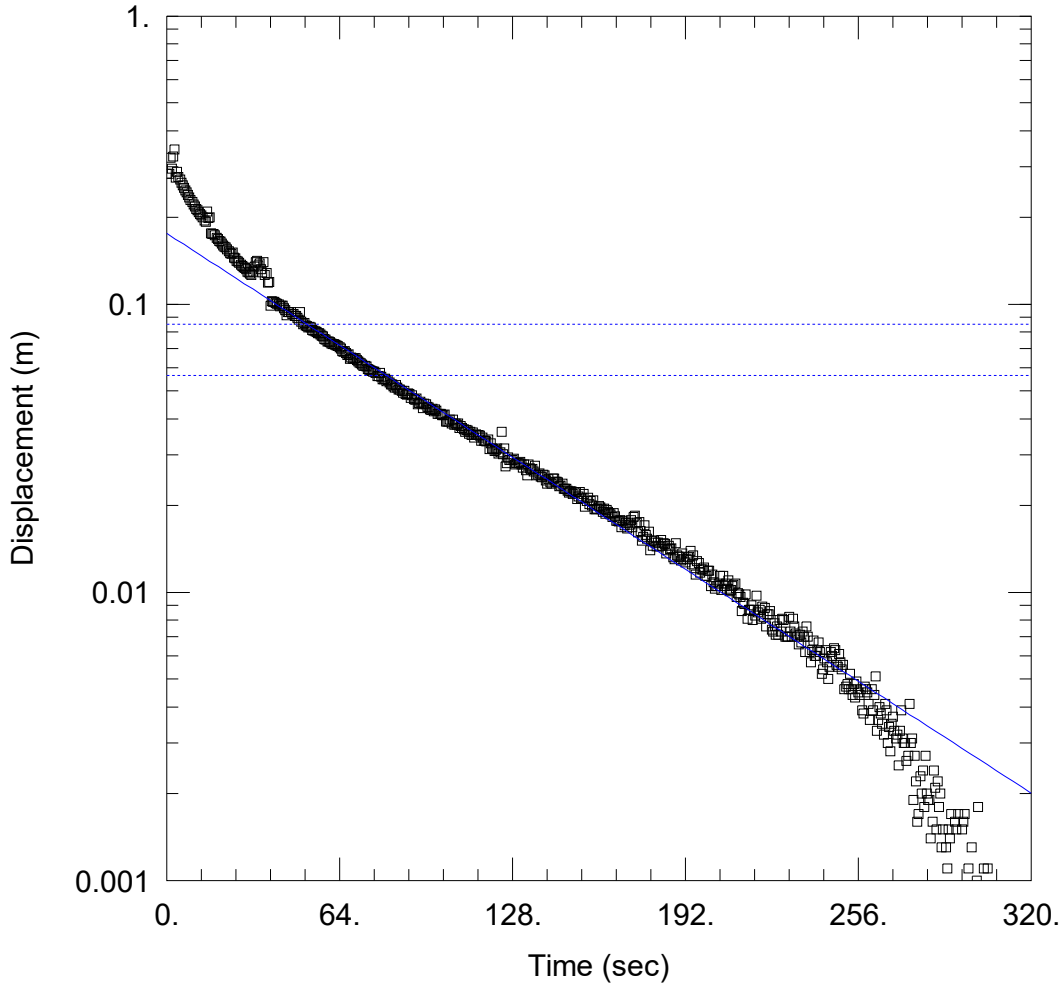
WELL DATA (GW17-26-04)

Initial Displacement: 0.8621 m Static Water Column Height: 5.99 m
Total Well Penetration Depth: 5.485 m Screen Length: 3. m
Casing Radius: 0.025 m Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined Solution Method: Bouwer-Rice

K = 0.1059 m/day y0 = 0.4519 m



GW17-26-05 FHT

Data Set: \...\5_FHT1_B.aqt
Date: 05/04/18 Time: 15:51:53

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-05
Test Date: 31/08/17

AQUIFER DATA

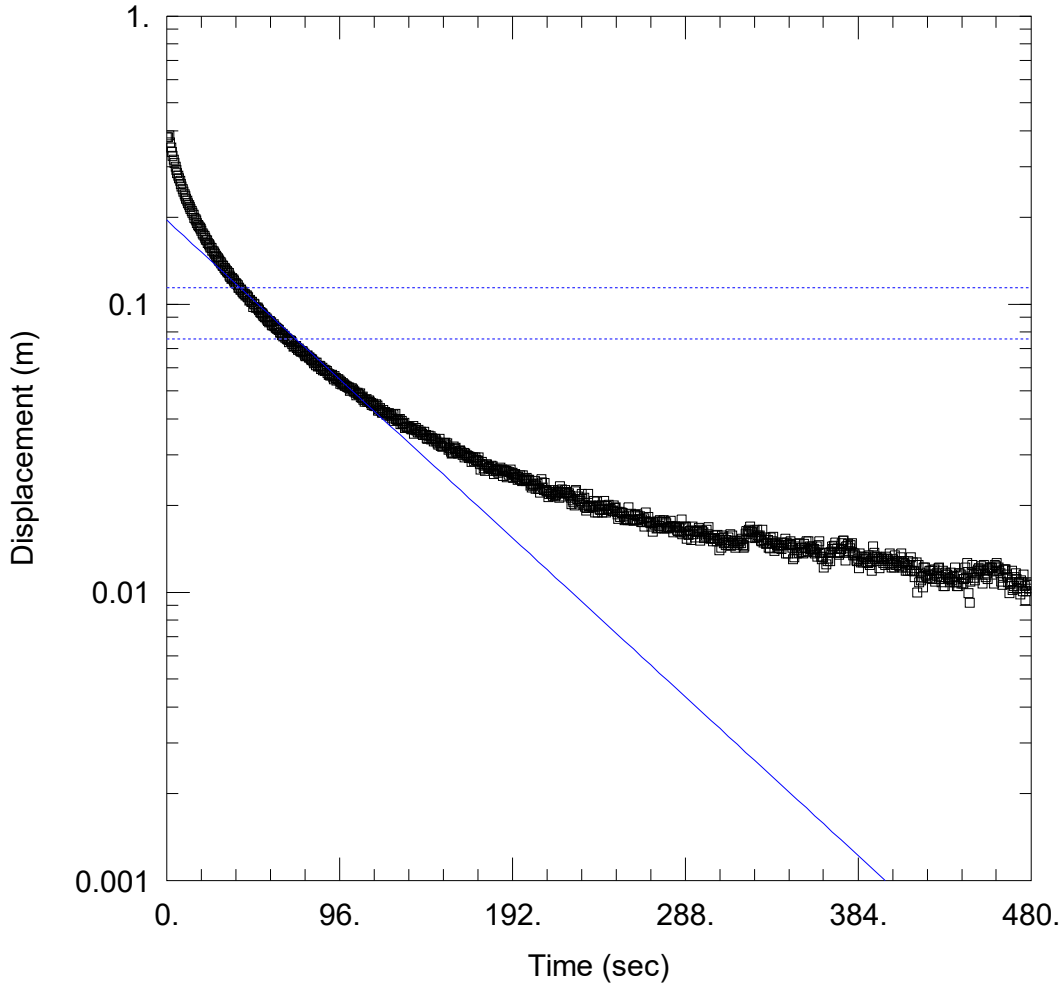
Saturated Thickness: 5.48 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW17-26-05)

Initial Displacement: 0.2831 m
Total Well Penetration Depth: 5.665 m
Casing Radius: 0.025 m
Static Water Column Height: 5.48 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.4454 m/day
y0 = 0.176 m



GW17-26-05 RHT

Data Set: \...\5_RHT1_B.aqt
Date: 05/04/18 Time: 15:50:43

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-05
Test Date: 31/08/17

AQUIFER DATA

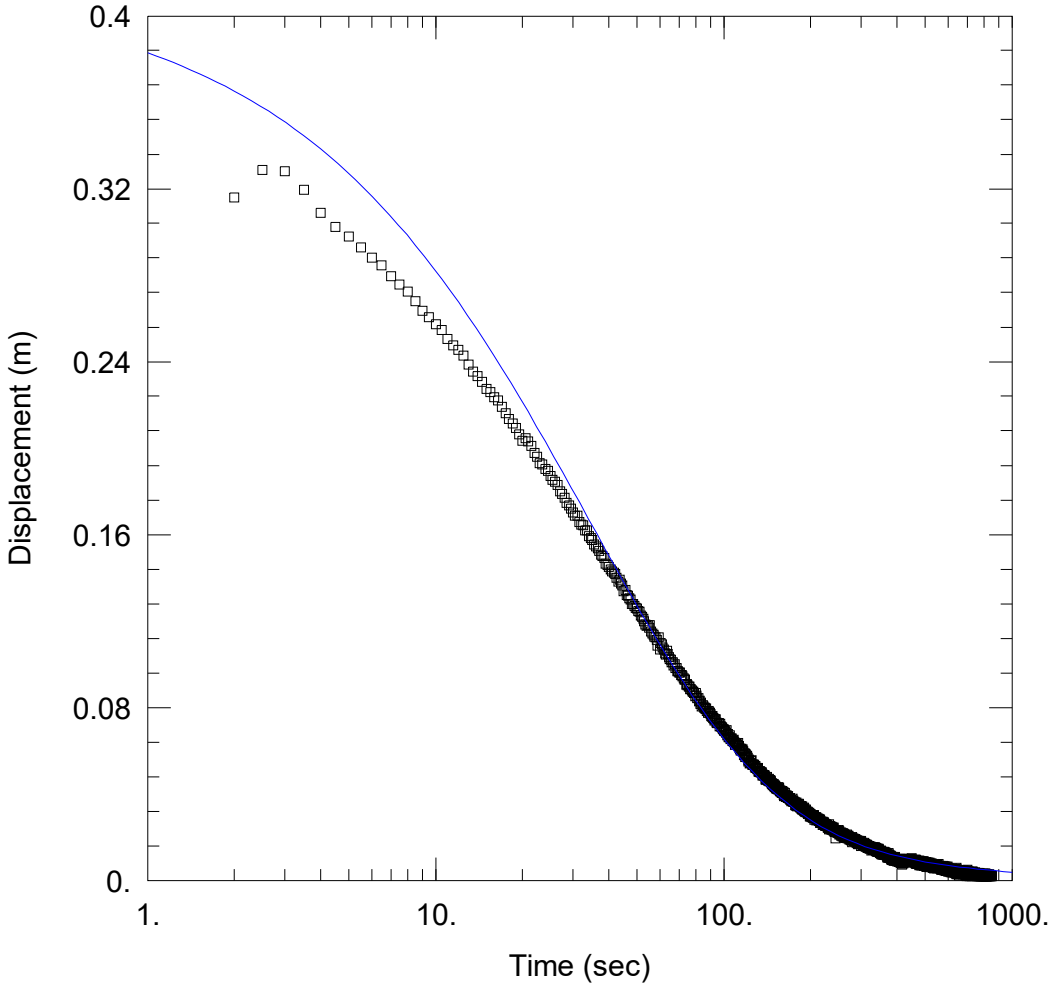
Saturated Thickness: 5.99 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW17-26-05)

Initial Displacement: 0.379 m
Total Well Penetration Depth: 5.665 m
Casing Radius: 0.025 m
Static Water Column Height: 5.99 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice
K = 0.3894 m/day
y0 = 0.1955 m



GW17-26-06 RHT2

Data Set: \...\6_RHT_CBP_B.aqt
Date: 05/02/18 Time: 15:19:17

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-06
Test Date: 31/08/17

AQUIFER DATA

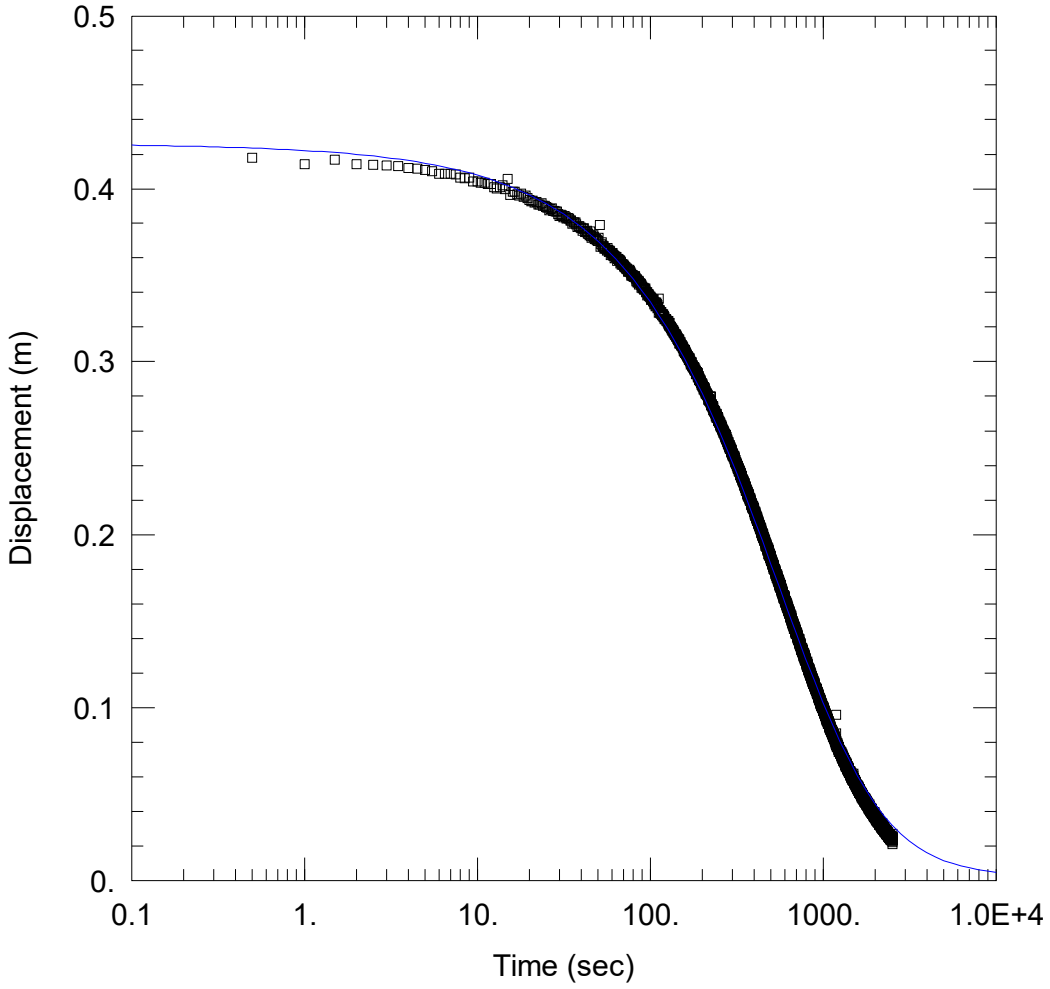
Saturated Thickness: 4.8 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (6 RHT)

Initial Displacement: 0.4166 m
Total Well Penetration Depth: 5.5 m
Casing Radius: 0.025 m
Static Water Column Height: 4.8 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 1.647 m^2/day
S = 0.00569



GW17-26-07 FHT2

Data Set: \...\7_FHT_CBP_B.aqt
Date: 05/02/18 Time: 15:37:39

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-07
Test Date: 31/08/17

AQUIFER DATA

Saturated Thickness: 4.99 m Anisotropy Ratio (Kz/Kr): 1.

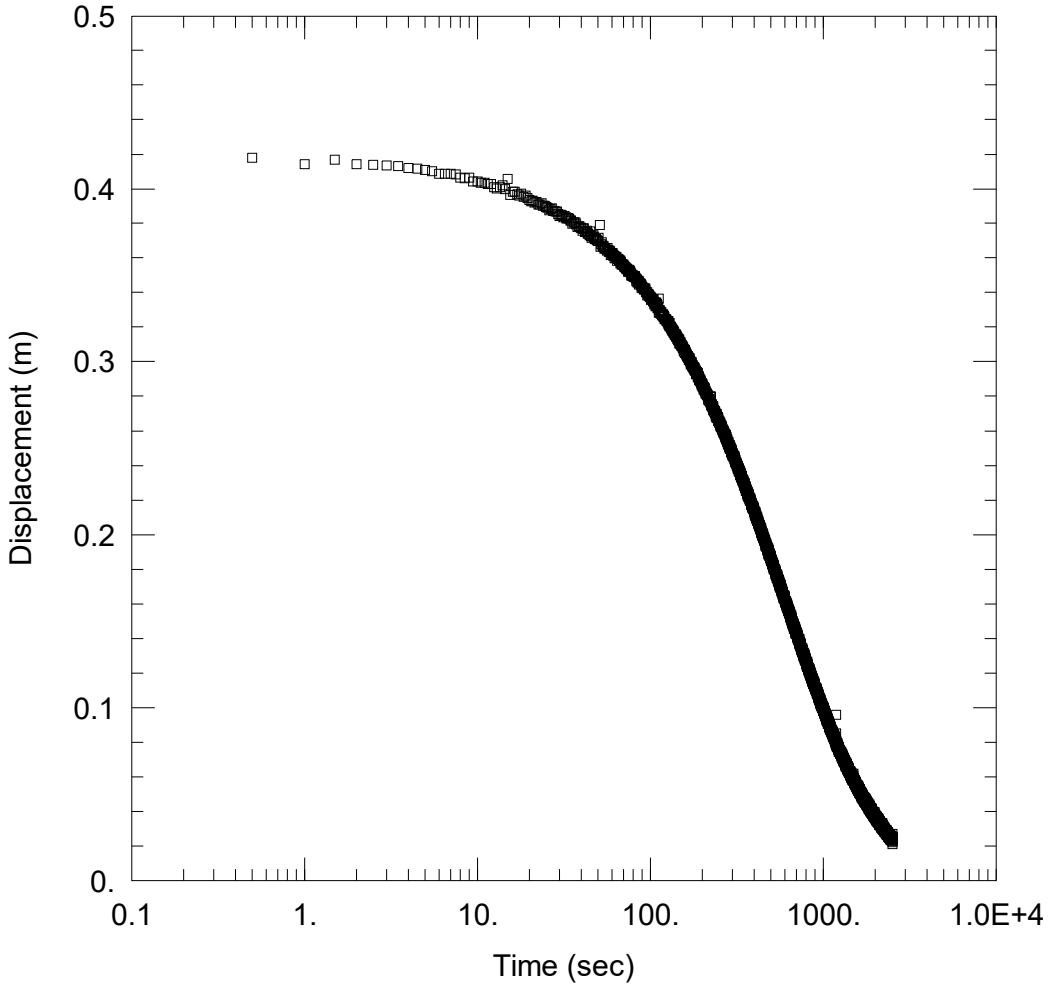
WELL DATA (7 FHT)

Initial Displacement: 0.4263 m
Total Well Penetration Depth: 5.5 m
Casing Radius: 0.025 m
Static Water Column Height: 4.99 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 0.1447 m^2/day
S = 0.001



GW17-26-07 RHT3

Data Set: \...\7_RHT_CBP_B.aqt
Date: 05/02/18 Time: 15:37:10

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-07
Test Date: 31/08/17

AQUIFER DATA

Saturated Thickness: 4.99 m Anisotropy Ratio (Kz/Kr): 1.

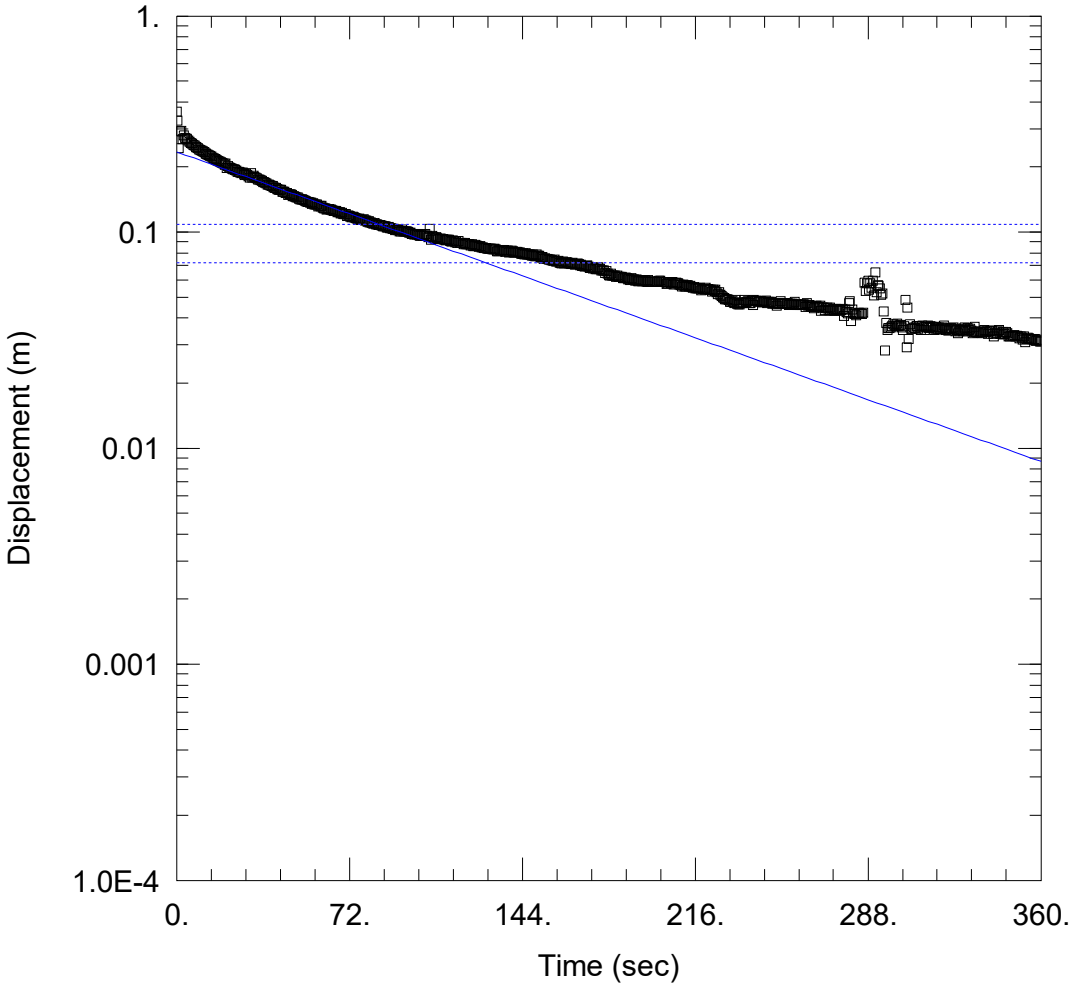
WELL DATA (7 RHT)

Initial Displacement: 0.4304 m
Total Well Penetration Depth: 4.33 m
Casing Radius: 0.025 m
Static Water Column Height: 4.99 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 0.1489 m^2/day
S = 0.001



GW17-26-08 FHT

Data Set: \...\8_FHT.aqt
Date: 05/04/18 Time: 16:47:02

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-08
Test Date: 29/08/2017

AQUIFER DATA

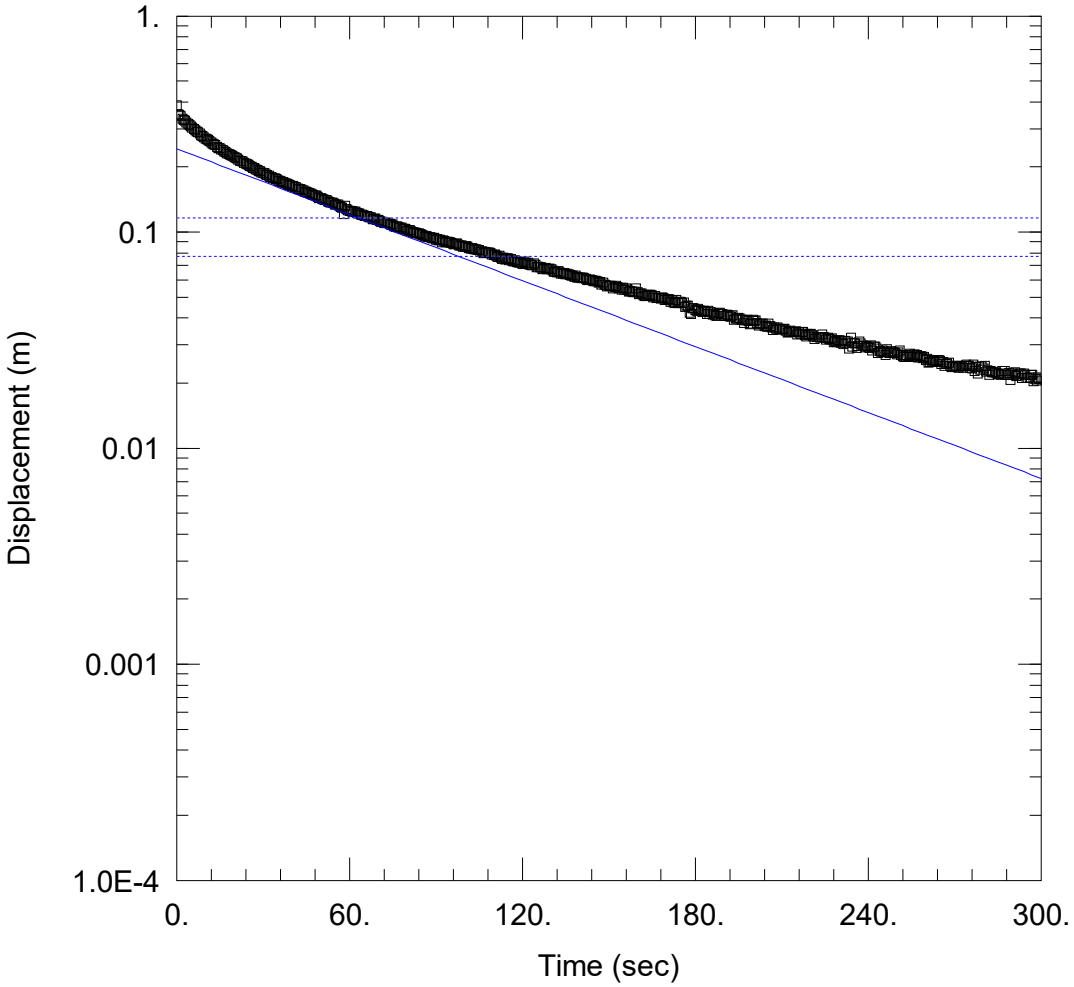
Saturated Thickness: 4.9 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (8)

Initial Displacement: 0.3616 m
Total Well Penetration Depth: 4.4 m
Casing Radius: 0.025 m
Static Water Column Height: 4.9 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.2557 m/day
y0 = 0.235 m



GW17-26-08 RHT

Data Set: \...\8_RHT.aqt
Date: 05/04/18 Time: 16:46:29

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-08
Test Date: 29/08/2017

AQUIFER DATA

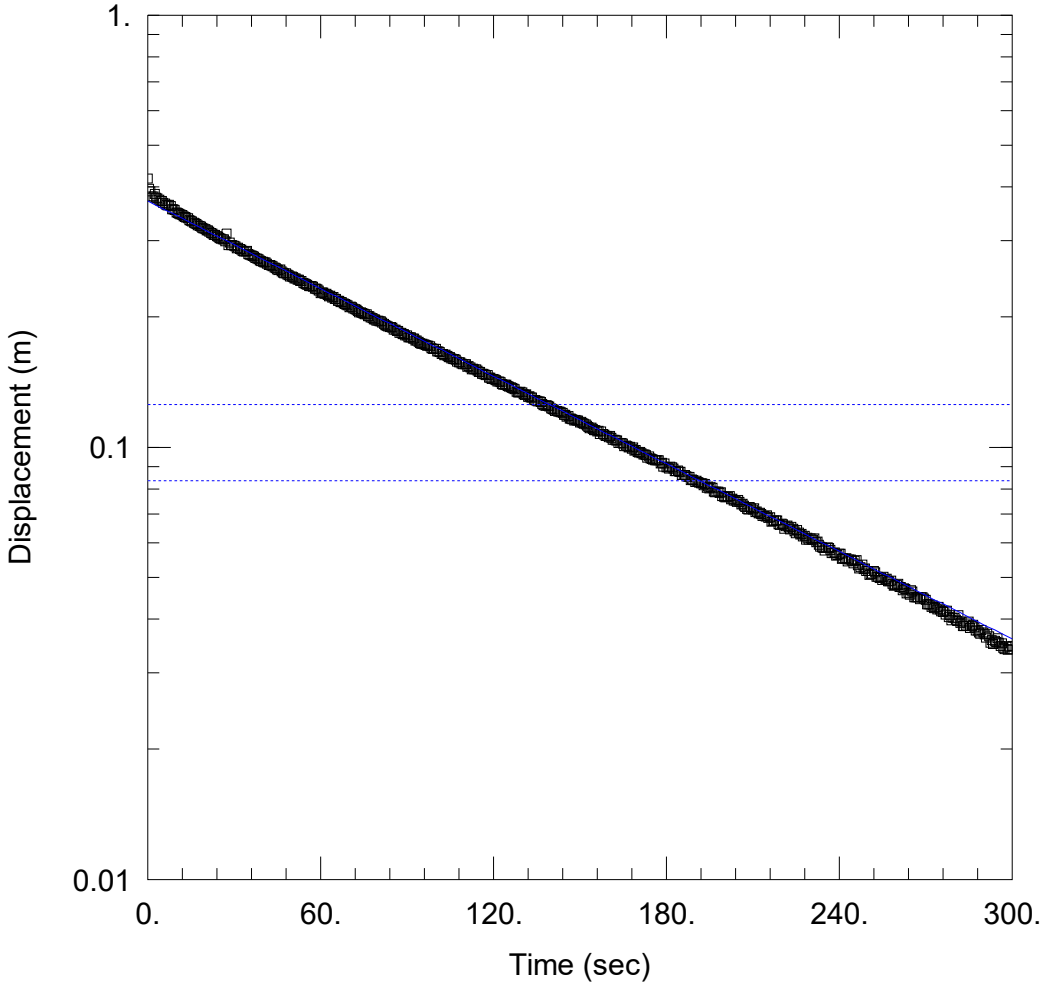
Saturated Thickness: 4.9 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (8)

Initial Displacement: 0.3871 m
Total Well Penetration Depth: 4.4 m
Casing Radius: 0.025 m
Static Water Column Height: 4.9 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.3266 m/day
y0 = 0.243 m



GW17-26-09 FHT

Data Set: \...\9_FHT.aqt
Date: 05/04/18 Time: 16:50:53

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-09
Test Date: 29/08/2017

AQUIFER DATA

Saturated Thickness: 4.8 m Anisotropy Ratio (Kz/Kr): 1.

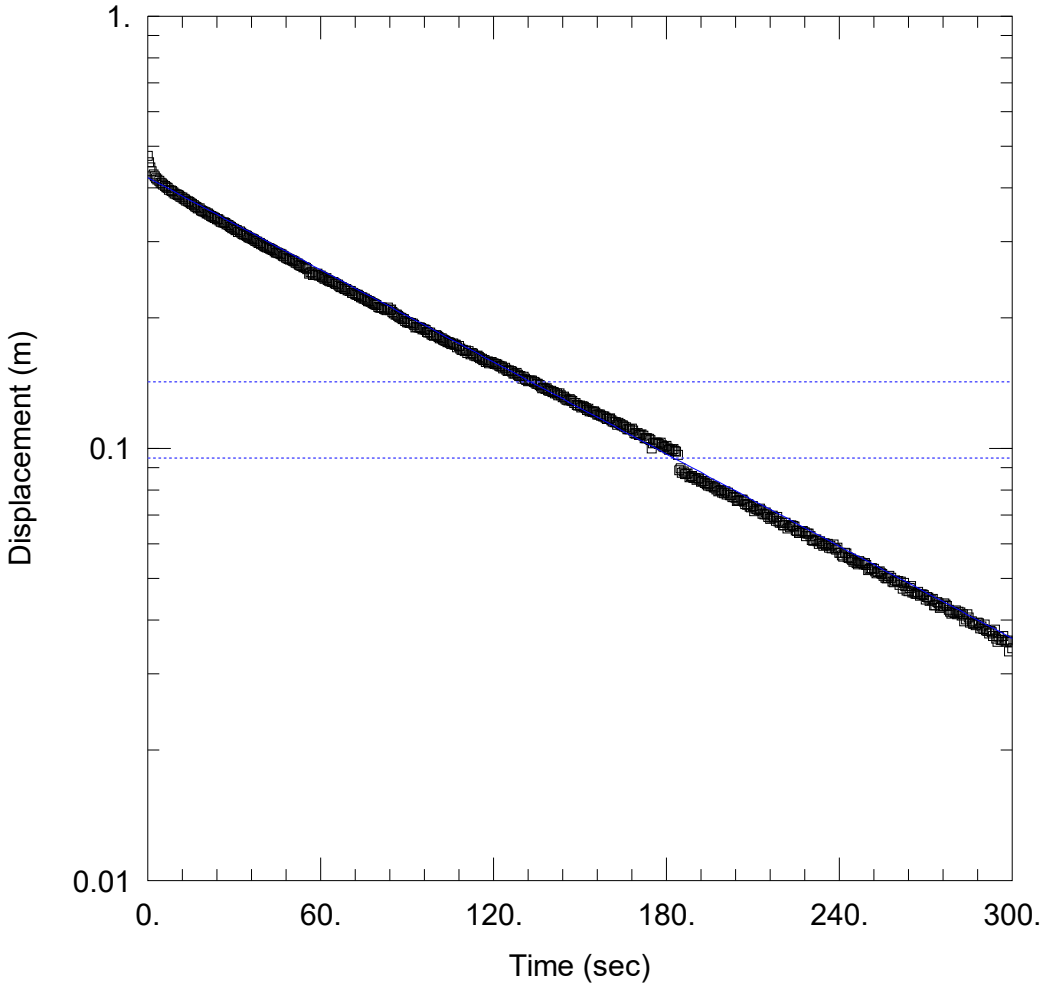
WELL DATA (9)

Initial Displacement: 0.4177 m
Total Well Penetration Depth: 4.3 m
Casing Radius: 0.025 m
Static Water Column Height: 4.8 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.2162 m/day
y0 = 0.3715 m



GW17-26-09 RHT

Data Set: \...\9_RHT.aqt
Date: 05/04/18 Time: 17:00:00

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-09
Test Date: 29/08/2017

AQUIFER DATA

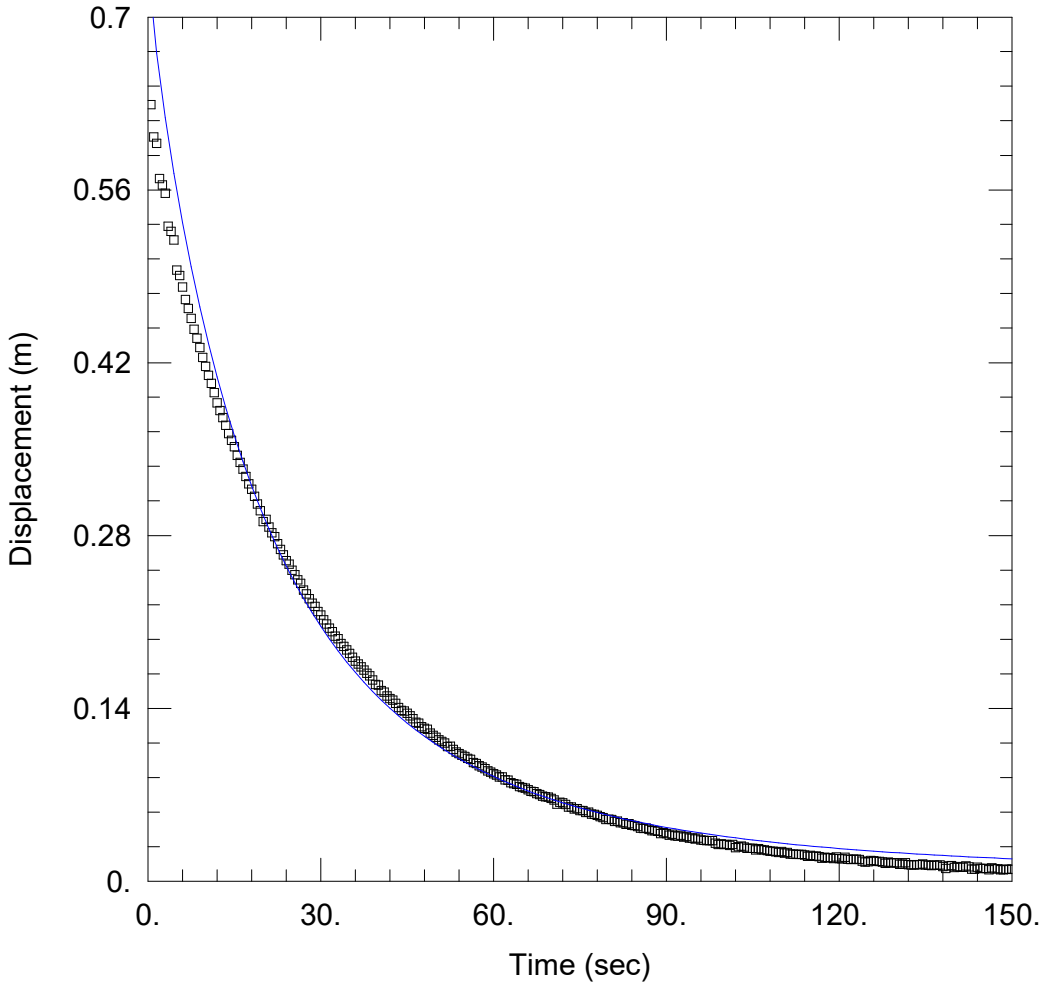
Saturated Thickness: 4.8 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (9)

Initial Displacement: 0.4739 m
Total Well Penetration Depth: 4.3 m
Casing Radius: 0.025 m
Static Water Column Height: 4.8 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.2274 m/day
y0 = 0.4228 m



GW17-26-10D RHT

Data Set: \...\10D_RHT_CBP.aqt
Date: 06/08/18 Time: 09:58:56

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-10D
Test Date: 28/08/2017

AQUIFER DATA

Saturated Thickness: 18. m Anisotropy Ratio (Kz/Kr): 1.

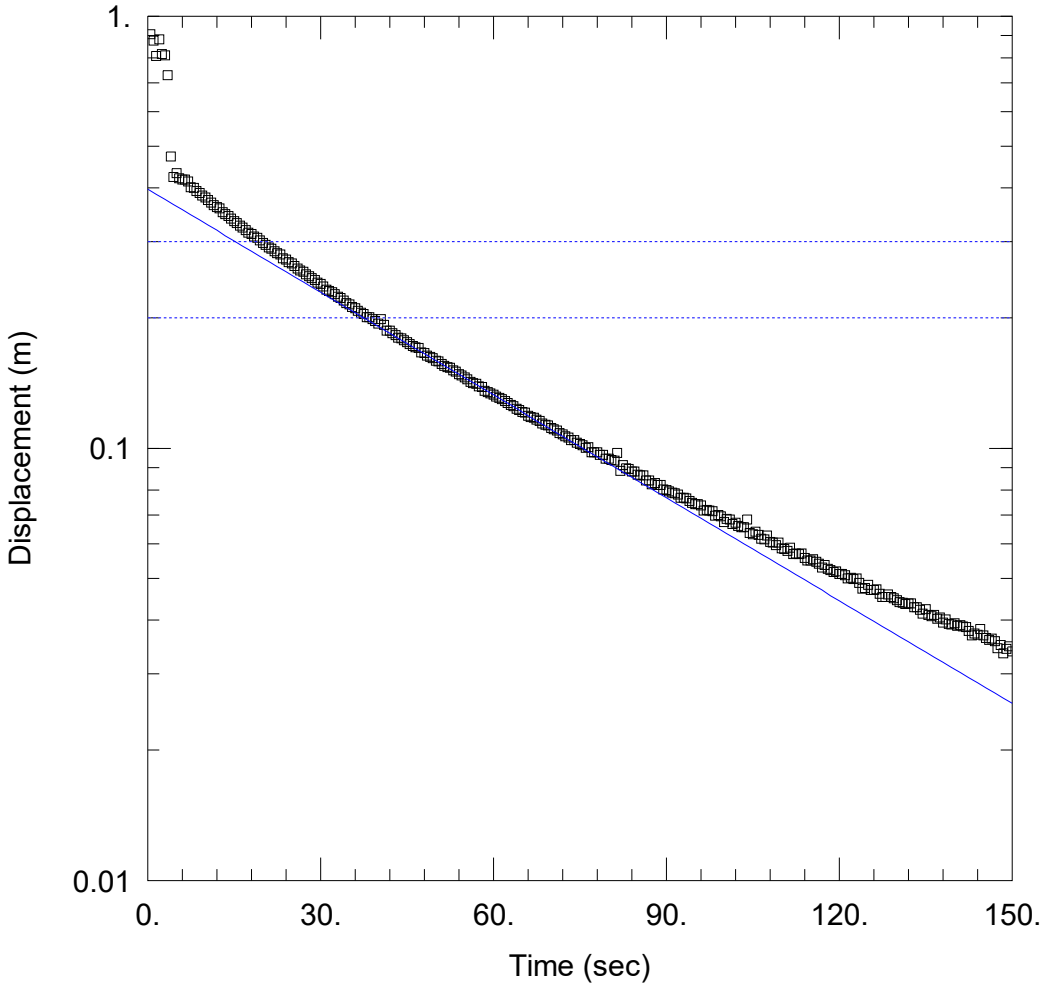
WELL DATA (10D)

Initial Displacement: 0.7428 m Static Water Column Height: 18. m
Total Well Penetration Depth: 15. m Screen Length: 9. m
Casing Radius: 0.025 m Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Bredehoeft-Papadopulos

T = 5.913 m^2/day S = 6.485E-5



GW17-26-10S FHT

Data Set: \...\10S_FHT.aqt
Date: 05/08/18 Time: 10:16:12

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-10S
Test Date: 28/08/2017

AQUIFER DATA

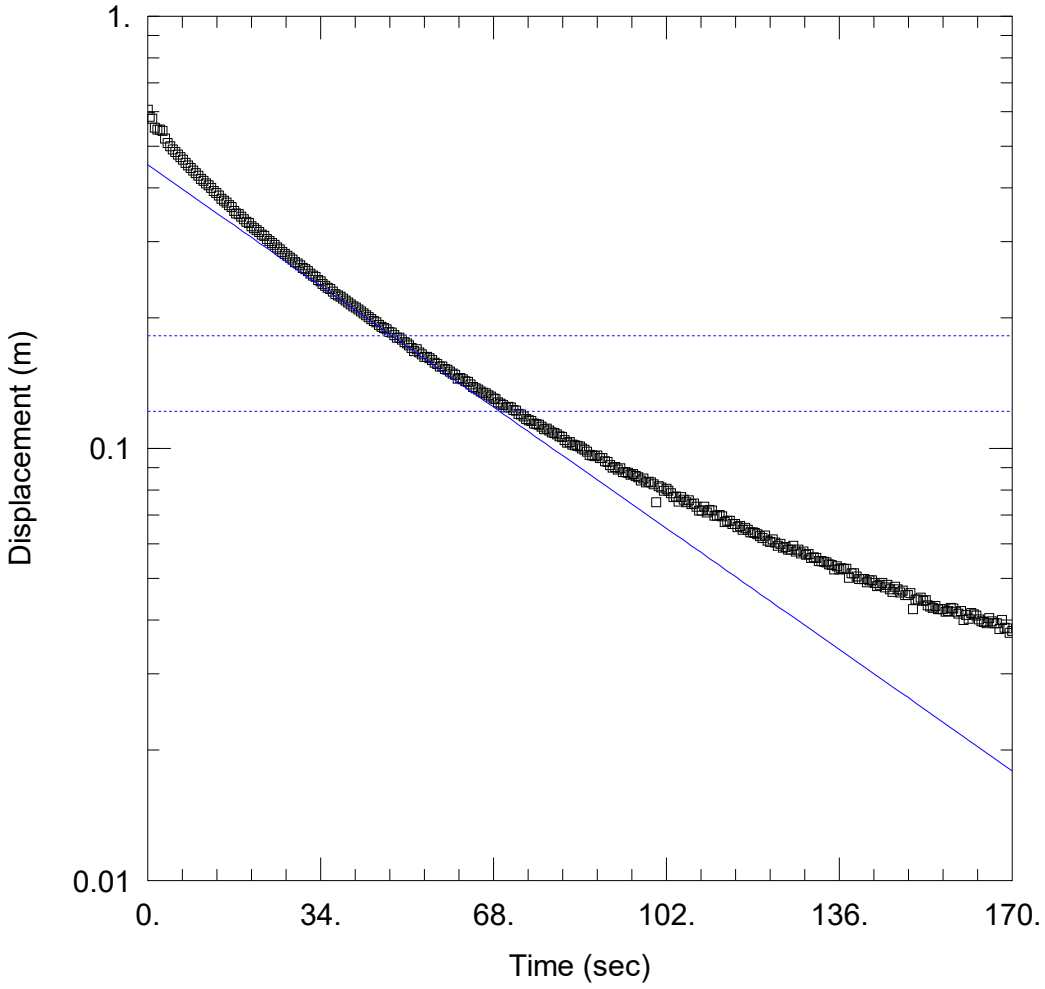
Saturated Thickness: 4.6 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (10S)

Initial Displacement: 1.002 m
Total Well Penetration Depth: 4.1 m
Casing Radius: 0.025 m
Static Water Column Height: 4.6 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.5031 m/day
y0 = 0.3971 m



GW17-26-10S RHT

Data Set: \...\10S_RHT.aqt
Date: 05/08/18 Time: 10:15:40

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-10S
Test Date: 28/08/2017

AQUIFER DATA

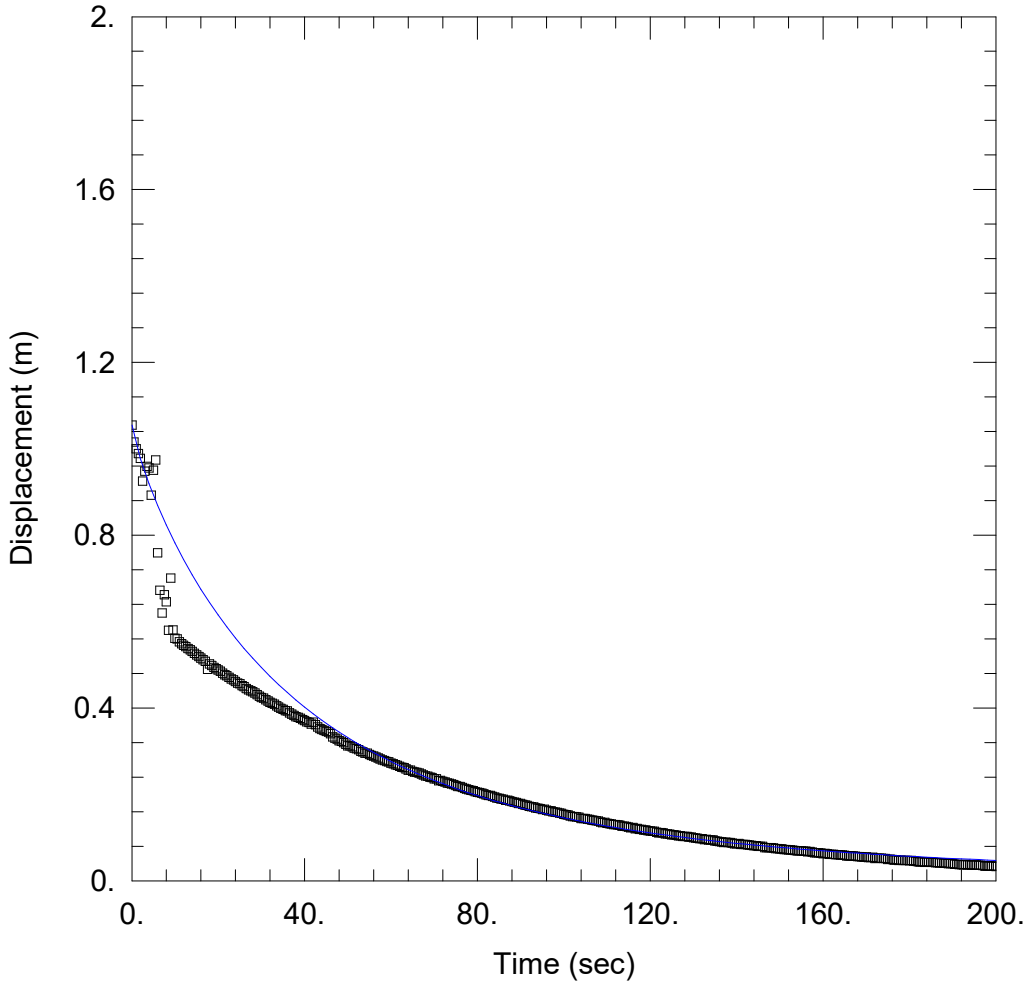
Saturated Thickness: 4.6 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (10S)

Initial Displacement: 0.6076 m
Total Well Penetration Depth: 4.1 m
Casing Radius: 0.025 m
Static Water Column Height: 4.6 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.5232 m/day
y0 = 0.4527 m



GW17-26-11D FHT

Data Set: \...\11D_FHT_CBP.aqt
Date: 06/08/18 Time: 10:00:42

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-11D
Test Date: 28/08/2017

AQUIFER DATA

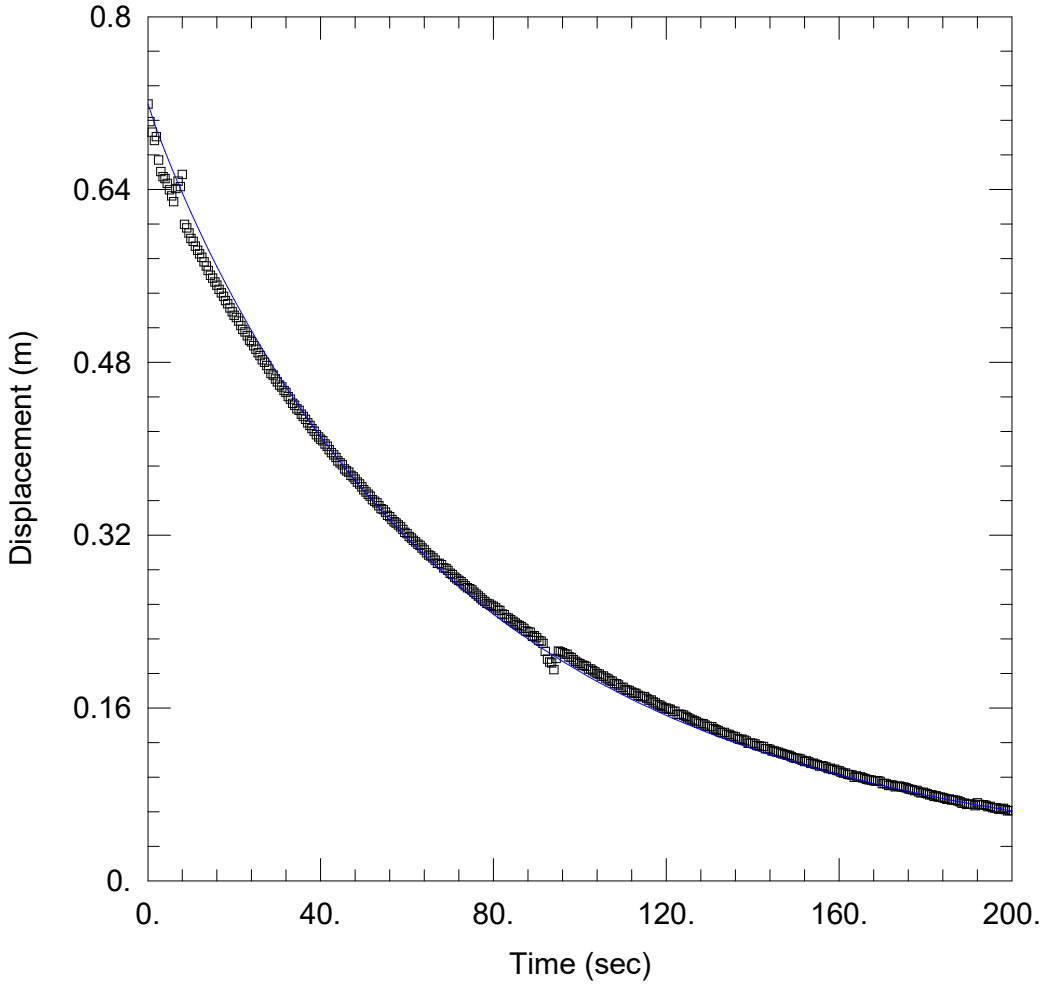
Saturated Thickness: 17.6 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (11D)

Initial Displacement: 1.055 m
Total Well Penetration Depth: 14.6 m
Casing Radius: 0.025 m
Static Water Column Height: 17.6 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 3.068 m^2/day
S = 7.852E-5



GW17-26-11D RHT

Data Set: \...\11D_RHT_CBP.aqt
Date: 06/08/18 Time: 10:01:48

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-11D
Test Date: 28/08/2017

AQUIFER DATA

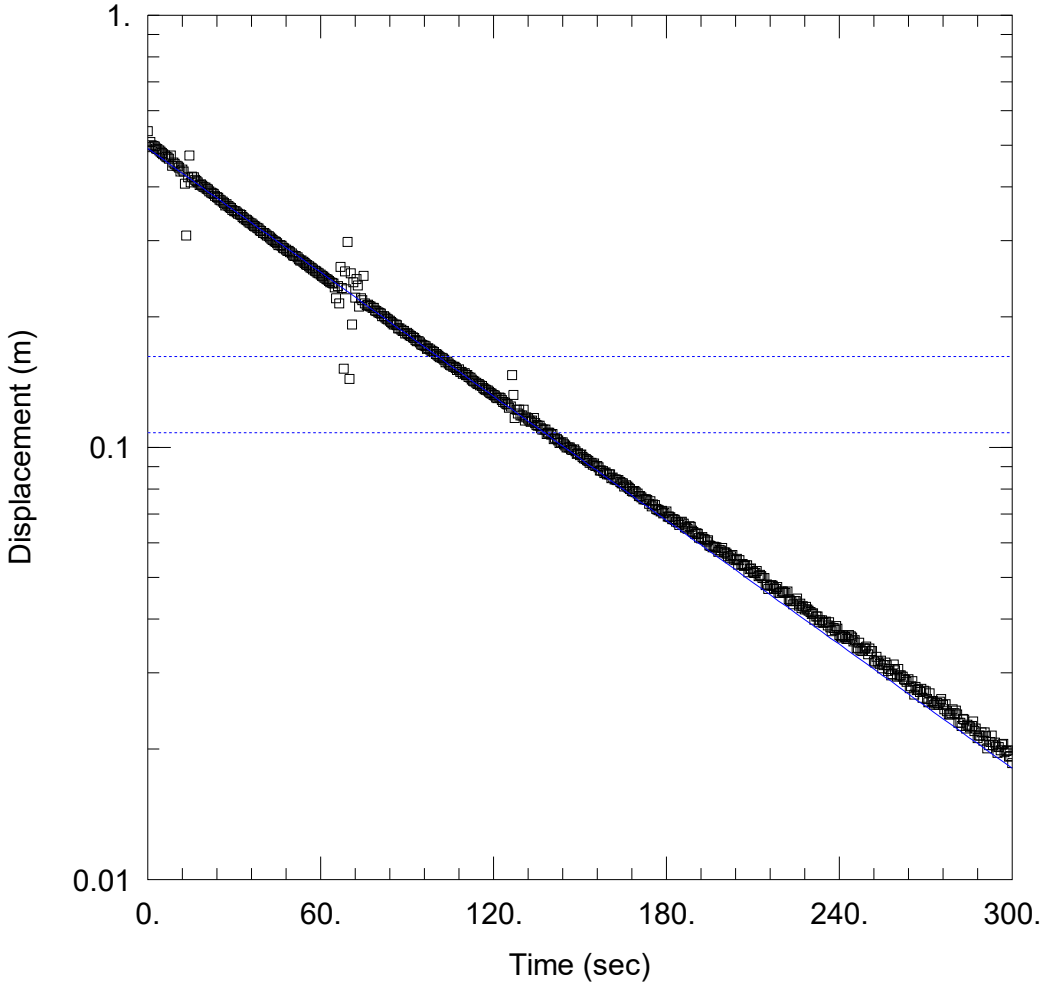
Saturated Thickness: 17.6 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (11D)

Initial Displacement: 0.7191 m
Total Well Penetration Depth: 14.6 m
Casing Radius: 0.025 m
Static Water Column Height: 17.6 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 4.328 m^2/day
S = 1.0E-10



GW17-26-11S FHT

Data Set: \...\11S_FHT.aqt
Date: 05/08/18 Time: 10:23:57

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-11S
Test Date: 28/08/2017

AQUIFER DATA

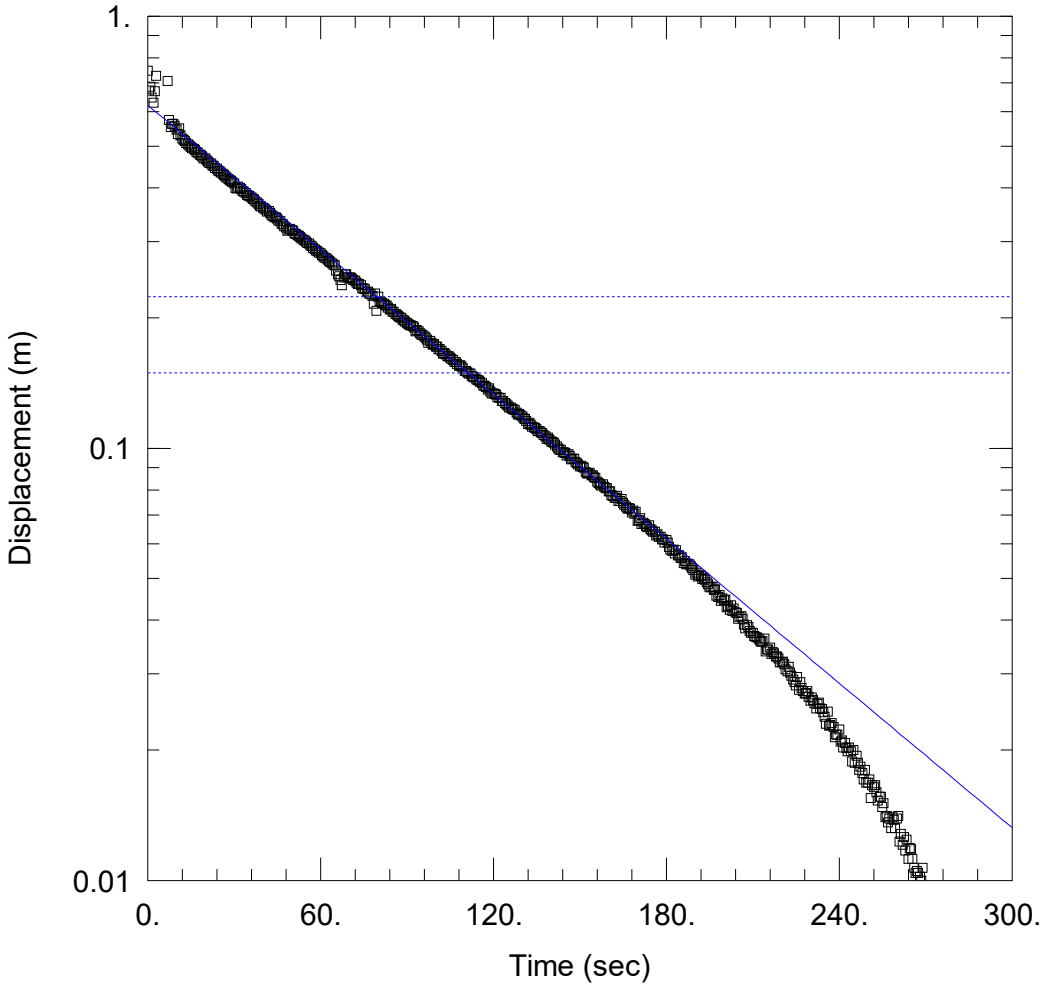
Saturated Thickness: 4.4 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (11S)

Initial Displacement: 0.5393 m
Total Well Penetration Depth: 3.86 m
Casing Radius: 0.025 m
Static Water Column Height: 4.4 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.2996 m/day
y0 = 0.4914 m



GW17-26-11S RHT

Data Set: \...\11S_RHT.aqt
Date: 05/08/18 Time: 10:24:55

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-11S
Test Date: 28/08/2017

AQUIFER DATA

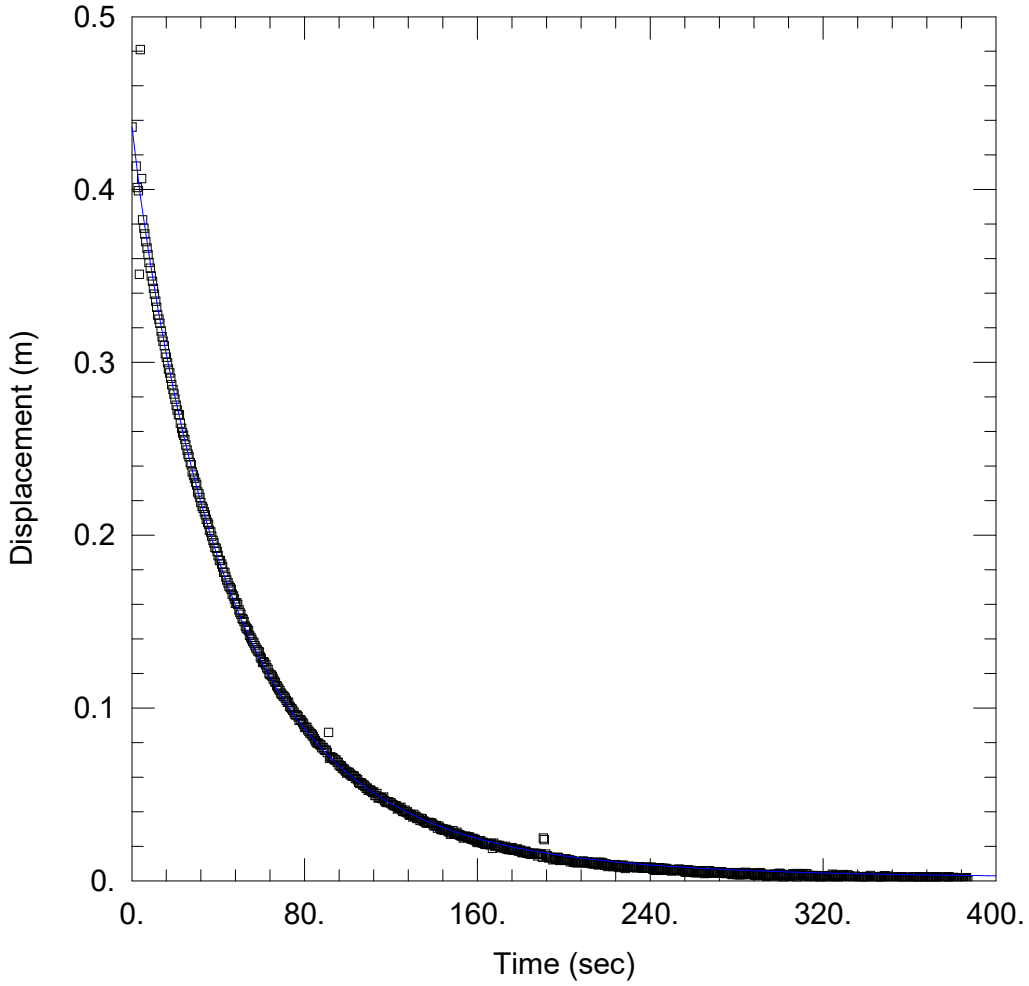
Saturated Thickness: 4.4 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (11S)

Initial Displacement: 0.7463 m
Total Well Penetration Depth: 3.86 m
Casing Radius: 0.025 m
Static Water Column Height: 4.4 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.3492 m/day
y0 = 0.6223 m



GW17-26-12D FHT

Data Set: \...\12D_FHT_CBP.aqt
Date: 06/08/18 Time: 10:04:50

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-12D
Test Date: 30/08/2017

AQUIFER DATA

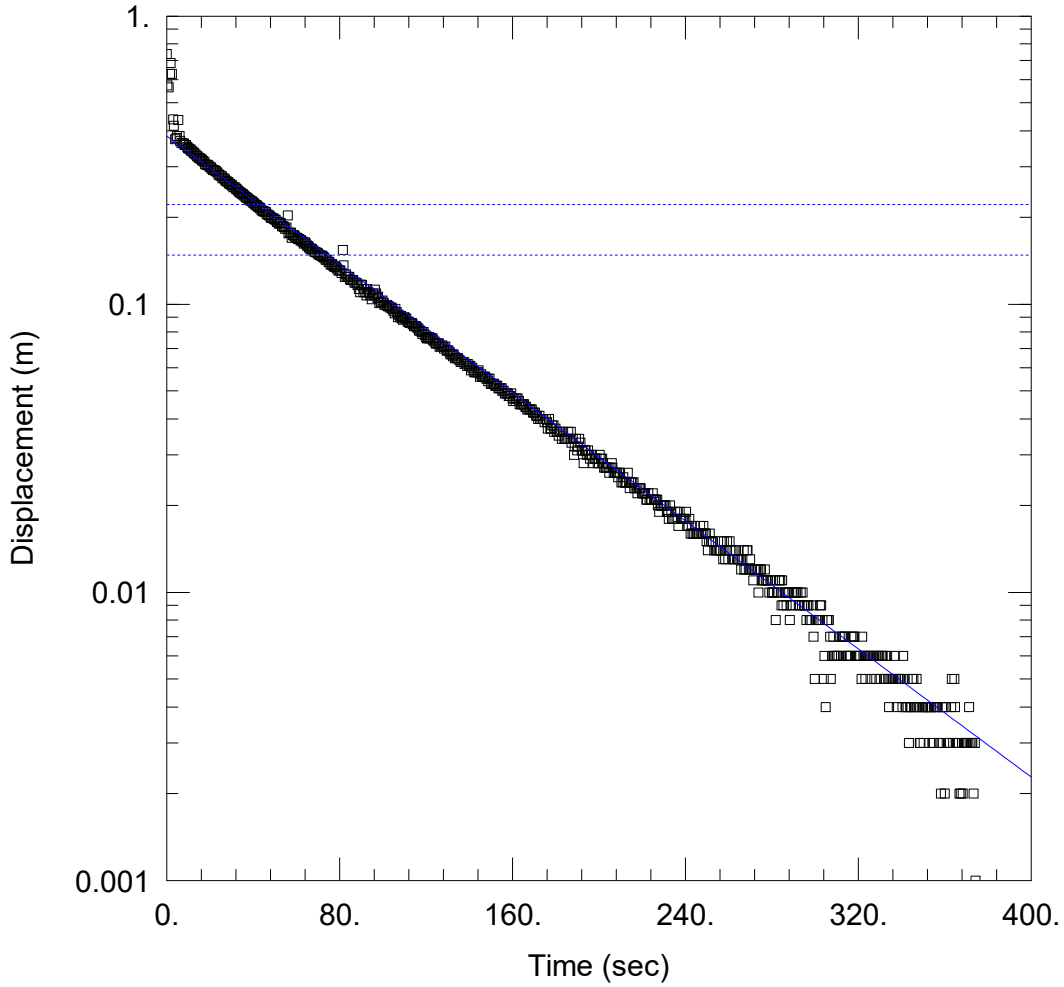
Saturated Thickness: 17. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (12D)

Initial Displacement: 0.4361 m Static Water Column Height: 17. m
Total Well Penetration Depth: 11. m Screen Length: 6. m
Casing Radius: 0.025 m Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined Solution Method: Cooper-Bredehoeft-Papadopulos
T = 6.757 m^2/day S = 1.0E-10



GW17-26-12S FHT

Data Set: \...\12S_FHT_BR.aqt
Date: 05/08/18 Time: 10:30:30

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-12S
Test Date: 30/08/2017

AQUIFER DATA

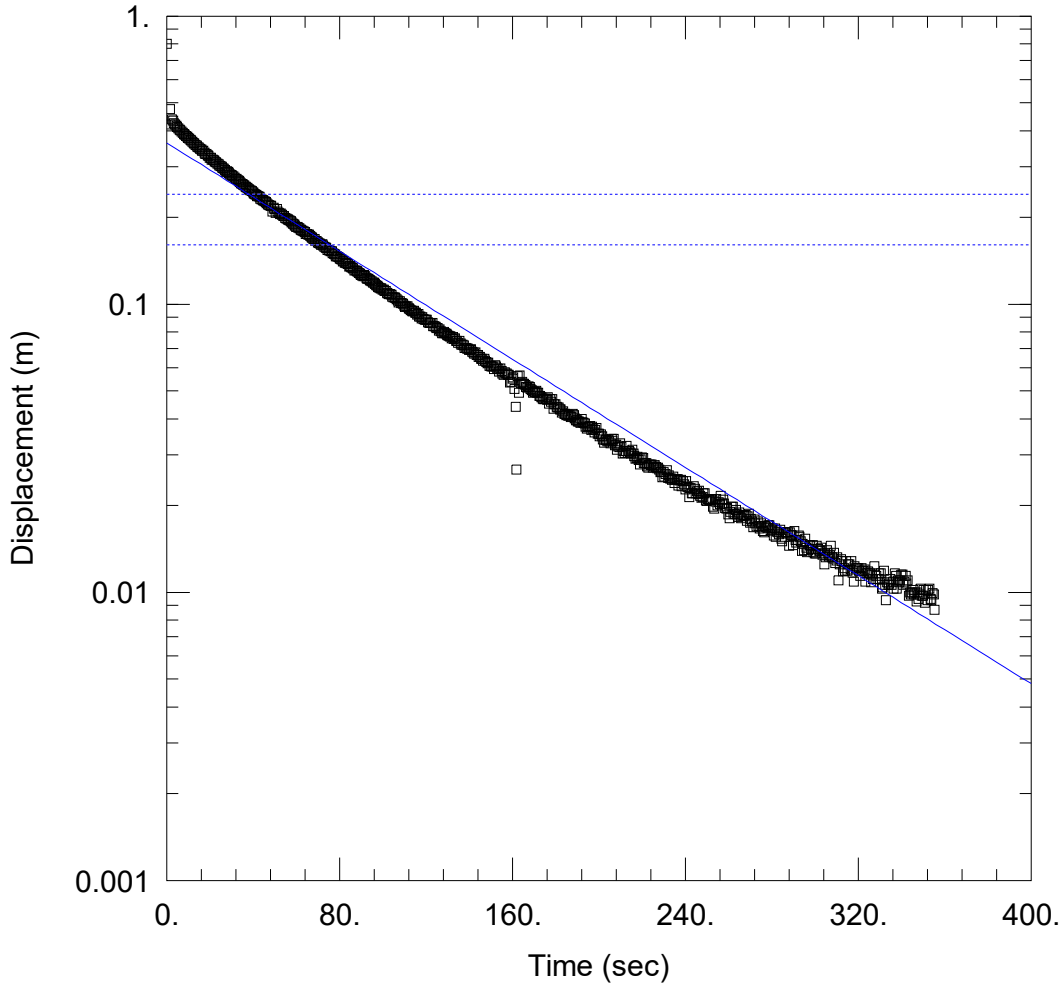
Saturated Thickness: 4.81 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (12S)

Initial Displacement: 0.7392 m
Total Well Penetration Depth: 4.81 m
Casing Radius: 0.025 m
Static Water Column Height: 4.81 m
Screen Length: 4. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.3015 m/day
y0 = 0.3834 m



GW17-26-12S RHT

Data Set: \...\12S_RHT_BR.aqt
Date: 05/08/18 Time: 10:32:09

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-12S
Test Date: 30/08/2017

AQUIFER DATA

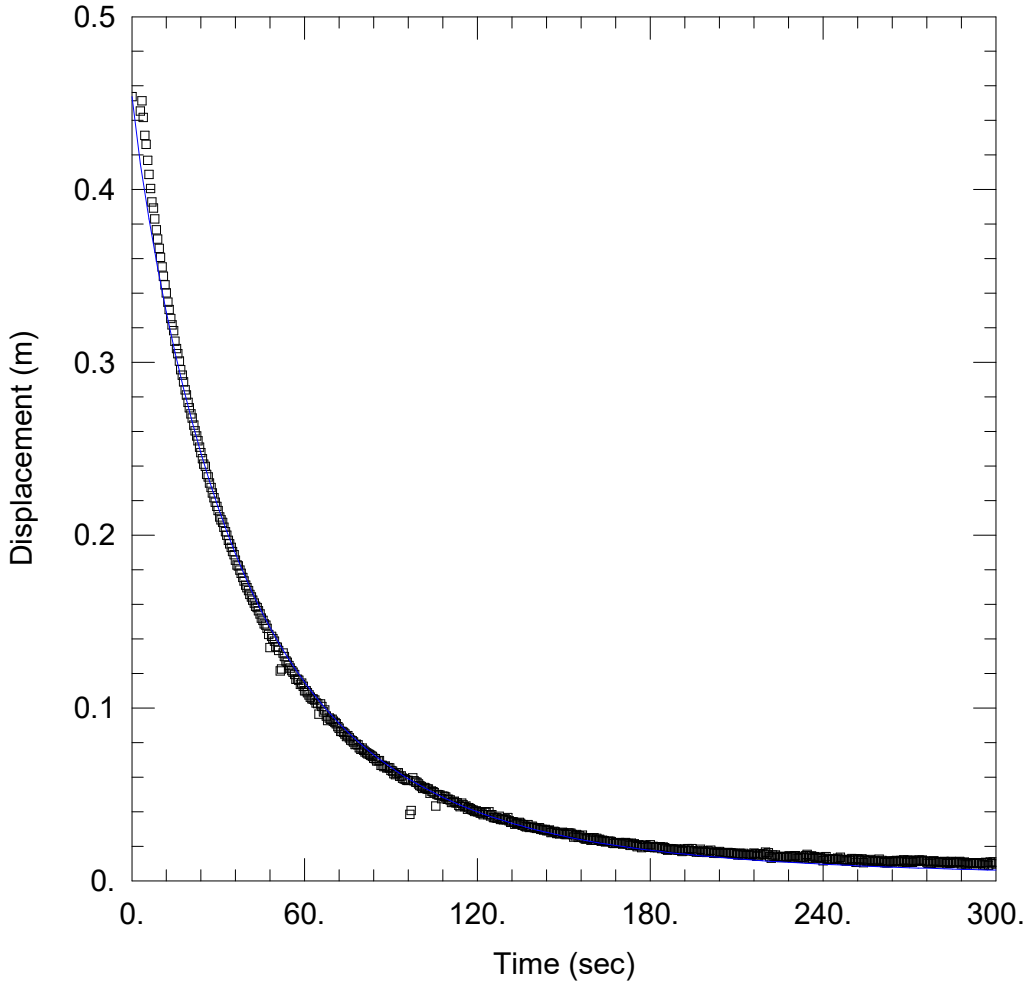
Saturated Thickness: 4.81 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (12S)

Initial Displacement: 0.8022 m
Total Well Penetration Depth: 4.81 m
Casing Radius: 0.025 m
Static Water Column Height: 4.81 m
Screen Length: 4. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.2543 m/day
y0 = 0.3627 m



GW17-26-13D RHT

Data Set: \...\13D RHT_CBP.aqt
Date: 06/08/18 Time: 10:07:28

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-13D
Test Date: 30/08/2017

AQUIFER DATA

Saturated Thickness: 17.3 m Anisotropy Ratio (Kz/Kr): 1.

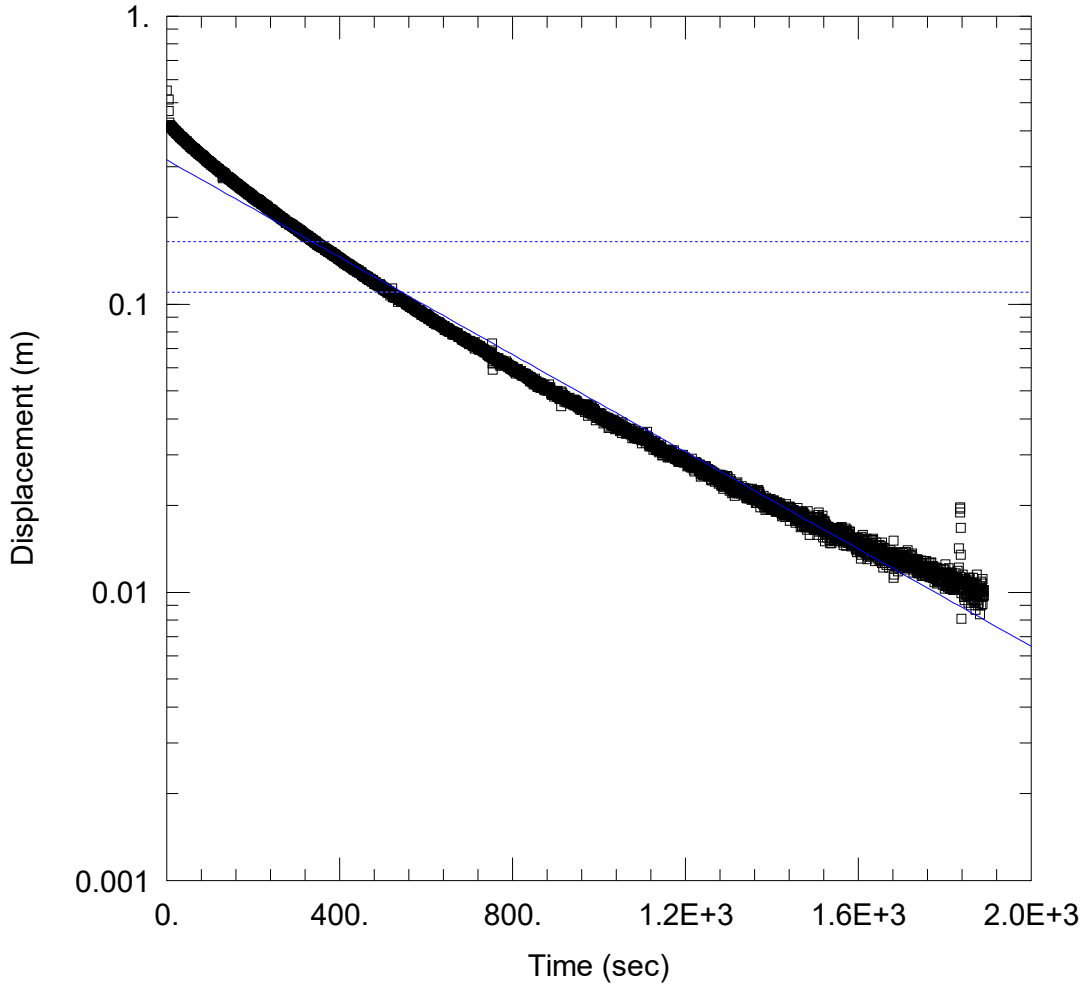
WELL DATA (13D RHT)

Initial Displacement: 0.4538 m
Total Well Penetration Depth: 12.3 m
Casing Radius: 0.025 m
Static Water Column Height: 17.3 m
Screen Length: 7. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 5.131 m^2/day
S = 2.006E-7



GW17-26-13S FHT

Data Set: \...\13S FHT.aqt
Date: 05/08/18 Time: 10:41:14

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-13S
Test Date: 30/08/2017

AQUIFER DATA

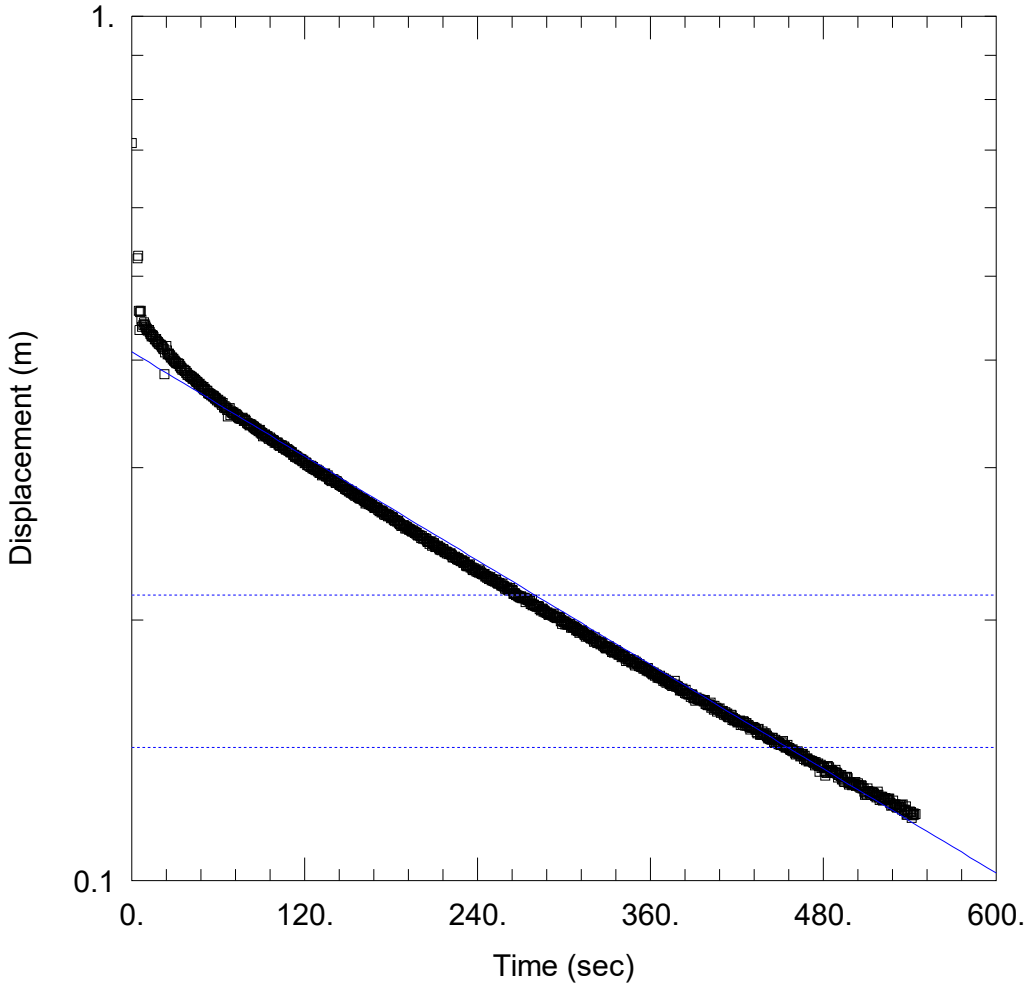
Saturated Thickness: 4.3 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (13S)

Initial Displacement: 0.5501 m
Total Well Penetration Depth: 3.8 m
Casing Radius: 0.025 m
Static Water Column Height: 4.3 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.05284 m/day
y0 = 0.3164 m



GW17-26-13S RHT

Data Set: \...\13S RHT.aqt
Date: 05/08/18 Time: 10:43:22

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-13S
Test Date: 30/08/2017

AQUIFER DATA

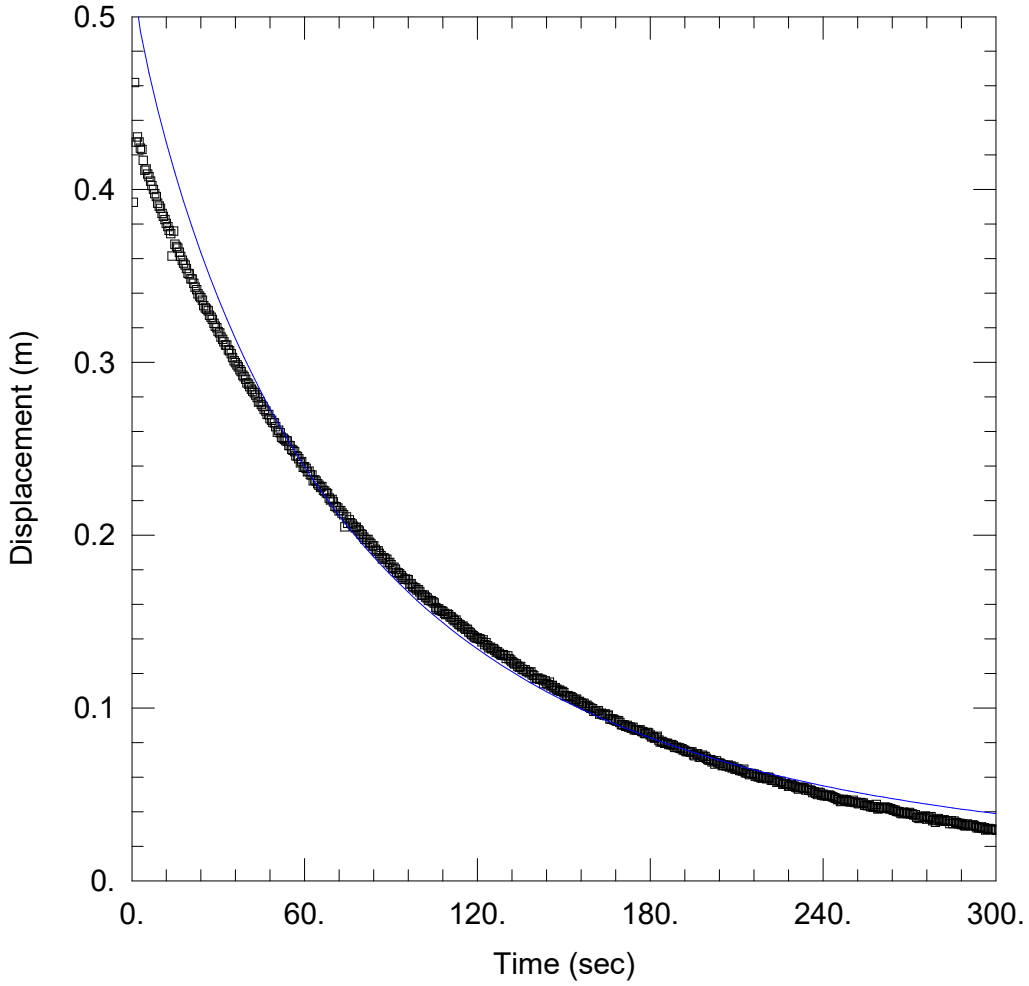
Saturated Thickness: 4.3 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (13S)

Initial Displacement: 0.7129 m
Total Well Penetration Depth: 3.8 m
Casing Radius: 0.025 m
Static Water Column Height: 4.3 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0629 m/day
y0 = 0.4086 m



GW17-26-14D RHT

Data Set: \...\14D_RHT_CBP.aqt
Date: 06/08/18 Time: 10:09:05

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-14D
Test Date: 29/08/2017

AQUIFER DATA

Saturated Thickness: 13.5 m Anisotropy Ratio (Kz/Kr): 1.

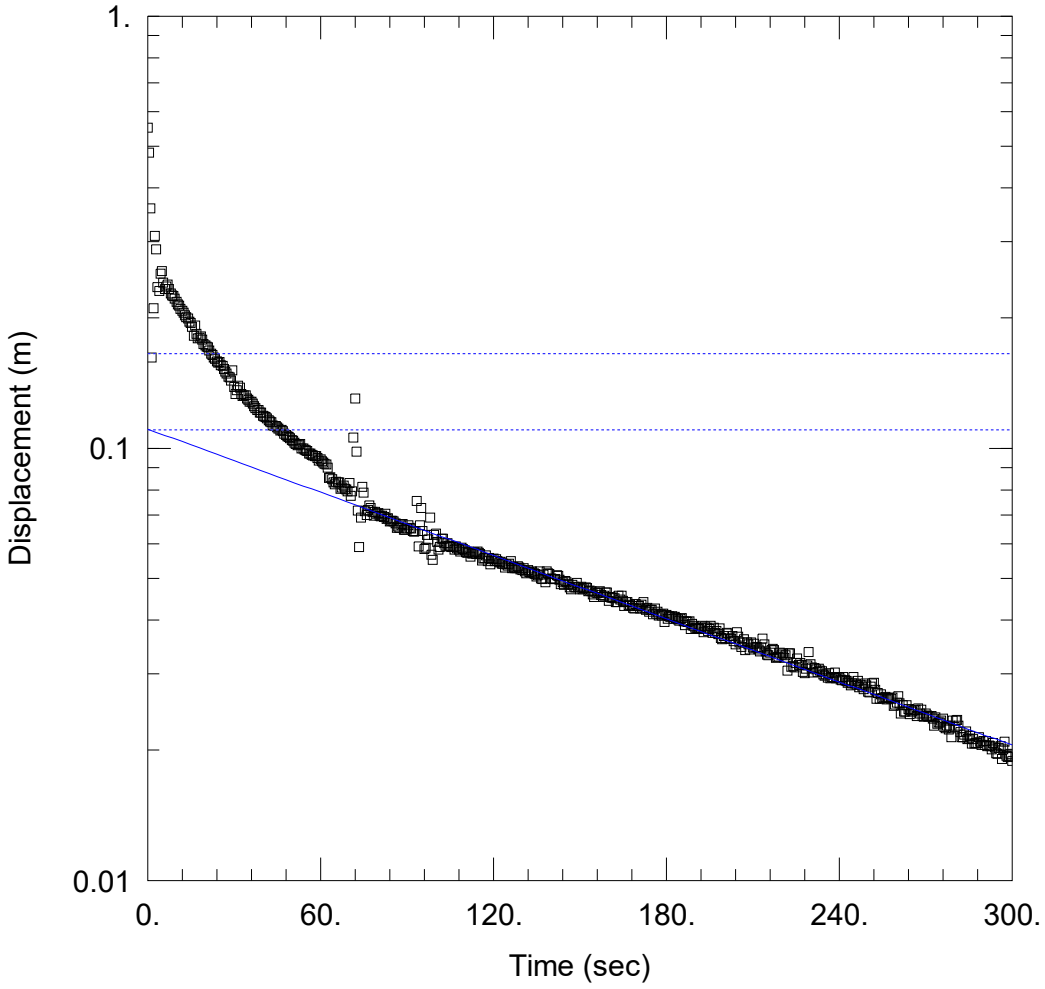
WELL DATA (14D)

Initial Displacement: 0.5261 m
Total Well Penetration Depth: 12.45 m
Casing Radius: 0.025 m
Static Water Column Height: 13.5 m
Screen Length: 7. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 1.411 m^2/day
S = 0.0002052



GW17-26-14S FHT

Data Set: \...\14S_FHT lt.aqt
Date: 05/08/18 Time: 10:58:25

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-14S
Test Date: 29/08/2017

AQUIFER DATA

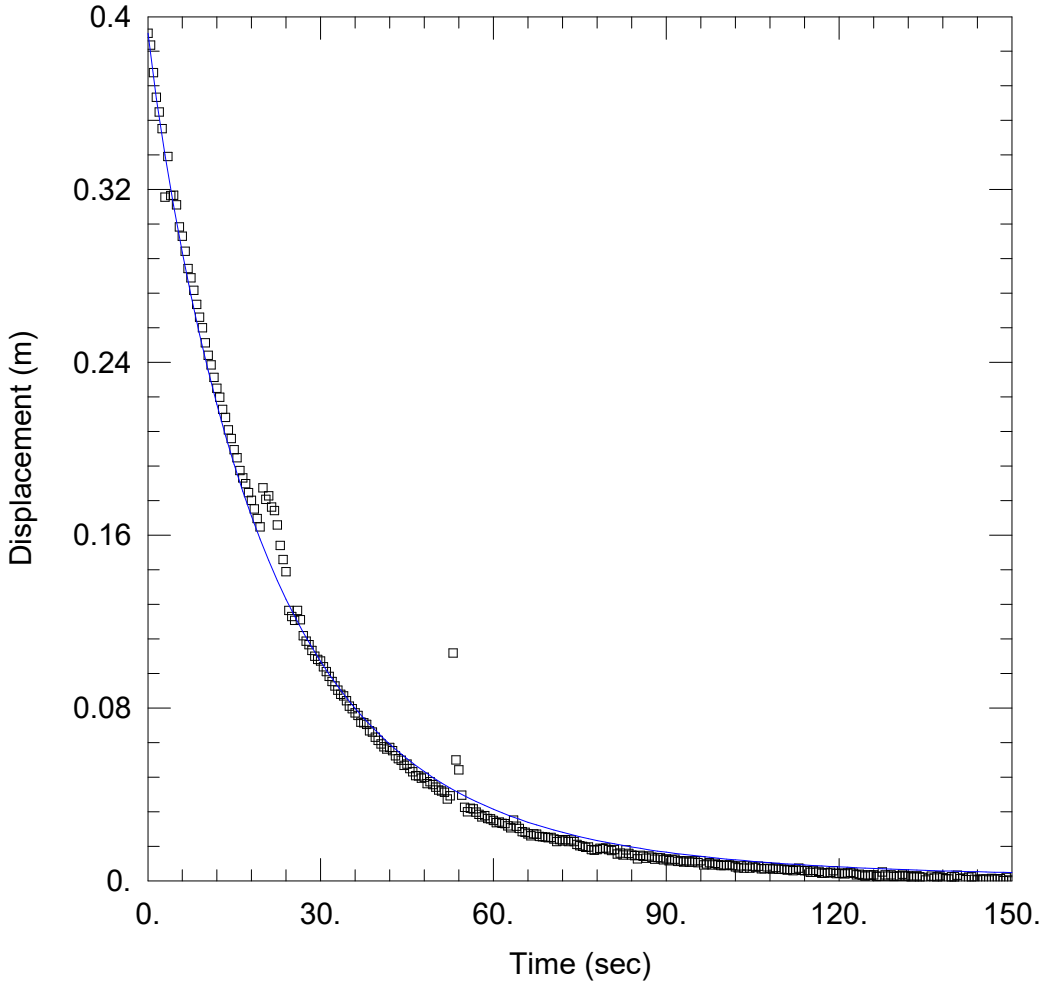
Saturated Thickness: 4. m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (14S)

Initial Displacement: 0.5519 m
Total Well Penetration Depth: 3.475 m
Casing Radius: 0.025 m
Static Water Column Height: 4. m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.15 m/day
y0 = 0.1107 m



GW17-26-15D FHT

Data Set: \...\15D_FHT_CBP.aqt
Date: 06/08/18 Time: 10:10:35

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-15D
Test Date: 29/08/2017

AQUIFER DATA

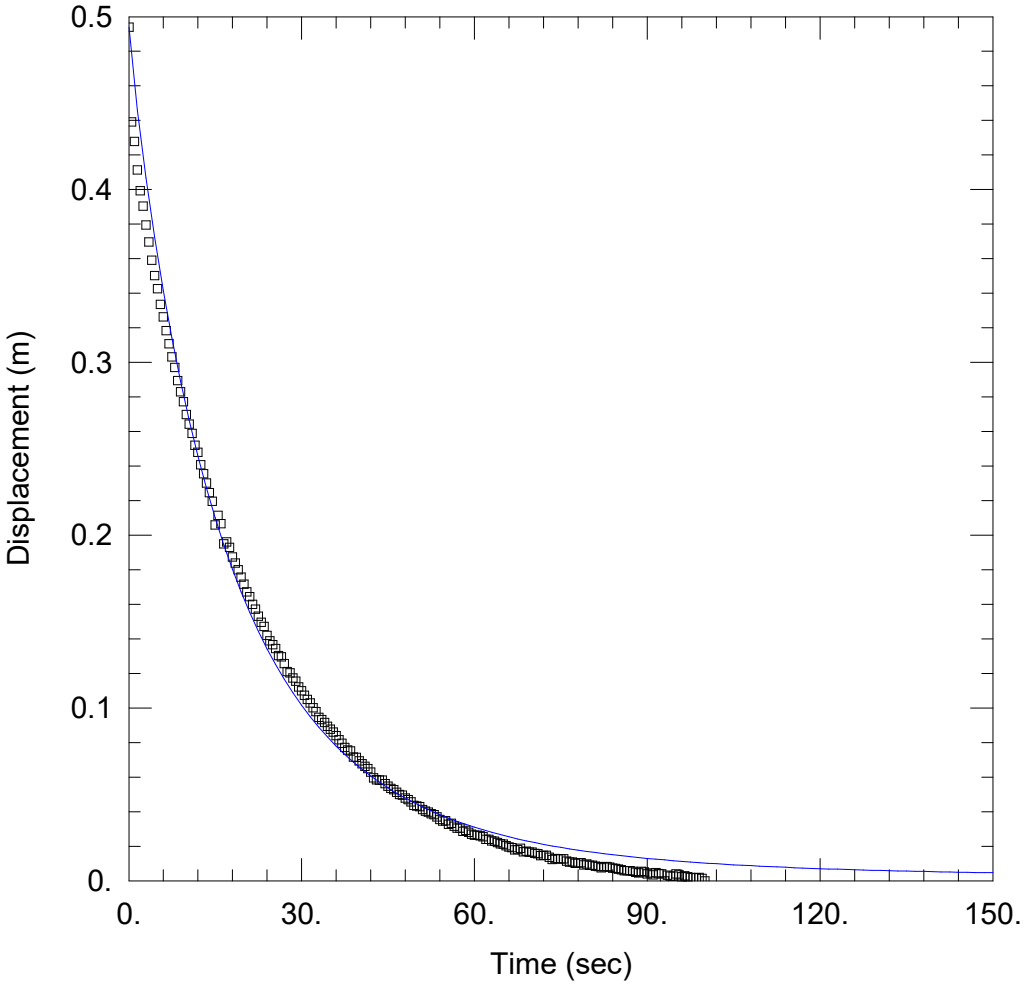
Saturated Thickness: 13.7 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (15D)

Initial Displacement: 0.3924 m
Total Well Penetration Depth: 12.7 m
Casing Radius: 0.025 m
Static Water Column Height: 13.7 m
Screen Length: 7. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 14.9 m^2/day
S = 1.0E-10



GW17-26-15D RHT

Data Set: \...\15D_RHT_CBP.aqt
Date: 06/08/18 Time: 10:11:27

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW17-26-15D
Test Date: 29/08/2017

AQUIFER DATA

Saturated Thickness: 13.7 m Anisotropy Ratio (Kz/Kr): 1.

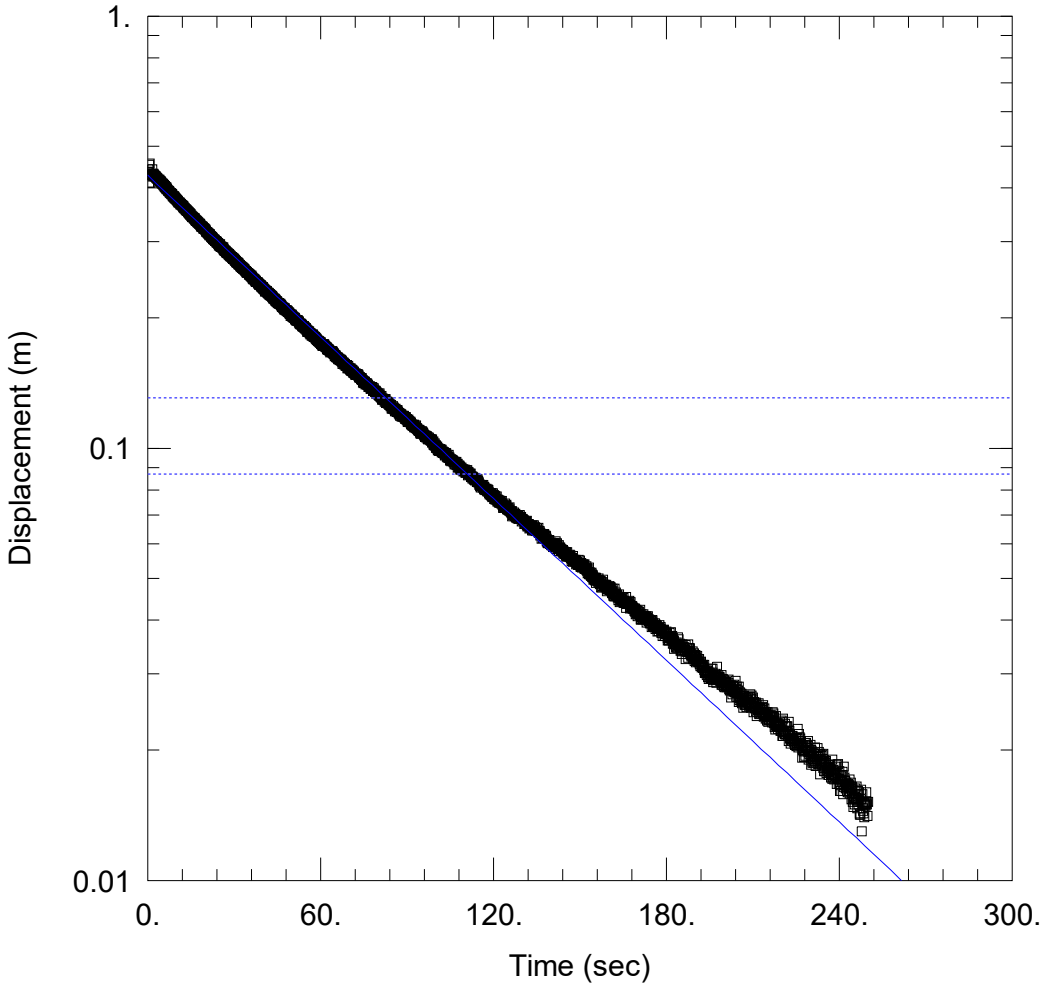
WELL DATA (15D)

Initial Displacement: 0.4939 m
Total Well Penetration Depth: 12.7 m
Casing Radius: 0.025 m
Static Water Column Height: 13.7 m
Screen Length: 7. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 13.01 m^2/day
S = 5.84E-8



GW18-26-16D FHT1

Data Set: \...\16D_FHT1.aqt
Date: 05/08/18 Time: 11:07:28

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-16D
Test Date: 15/02/18

AQUIFER DATA

Saturated Thickness: 15.17 m Anisotropy Ratio (Kz/Kr): 1.

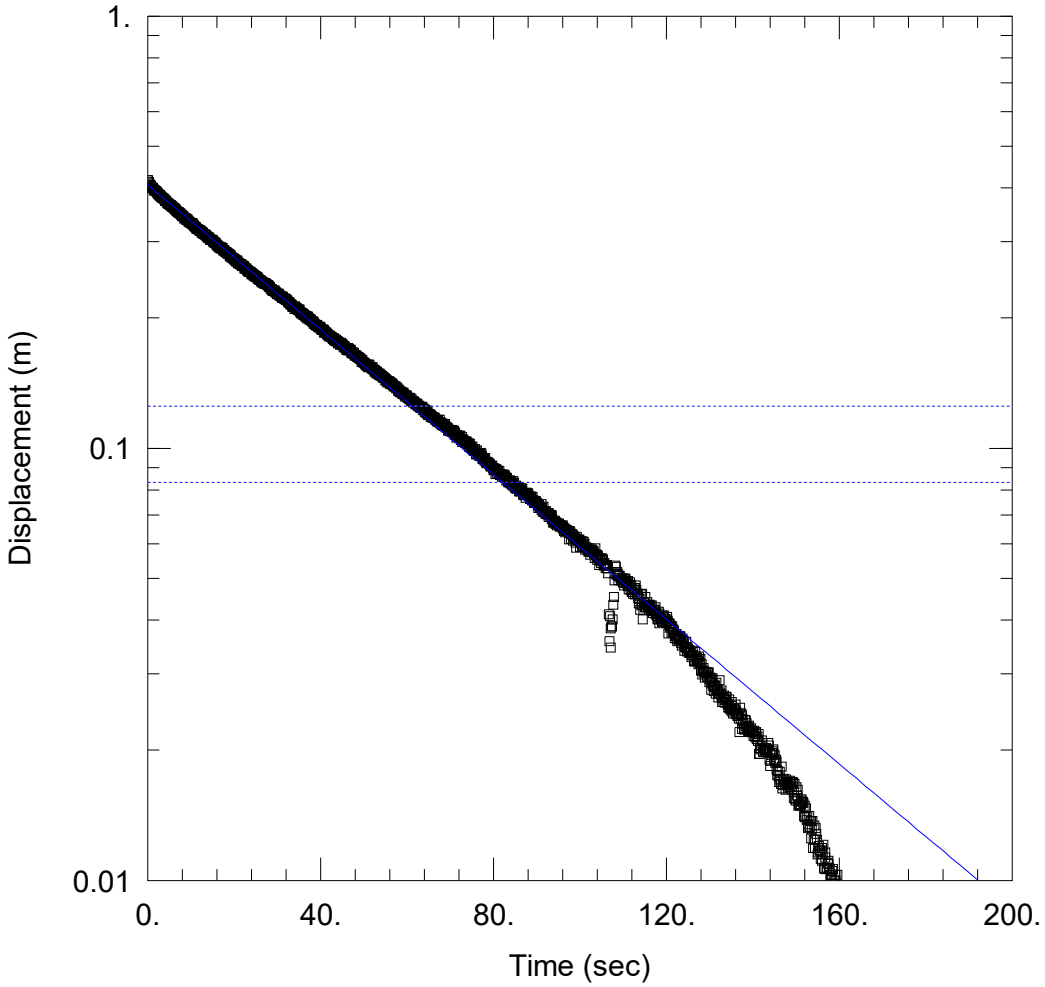
WELL DATA (GW18-26-16D)

Initial Displacement: 0.4351 m
Total Well Penetration Depth: 14.17 m
Casing Radius: 0.025 m
Static Water Column Height: 15.17 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.1757 m/day
y0 = 0.428 m



GW18-26-16D RHT1

Data Set: \...\16D_RHT1.aqt
Date: 05/08/18 Time: 11:05:32

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-16D
Test Date: 15/02/18

AQUIFER DATA

Saturated Thickness: 15.17 m Anisotropy Ratio (Kz/Kr): 1.

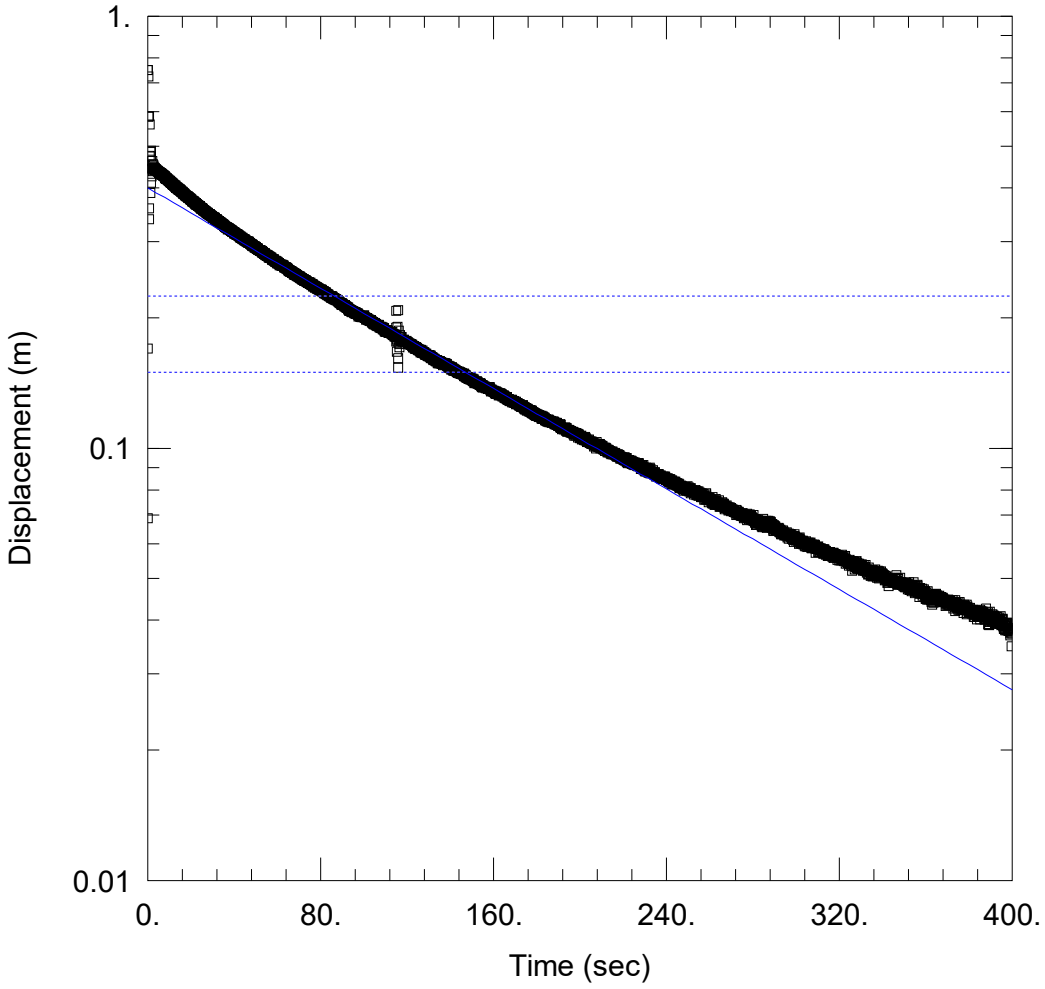
WELL DATA (GW18-26-16D)

Initial Displacement: 0.4162 m
Total Well Penetration Depth: 14.17 m
Casing Radius: 0.025 m
Static Water Column Height: 15.17 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Bouwer-Rice

K = 0.236 m/day
y0 = 0.4067 m



GW18-26-16S FHT1

Data Set: \...\16S_FHT1.aqt
Date: 05/09/18 Time: 10:07:37

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-16S
Test Date: 15/02/18

AQUIFER DATA

Saturated Thickness: 4.745 m Anisotropy Ratio (Kz/Kr): 1.

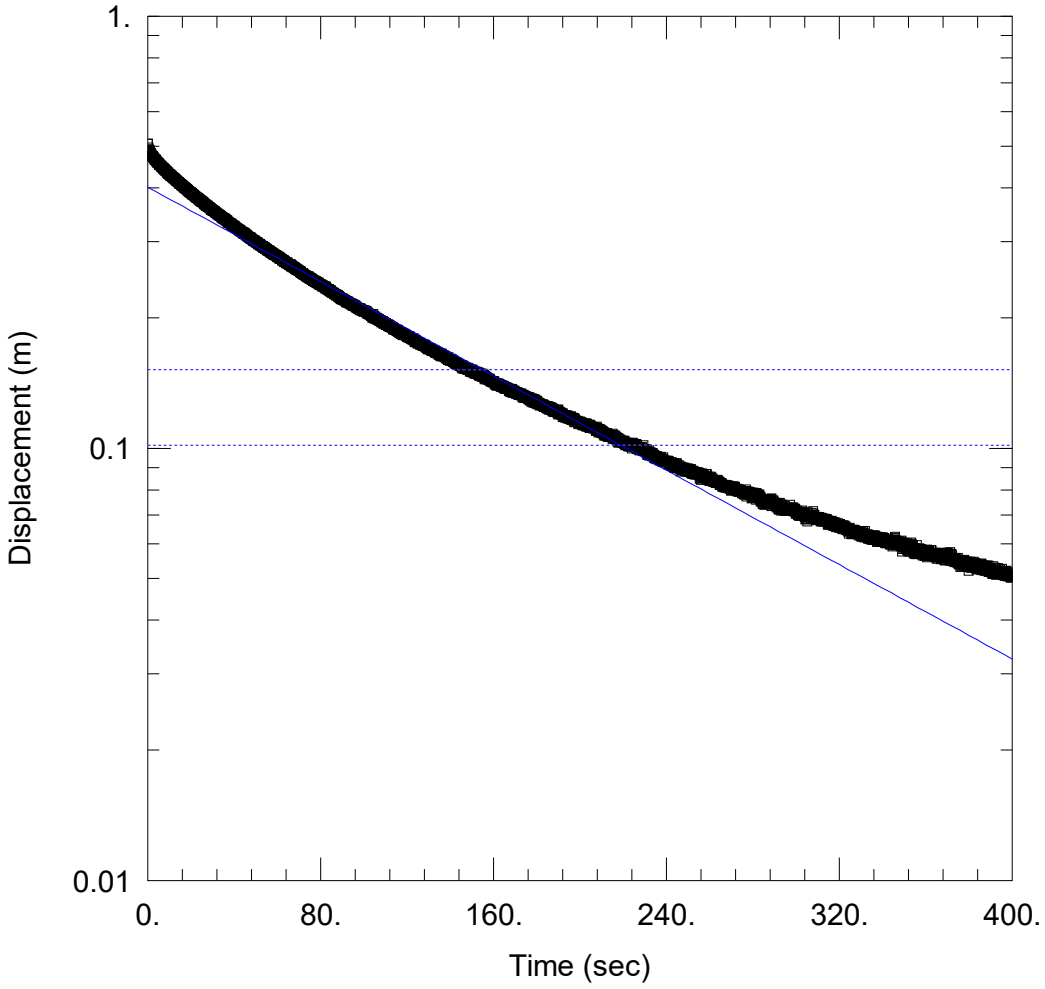
WELL DATA (GW18-26-16S)

Initial Displacement: 0.7502 m
Total Well Penetration Depth: 3.745 m
Casing Radius: 0.025 m
Static Water Column Height: 4.745 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.178 m/day
y0 = 0.4004 m



GW18-26-16S RHT1

Data Set: \...\16S_RHT1.aqt
Date: 05/09/18 Time: 10:09:03

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-GW16S
Test Date: 15/02/18

AQUIFER DATA

Saturated Thickness: 4.745 m Anisotropy Ratio (Kz/Kr): 1.

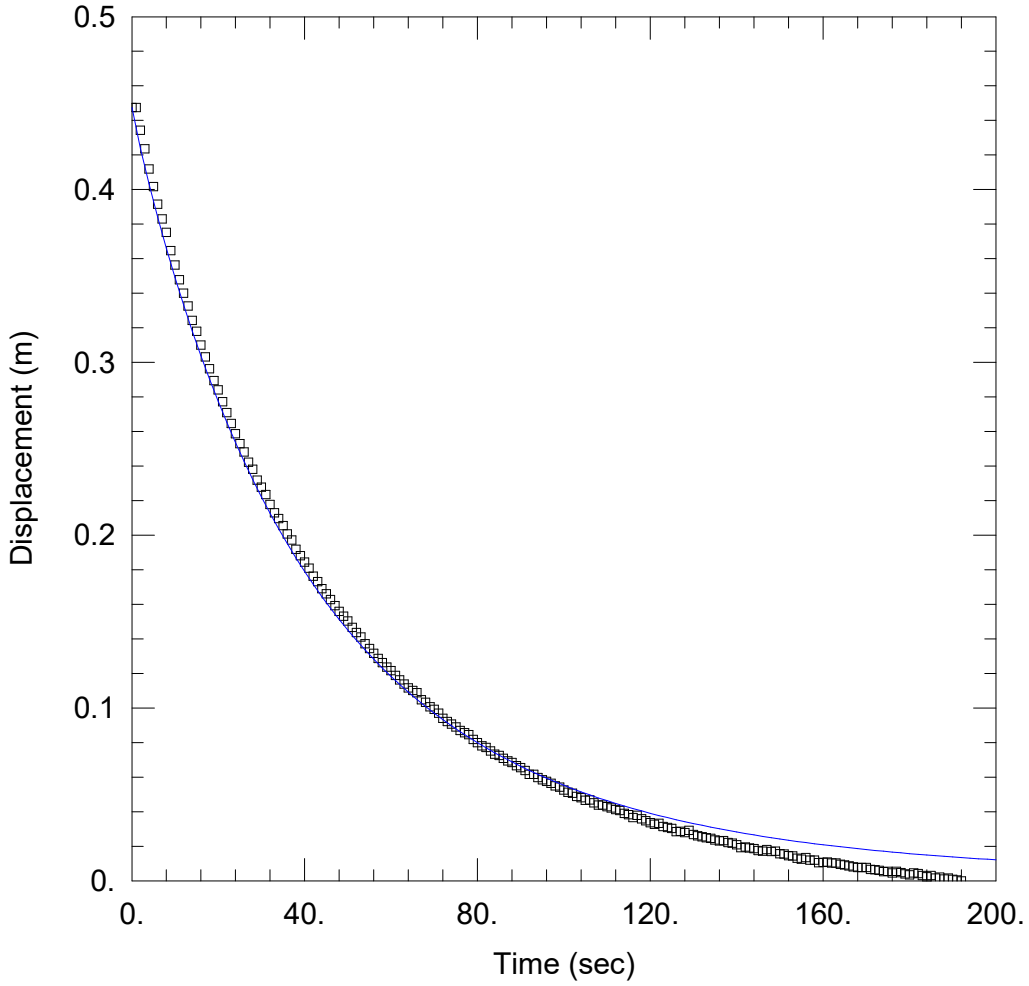
WELL DATA (GW18-26-16S)

Initial Displacement: 0.507 m
Total Well Penetration Depth: 3.745 m
Casing Radius: 0.025 m
Static Water Column Height: 4.745 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.1673 m/day
y0 = 0.4018 m



GW18-26-17D FHT1

Data Set: \...\GW18_26_17D_FHT1_CBP.aqt
Date: 06/08/18 Time: 10:12:58

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-17D
Test Date: 15/02/18

AQUIFER DATA

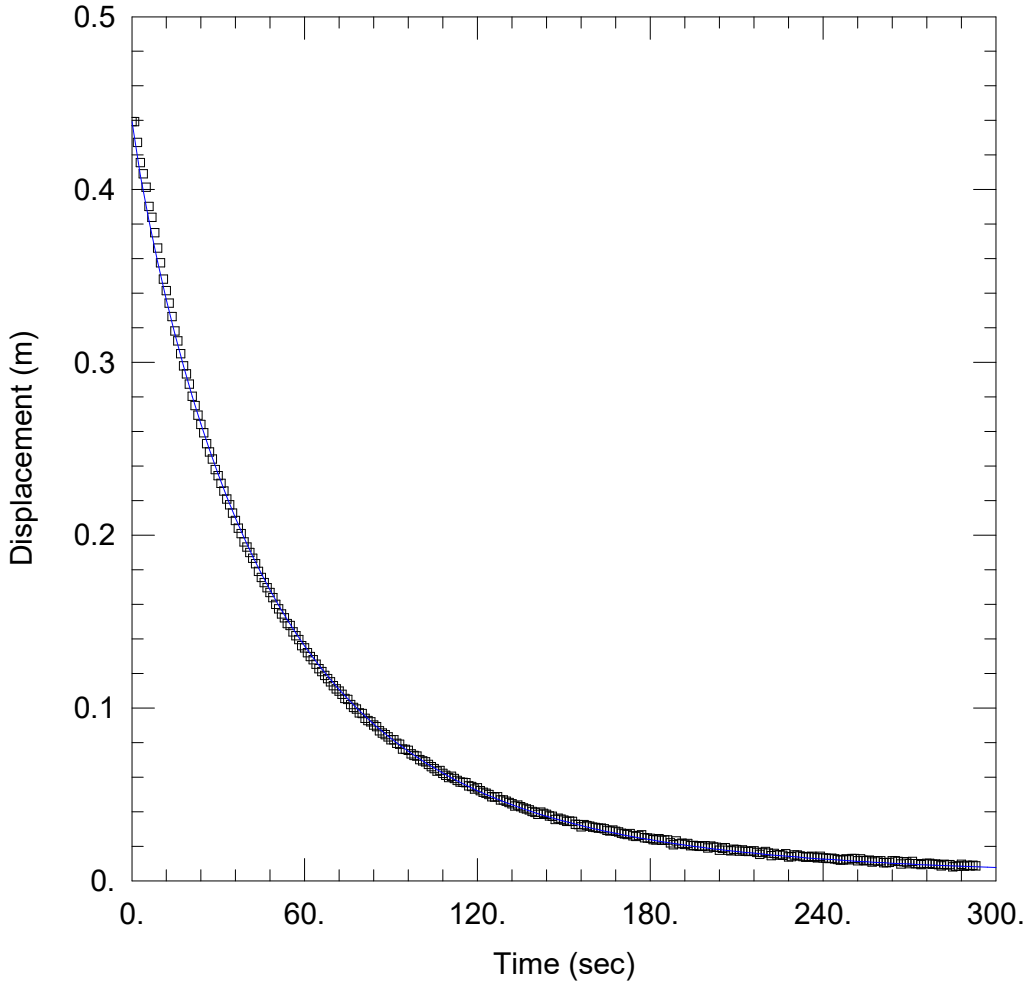
Saturated Thickness: 16.95 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-17D)

Initial Displacement: 0.4474 m
Total Well Penetration Depth: 15.95 m
Casing Radius: 0.025 m
Static Water Column Height: 16.95 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 7.326 m^2/day
S = 1.0E-10



GW18-26-17D FHT2

Data Set: \...\GW18_26_17D_FHT2_CBP.aqt
Date: 06/08/18 Time: 10:13:36

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-GW17D
Test Date: 15/02/18

AQUIFER DATA

Saturated Thickness: 16.95 m Anisotropy Ratio (Kz/Kr): 1.

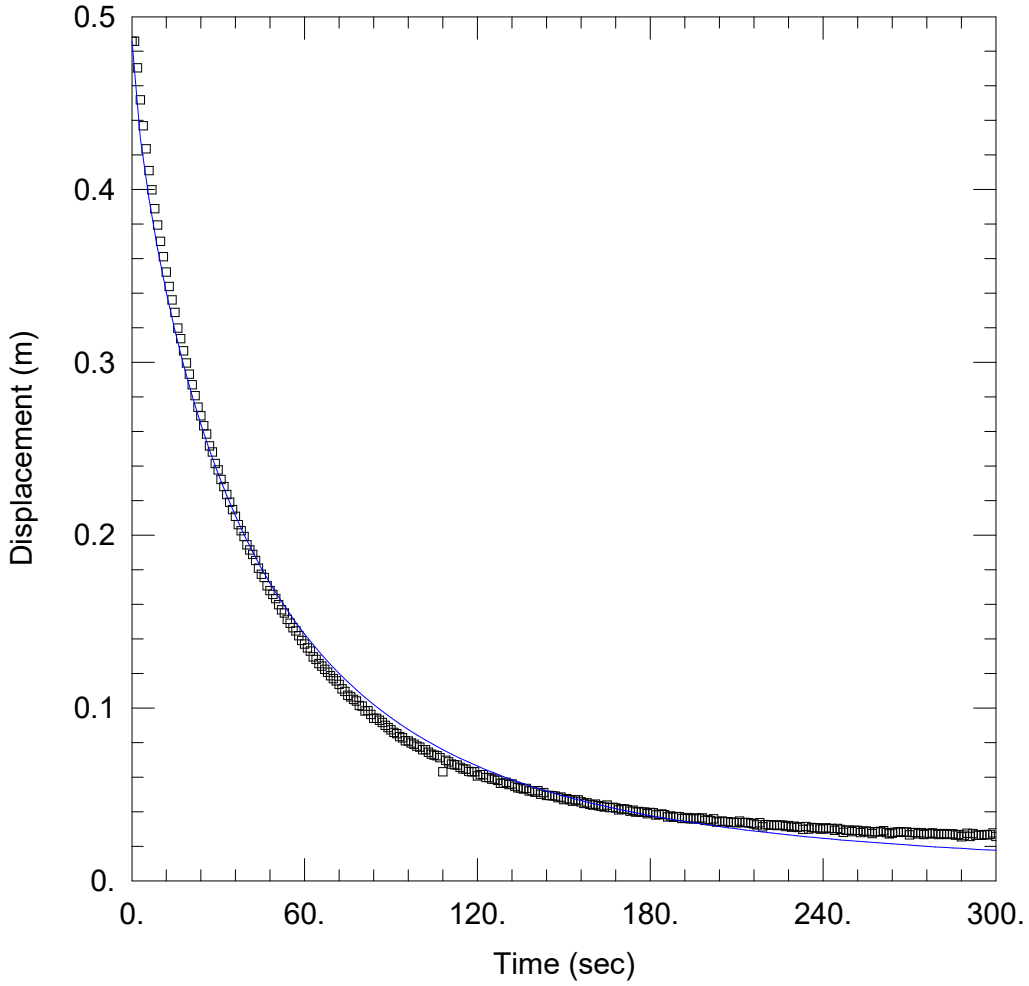
WELL DATA (GW18-26-17D)

Initial Displacement: 0.4393 m
Total Well Penetration Depth: 17.4 m
Casing Radius: 0.025 m
Static Water Column Height: 16.95 m
Screen Length: 9. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 4.837 m^2/day
S = 1.089E-7



GW18-26-17D RHT1

Data Set: \...\GW18_26_17D_RHT1_CBP.aqt
Date: 06/08/18 Time: 10:16:58

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-17D
Test Date: 15/02/18

AQUIFER DATA

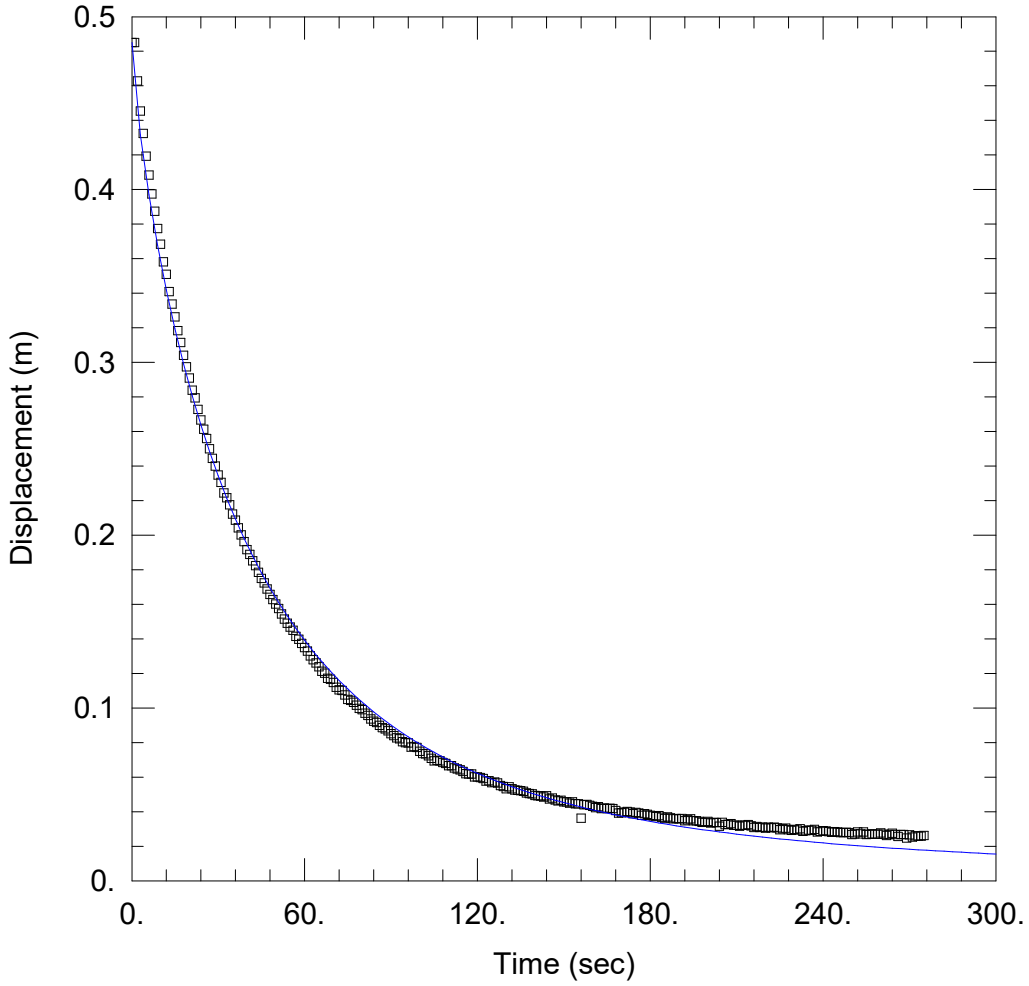
Saturated Thickness: 16.95 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-17D)

Initial Displacement: 0.4858 m
Total Well Penetration Depth: 15.95 m
Casing Radius: 0.025 m
Static Water Column Height: 16.95 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 1.968 m^2/day
S = 0.001011



GW18-26-17D RHT2

Data Set: \...\GW18_26_17D_RHT2_CBP.aqt
Date: 06/08/18 Time: 10:18:30

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-17D
Test Date: 15/02/18

AQUIFER DATA

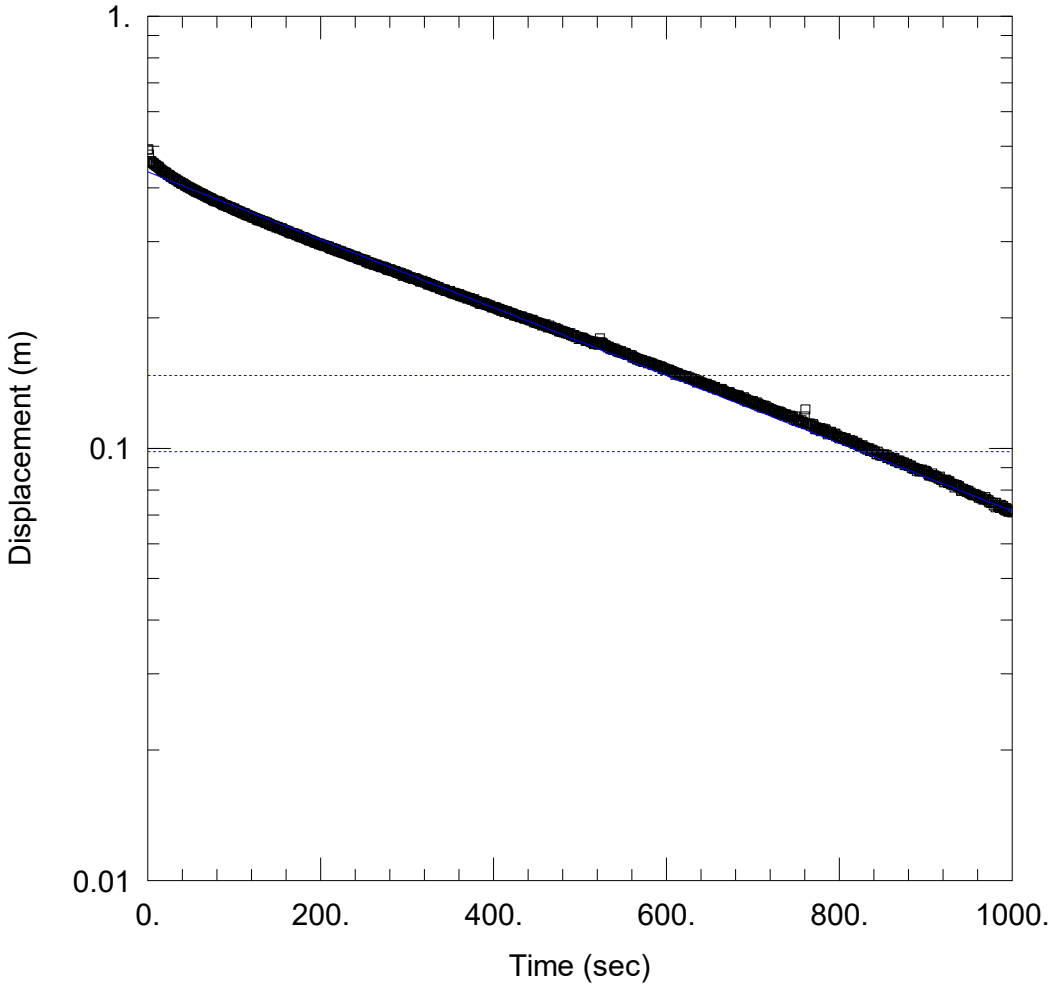
Saturated Thickness: 16.95 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-17D)

Initial Displacement: 0.4851 m
Total Well Penetration Depth: 15.95 m
Casing Radius: 0.025 m
Static Water Column Height: 16.95 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 2.235 m^2/day
S = 0.000506



GW18-26-17S FHT1

Data Set: \...\GW18_26_17S_FHT1.aqt
Date: 05/04/18 Time: 14:00:30

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-17S
Test Date: 15/02/18

AQUIFER DATA

Saturated Thickness: 5.69 m Anisotropy Ratio (Kz/Kr): 1.

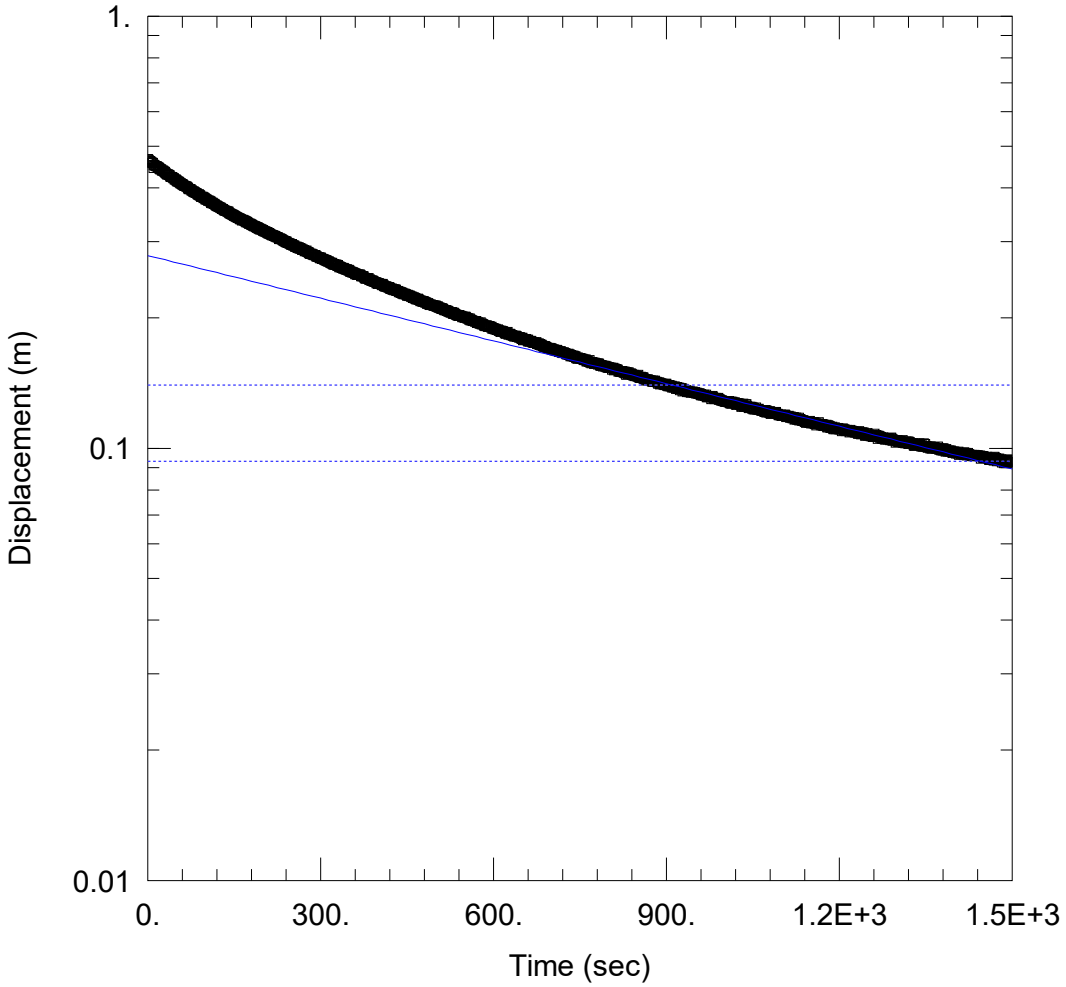
WELL DATA (GW18-26-17S)

Initial Displacement: 0.4912 m Static Water Column Height: 5.69 m
Total Well Penetration Depth: 4.69 m Screen Length: 3. m
Casing Radius: 0.025 m Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.04993 m/day y0 = 0.4355 m



GW18-26-17S RHT1

Data Set: \...\GW18_26_17S_RHT1.aqt
Date: 05/04/18 Time: 14:06:14

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-17S
Test Date: 15/02/18

AQUIFER DATA

Saturated Thickness: 5.69 m Anisotropy Ratio (Kz/Kr): 1.

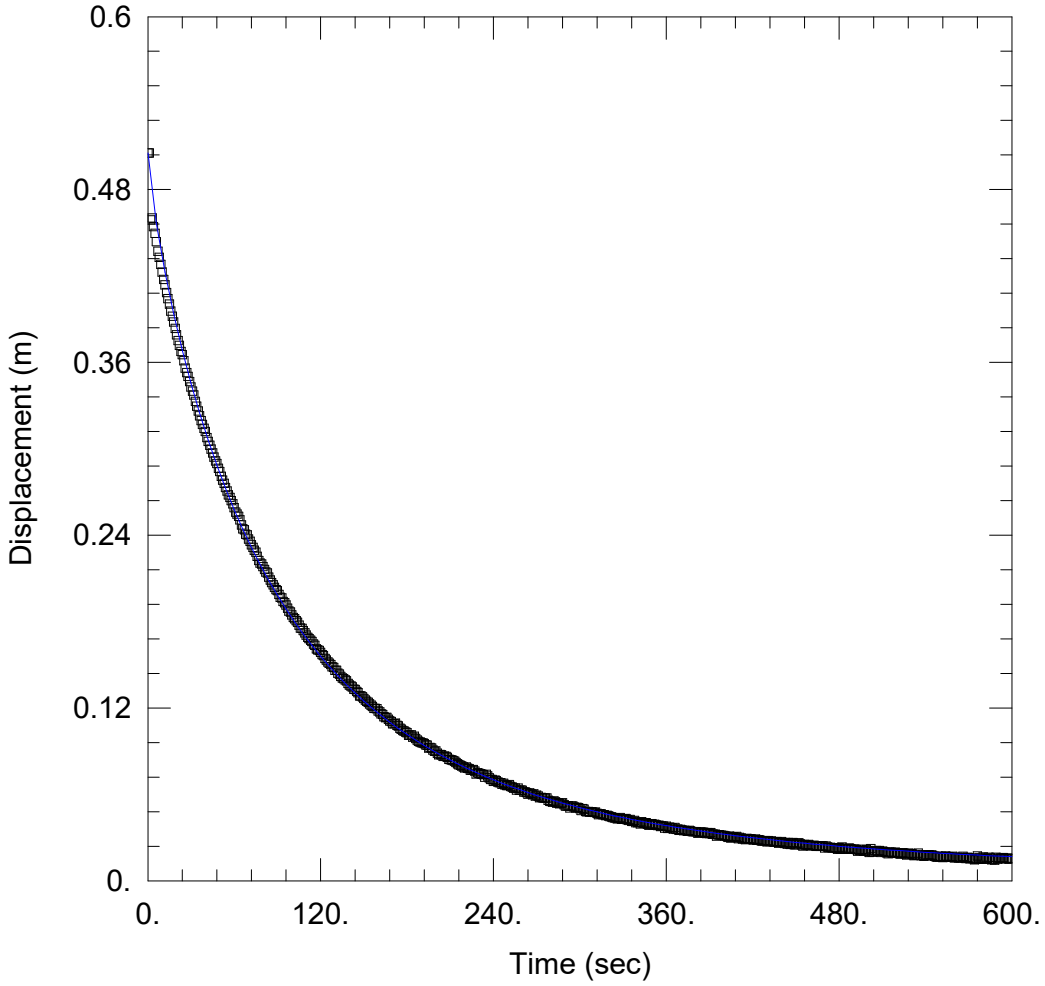
WELL DATA (GW18-26-17S)

Initial Displacement: 0.4662 m Static Water Column Height: 5.69 m
Total Well Penetration Depth: 4.69 m Screen Length: 3. m
Casing Radius: 0.025 m Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice

K = 0.02096 m/day y0 = 0.279 m



GW18-26-18D FHT1

Data Set: \...\GW18_26_18D_FHT1_CBP.aqt
Date: 06/08/18 Time: 10:20:17

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-18D
Test Date: 22/02/18

AQUIFER DATA

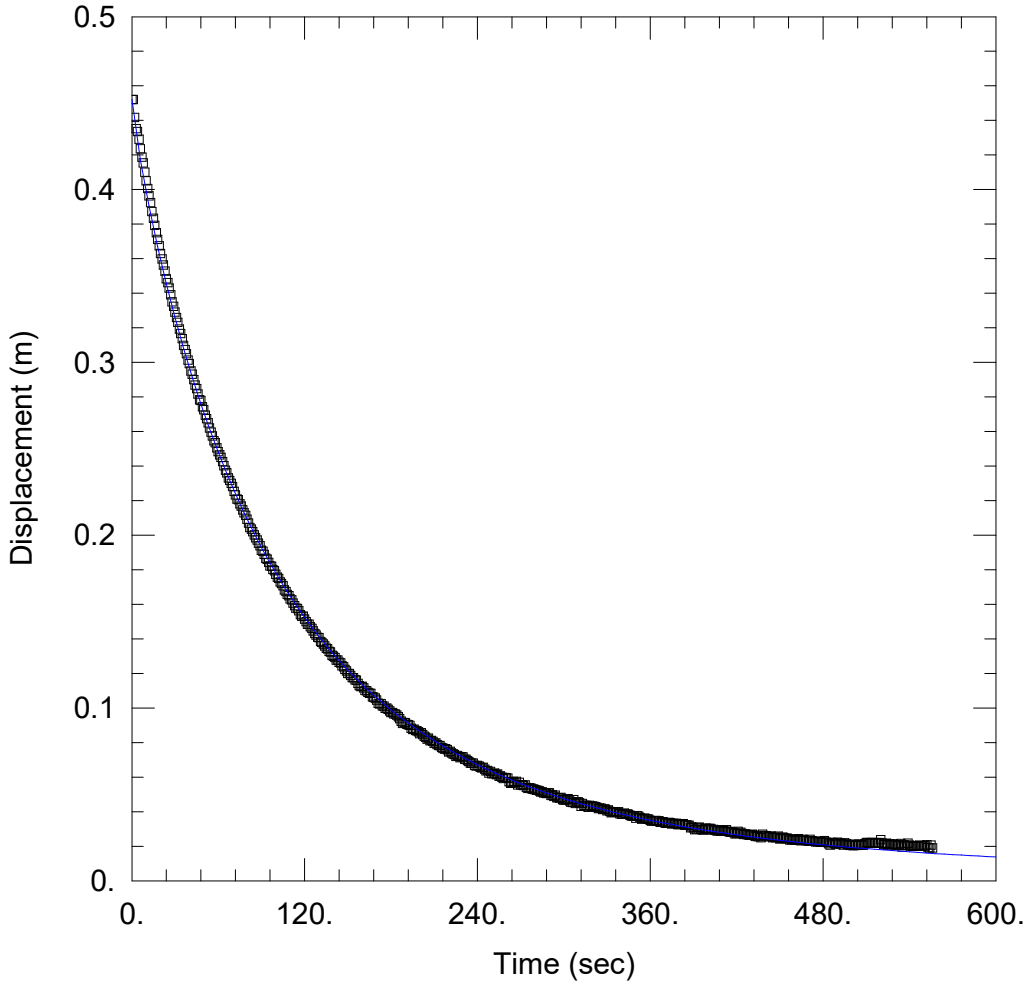
Saturated Thickness: 15.3 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-18D)

Initial Displacement: 0.5055 m
Total Well Penetration Depth: 14.3 m
Casing Radius: 0.025 m
Static Water Column Height: 15.3 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 1.147 m^2/day
S = 0.000231



GW18-26-18D FHT2

Data Set: \...\GW18_26_18D_FHT2_CBP.aqt
Date: 06/08/18 Time: 10:21:11

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-18D
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 15.3 m Anisotropy Ratio (Kz/Kr): 1.

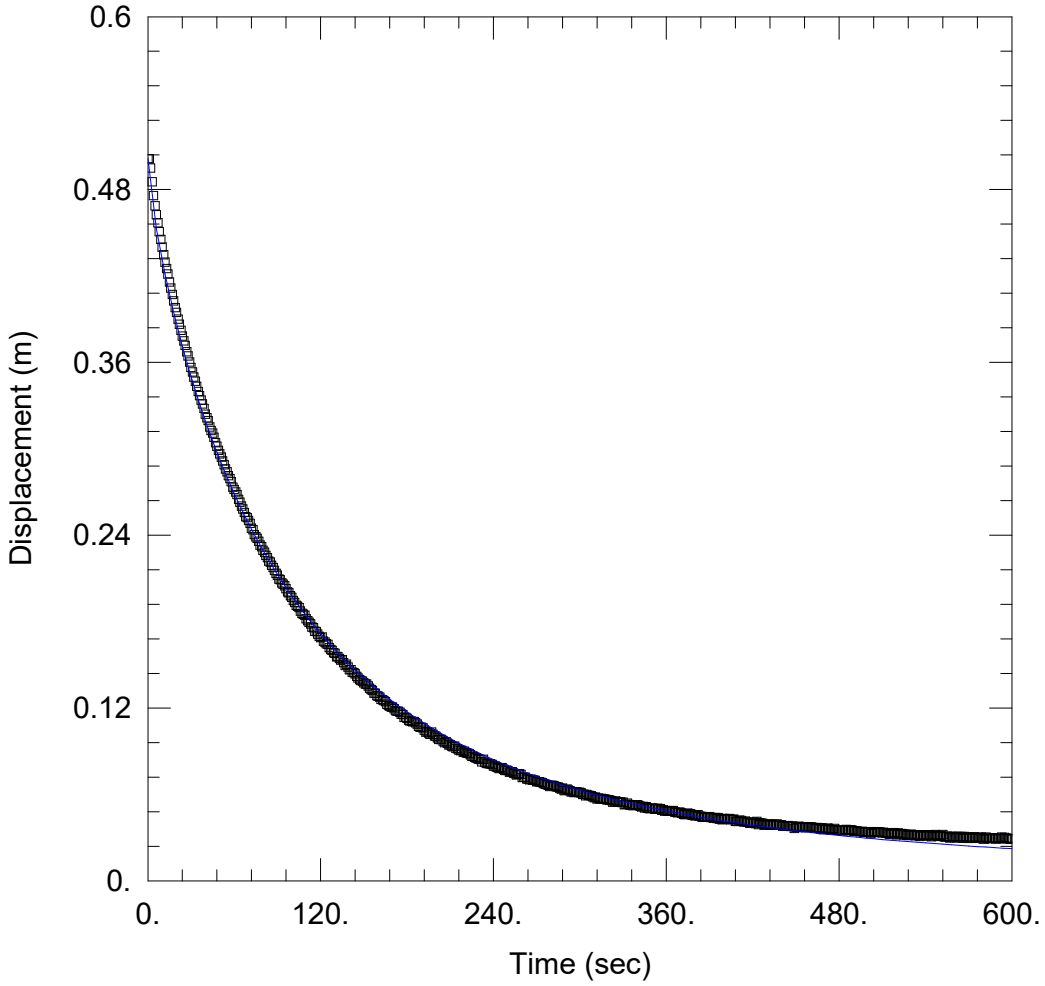
WELL DATA (GW18-26-18D)

Initial Displacement: 0.4521 m
Total Well Penetration Depth: 14.3 m
Casing Radius: 0.025 m
Static Water Column Height: 15.3 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 1.396 m^2/day
S = 1.576E-5



GW18-26-18D RHT1

Data Set: \...\GW18_26_18D_RHT1_CBP.aqt
Date: 06/08/18 Time: 10:22:13

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-18D
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 15.3 m Anisotropy Ratio (Kz/Kr): 1.

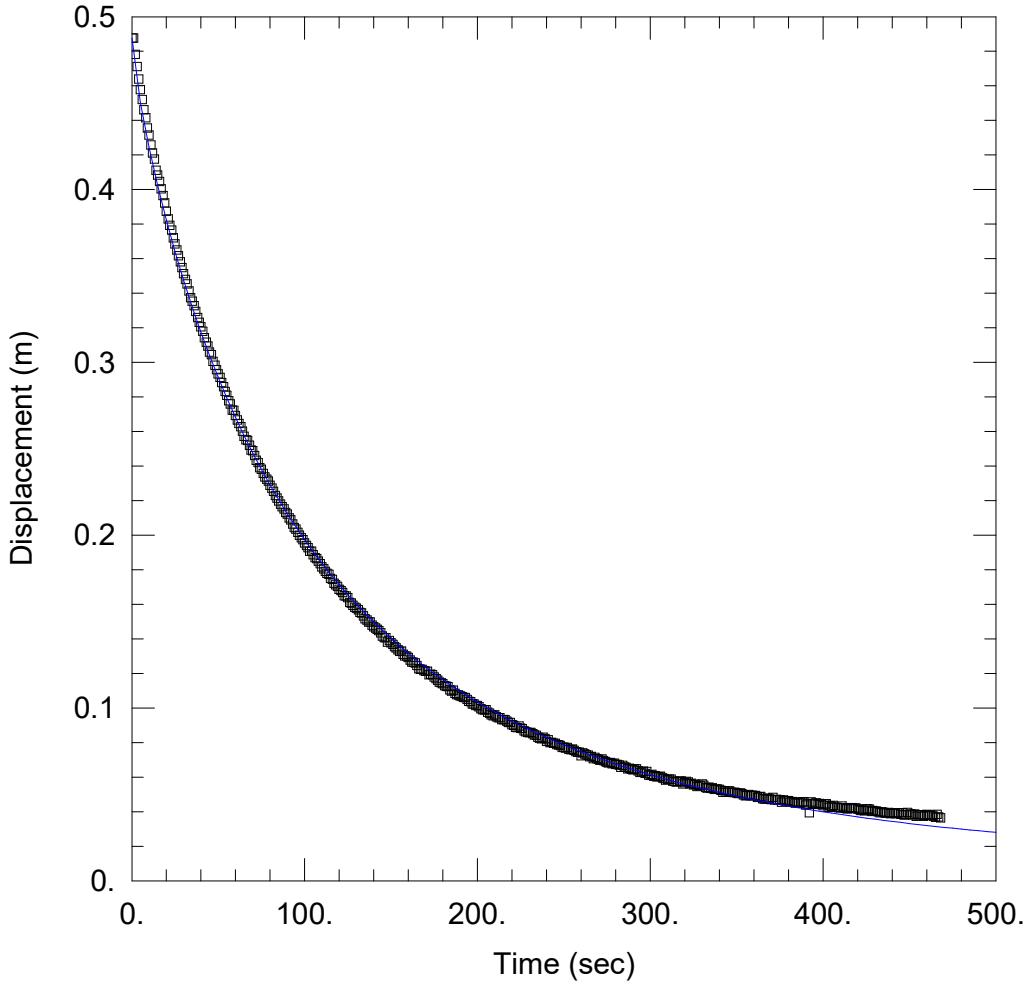
WELL DATA (GW18-26-18D)

Initial Displacement: 0.5013 m
Total Well Penetration Depth: 14.3 m
Casing Radius: 0.025 m
Static Water Column Height: 15.3 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 0.8922 m^2/day
S = 0.0005986



GW18-26-18D RHT2

Data Set: \...\GW18_26_18D_RHT2_CBP.aqt
Date: 06/08/18 Time: 10:22:57

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-18D
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 15.3 m Anisotropy Ratio (Kz/Kr): 1.

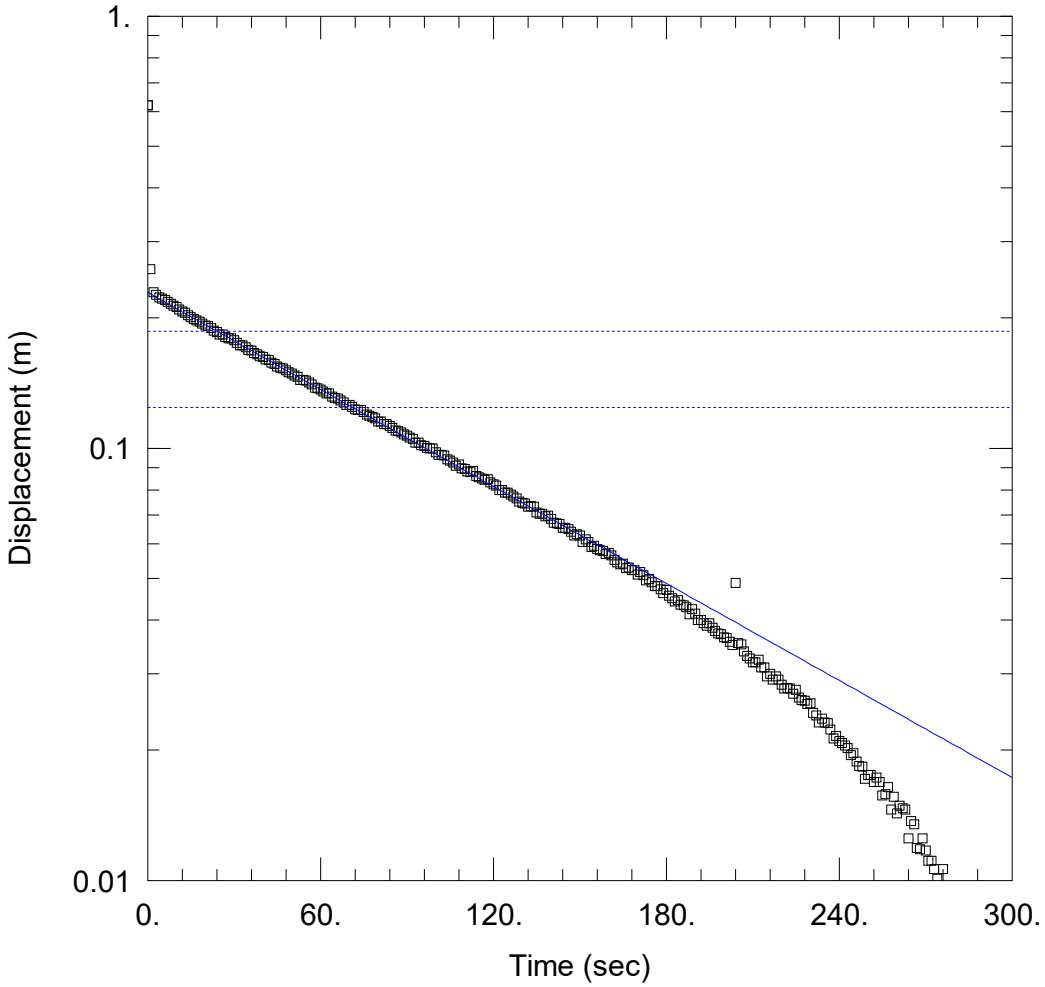
WELL DATA (GW18-26-18D)

Initial Displacement: 0.4876 m
Total Well Penetration Depth: 14.3 m
Casing Radius: 0.025 m
Static Water Column Height: 15.3 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 0.9686 m^2/day
S = 0.0002693



GW18-26-18S FHT1

Data Set: \...\GW18-26-18S_FHT1.aqt
Date: 05/03/18 Time: 11:36:21

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-18S
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 3.39 m Anisotropy Ratio (Kz/Kr): 1.

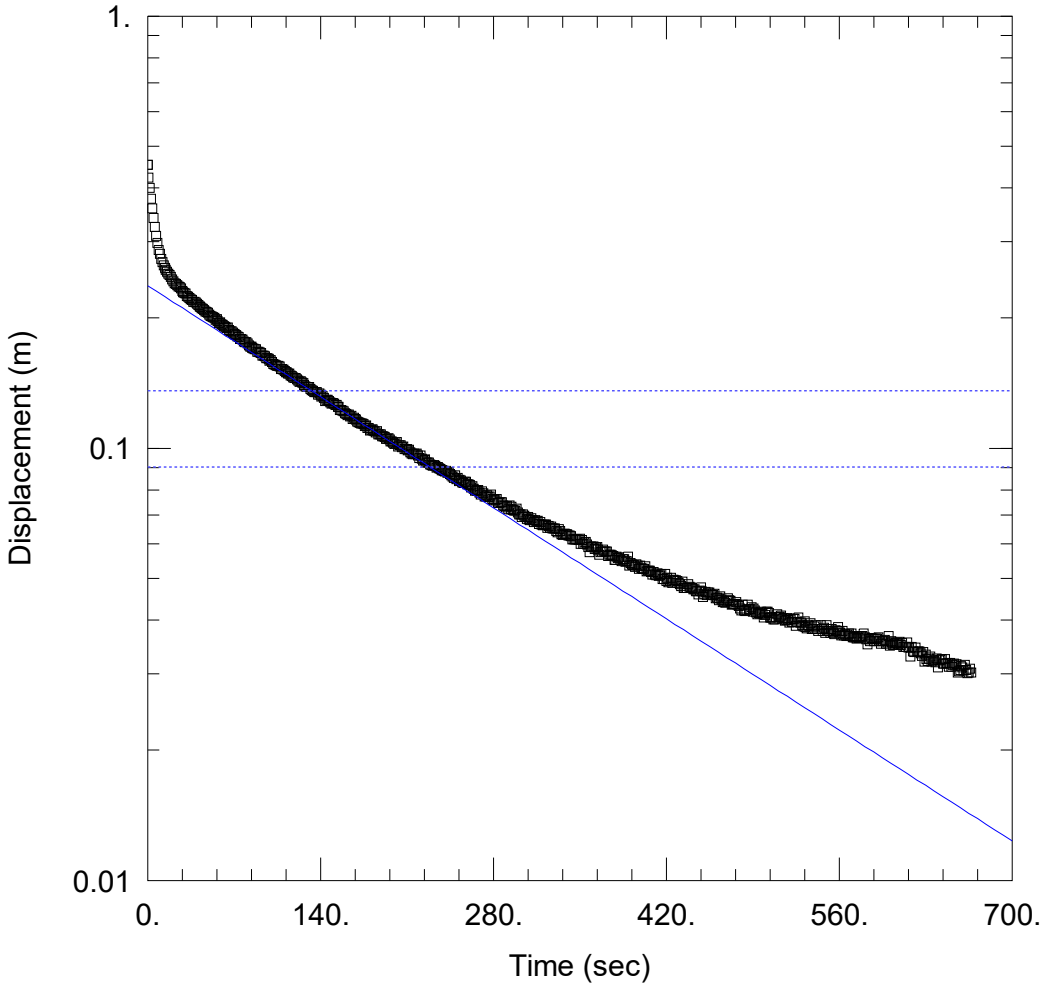
WELL DATA (GW18-26-18S)

Initial Displacement: 0.6205 m
Total Well Penetration Depth: 2.39 m
Casing Radius: 0.025 m
Static Water Column Height: 3.39 m
Screen Length: 2.39 m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.2576 m/day
y0 = 0.2292 m



GW18-26-18S FHT2

Data Set: \...\GW18-26-18S_FHT2.aqt
Date: 05/03/18 Time: 11:35:09

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-18S
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 3.39 m Anisotropy Ratio (Kz/Kr): 1.

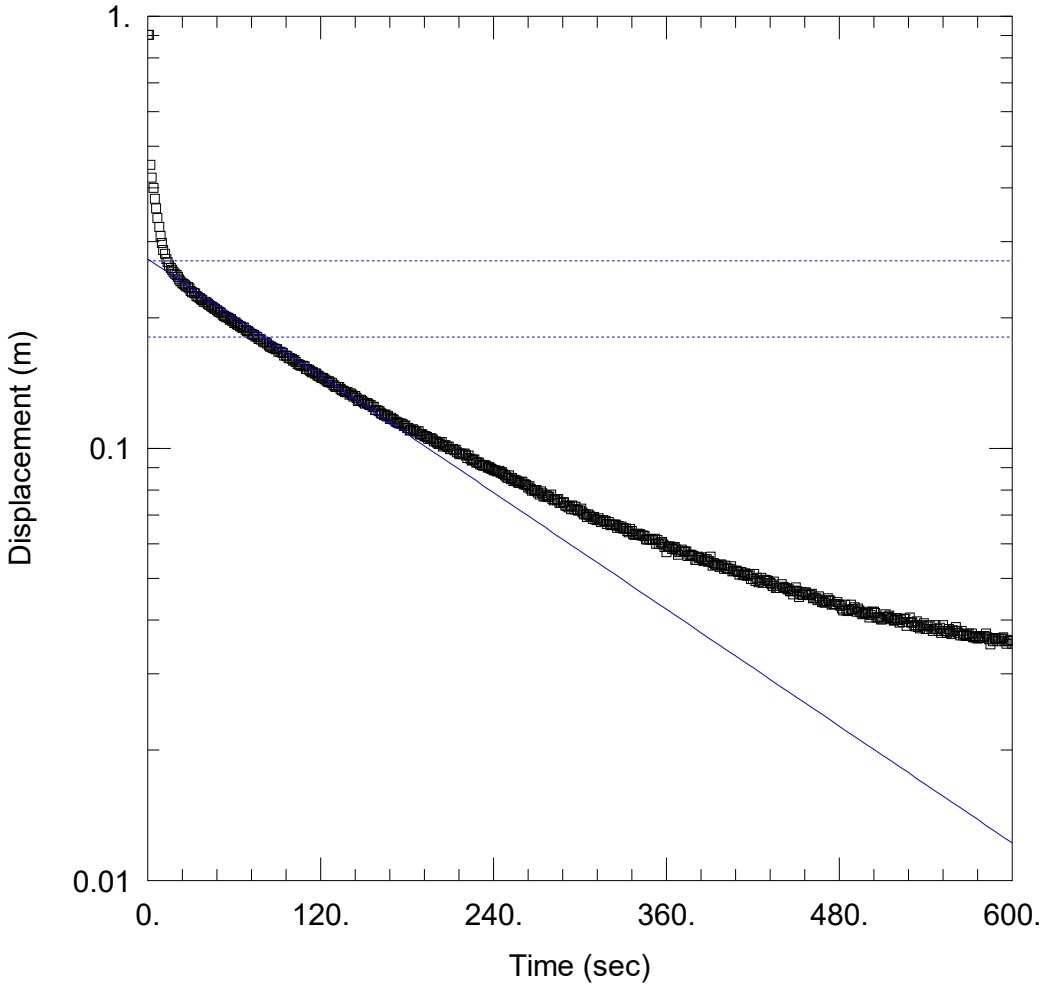
WELL DATA (GW18-26-18S)

Initial Displacement: 0.4522 m
Total Well Penetration Depth: 2.39 m
Casing Radius: 0.025 m
Static Water Column Height: 3.39 m
Screen Length: 2.39 m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.1264 m/day
y0 = 0.2377 m



GW18-26-18S RHT1

Data Set: \...\GW18-26-18S_RHT1.aqt
Date: 05/11/18 Time: 10:11:26

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-18S
Test Date: 15/02/18

AQUIFER DATA

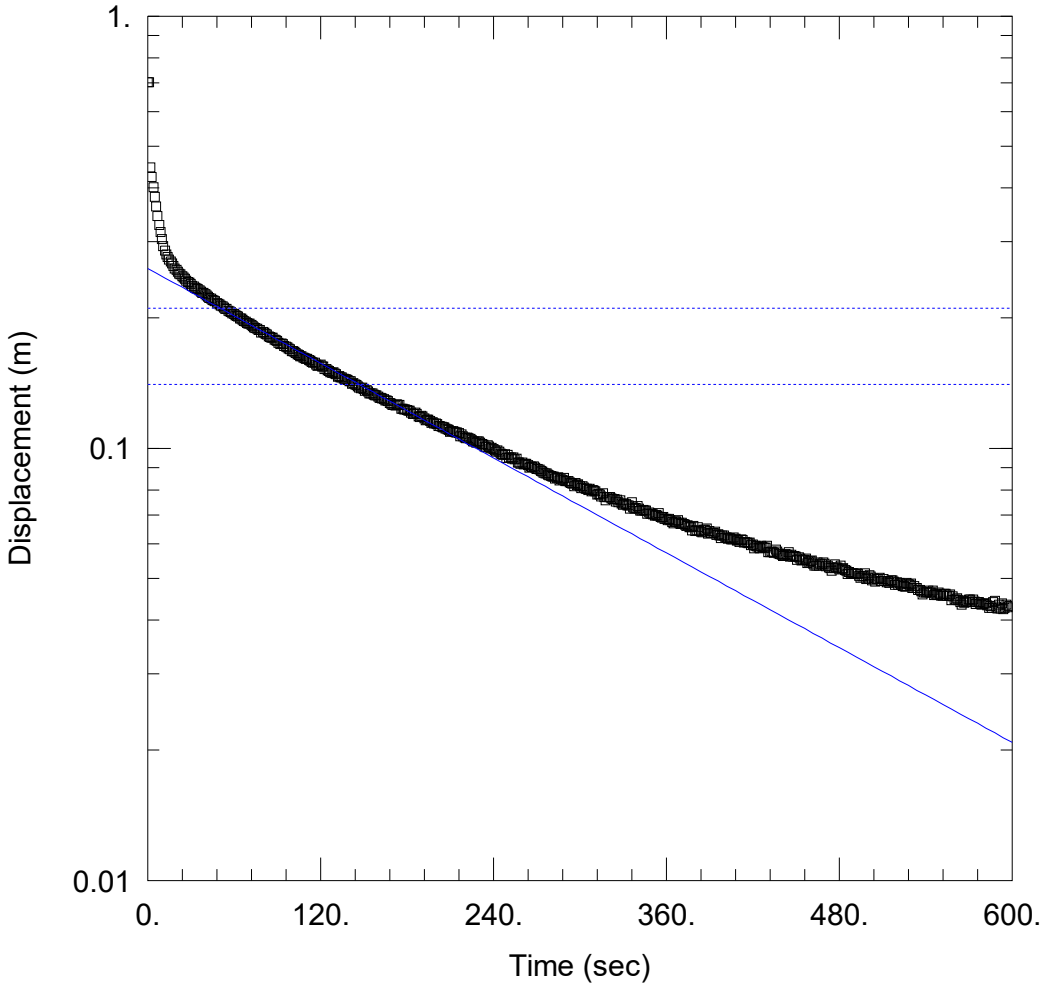
Saturated Thickness: 3.39 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-18S)

Initial Displacement: 0.9037 m
Total Well Penetration Depth: 2.39 m
Casing Radius: 0.025 m
Static Water Column Height: 3.39 m
Screen Length: 2.39 m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.1551 m/day
y0 = 0.2742 m



GW18-26-18S RHT2

Data Set: \...\GW18-26-18S_RHT2.aqt
Date: 05/11/18 Time: 10:18:48

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-18S
Test Date: 15/02/18

AQUIFER DATA

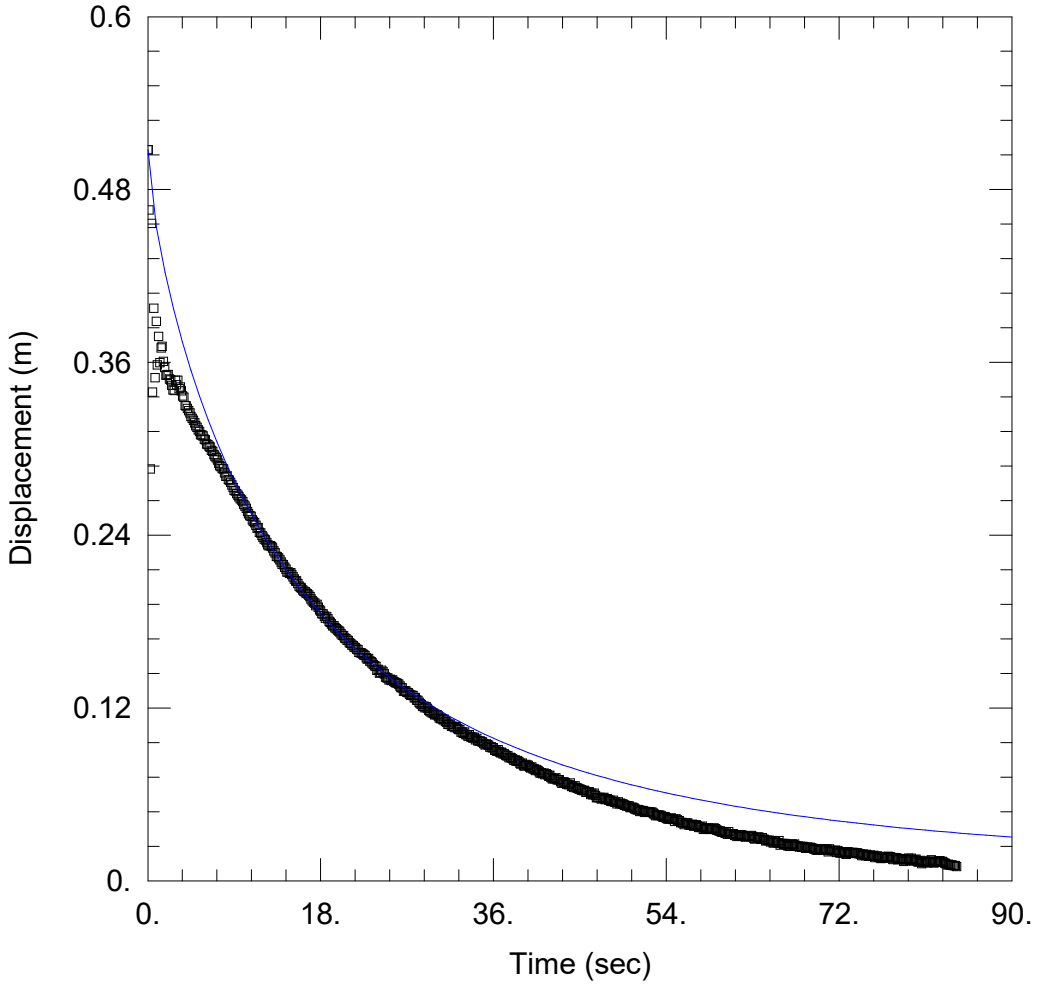
Saturated Thickness: 3.39 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-18S)

Initial Displacement: 0.7019 m
Total Well Penetration Depth: 5.28 m
Casing Radius: 0.025 m
Static Water Column Height: 3.39 m
Screen Length: 3. m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.1536 m/day
y0 = 0.2606 m



GW18-26-19D FHT1

Data Set: \...\19D_FHT1_CBP.aqt
Date: 06/08/18 Time: 10:24:09

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-19D
Test Date: 15/02/18

AQUIFER DATA

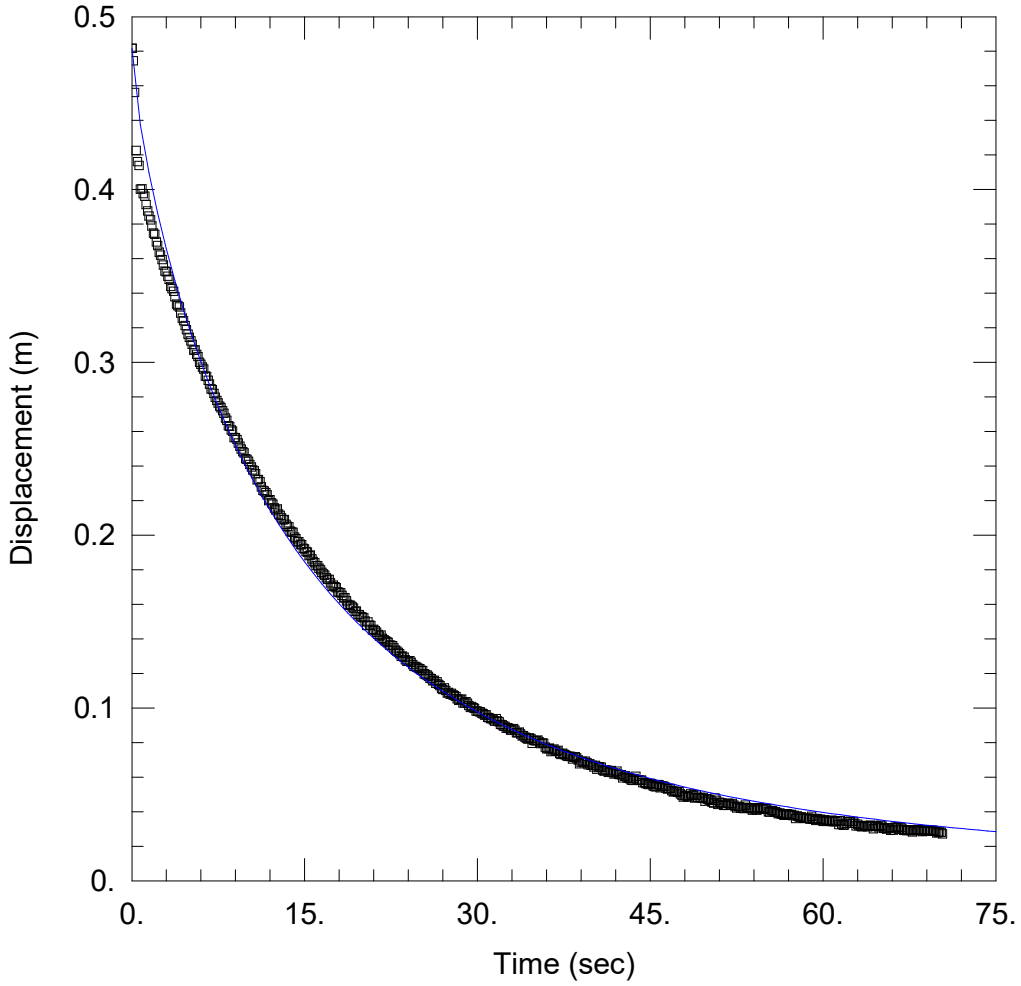
Saturated Thickness: 14.4 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-19D)

Initial Displacement: 0.5077 m
Total Well Penetration Depth: 13.4 m
Casing Radius: 0.025 m
Static Water Column Height: 14.4 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 4.387 m^2/day
S = 0.002181



GW18-26-19D RHT1

Data Set: \...\19D_RHT1_CBP.aqt
Date: 06/08/18 Time: 10:24:52

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-19D
Test Date: 15/02/18

AQUIFER DATA

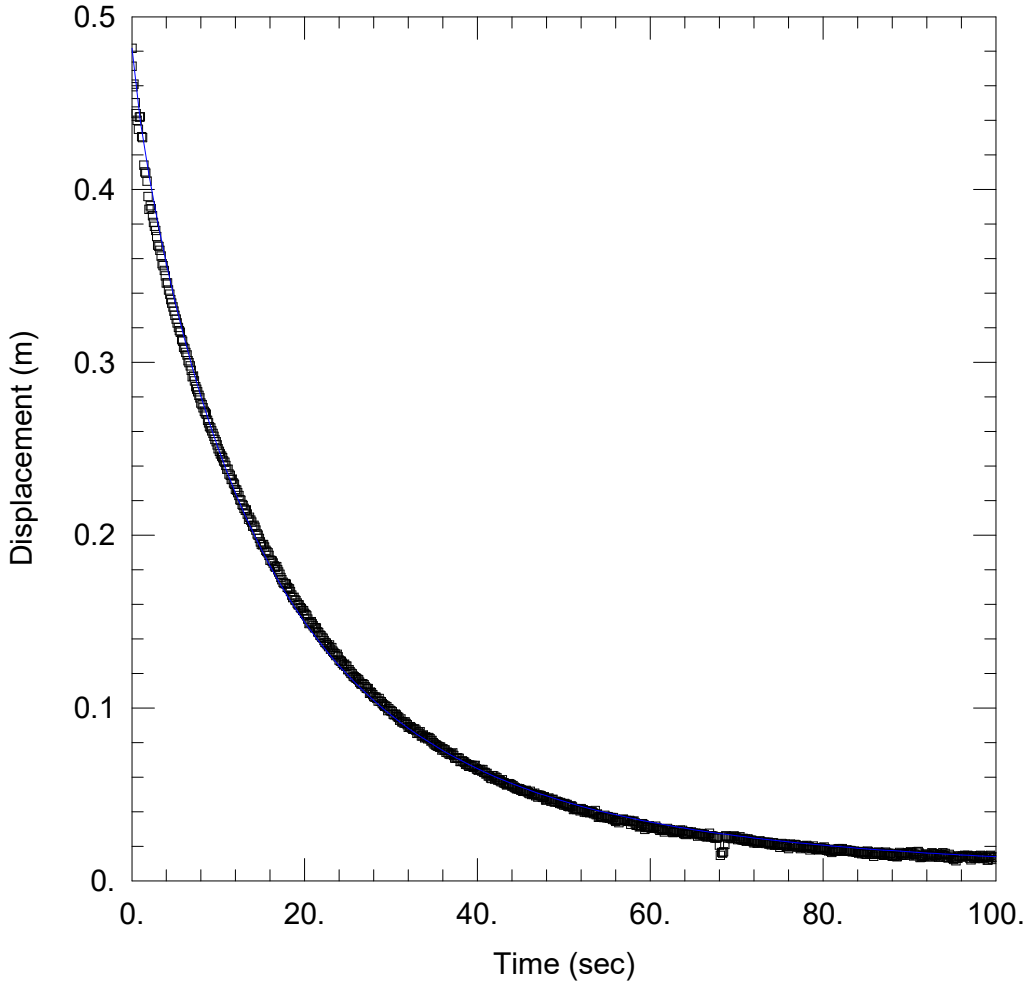
Saturated Thickness: 14.4 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-19D)

Initial Displacement: 0.4817 m
Total Well Penetration Depth: 13.4 m
Casing Radius: 0.025 m
Static Water Column Height: 14.4 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 5.691 m^2/day
S = 0.0009979



GW18-26-19D RHT2

Data Set: \...\19D_RHT2_CBP.aqt
Date: 06/08/18 Time: 10:25:34

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-19D
Test Date: 15/02/18

AQUIFER DATA

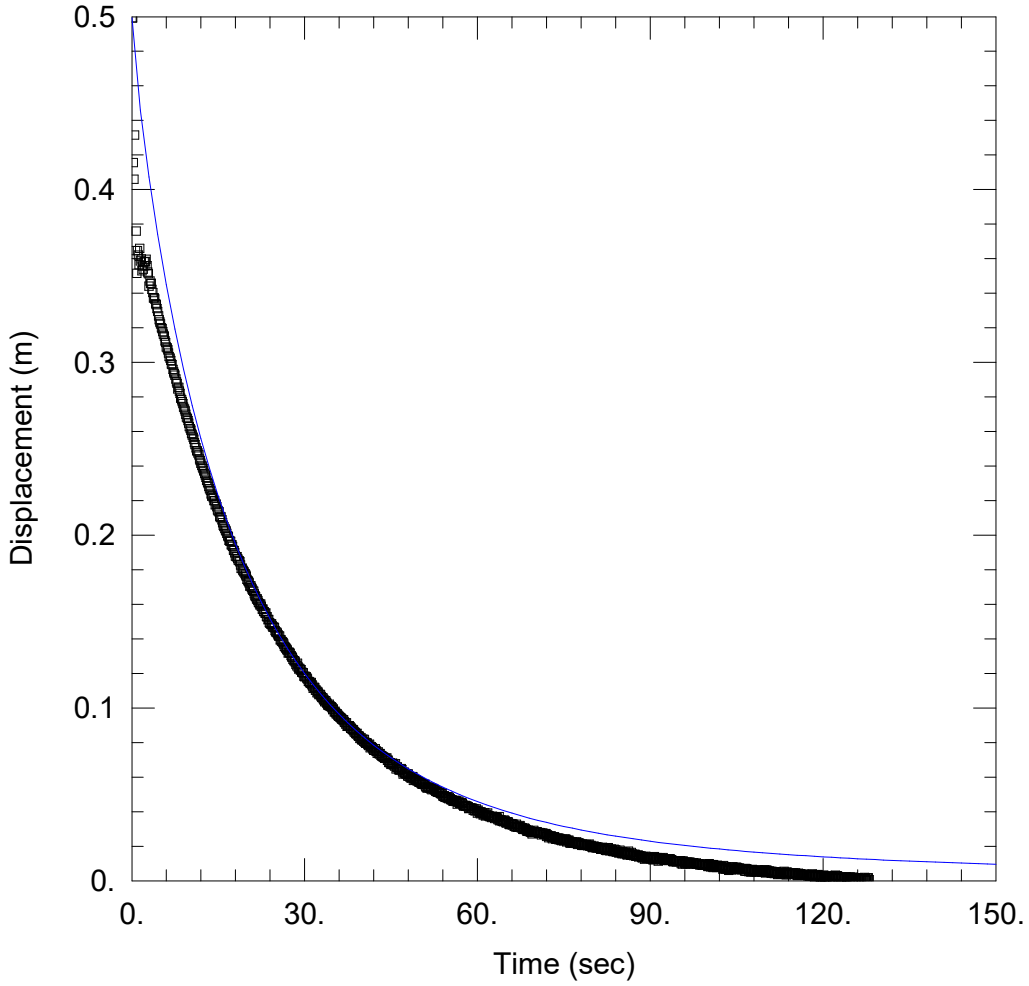
Saturated Thickness: 14.4 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-19D)

Initial Displacement: 0.4817 m
Total Well Penetration Depth: 13.4 m
Casing Radius: 0.025 m
Static Water Column Height: 14.4 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 8.072 m^2/day
S = 5.398E-5



GW18-26-20D FHT2

Data Set: \...\GW18-26-20D_FHT2_CBP.aqt
Date: 06/08/18 Time: 10:30:30

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-20D
Test Date: 15/02/18

AQUIFER DATA

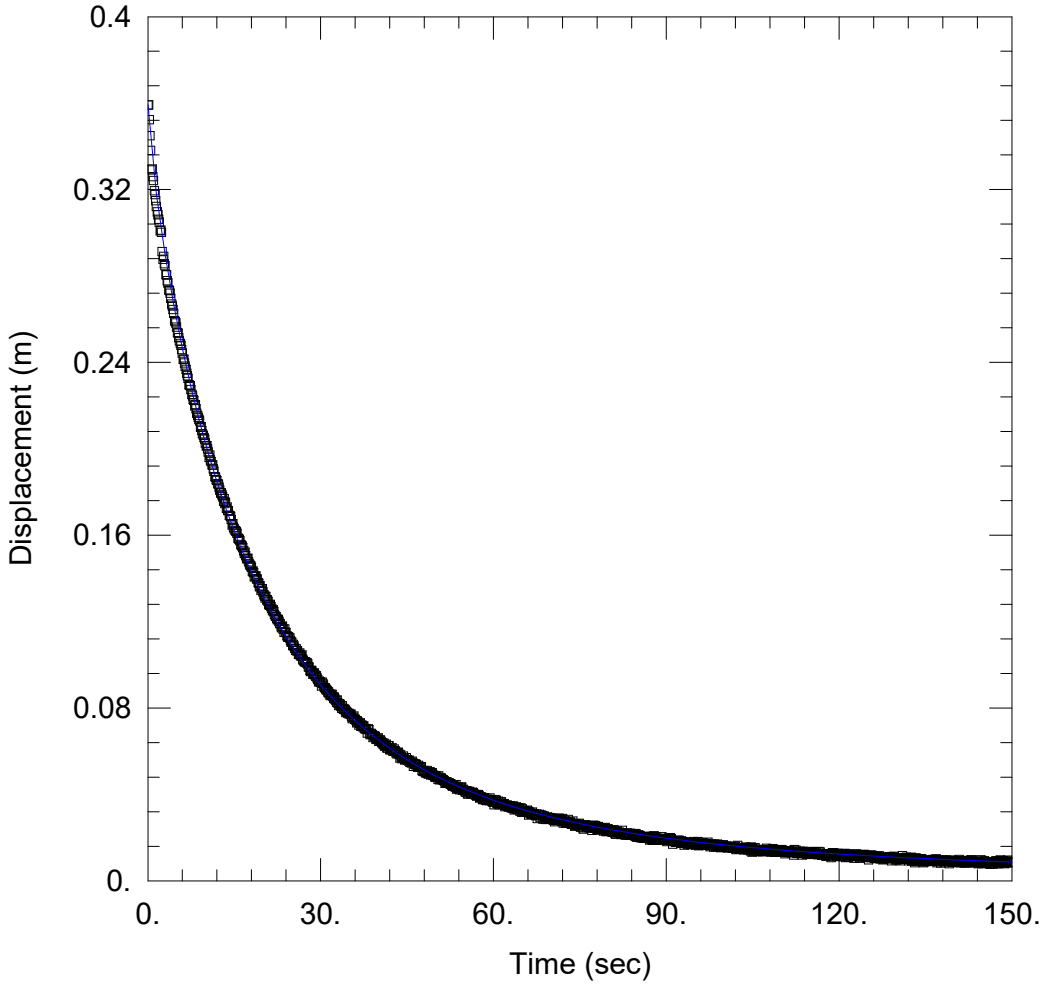
Saturated Thickness: 15.06 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-20D)

Initial Displacement: 0.4994 m
Total Well Penetration Depth: 14.06 m
Casing Radius: 0.025 m
Static Water Column Height: 15.06 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 6.904 m^2/day
S = 5.342E-5



GW18-26-20D RHT1

Data Set: \...\GW18-26-20D_RHT1_CBP.aqt
Date: 06/08/18 Time: 10:28:47

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-20D
Test Date: 15/02/18

AQUIFER DATA

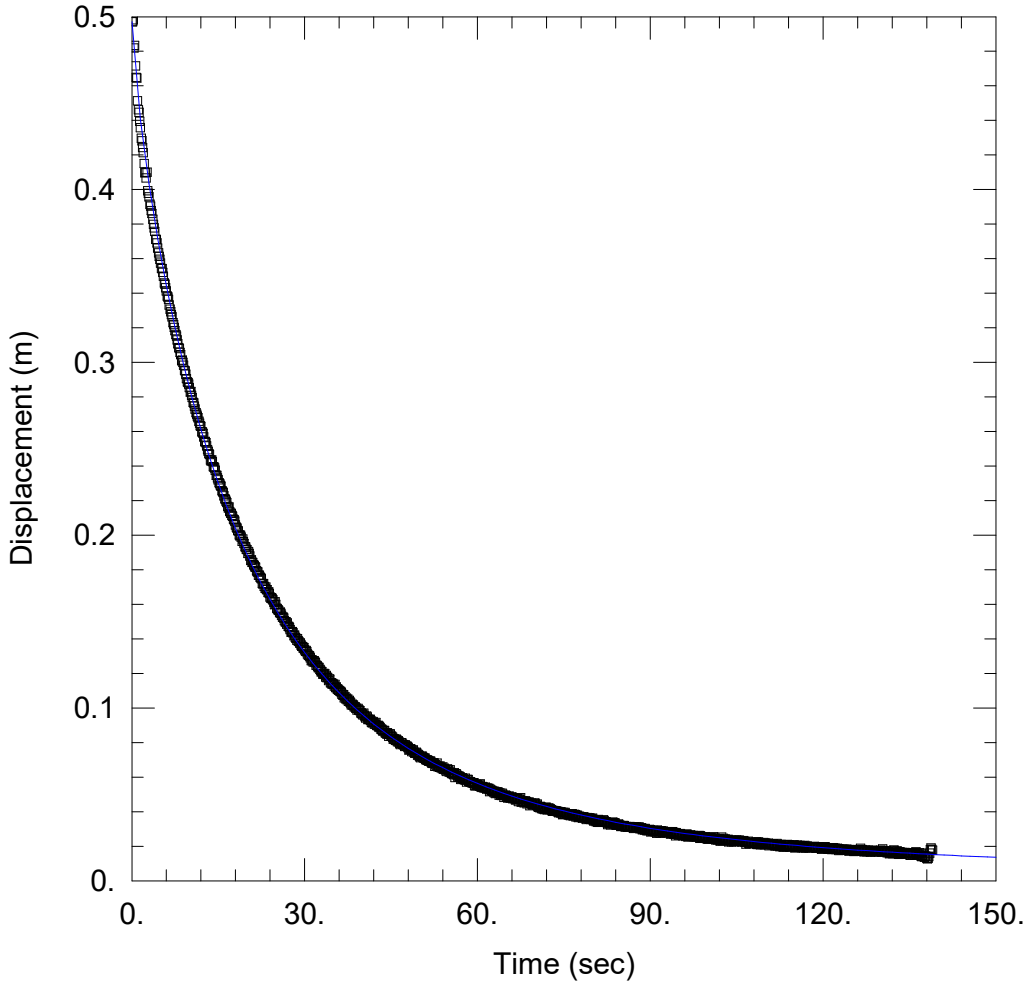
Saturated Thickness: 15.06 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-20D)

Initial Displacement: 0.3592 m
Total Well Penetration Depth: 14.06 m
Casing Radius: 0.025 m
Static Water Column Height: 15.06 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 5.55 m^2/day
S = 0.0002579



GW18-26-20D RHT2

Data Set: \...\GW18-26-20D_RHT2_CBP.aqt
Date: 06/08/18 Time: 10:29:43

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-20D
Test Date: 15/02/18

AQUIFER DATA

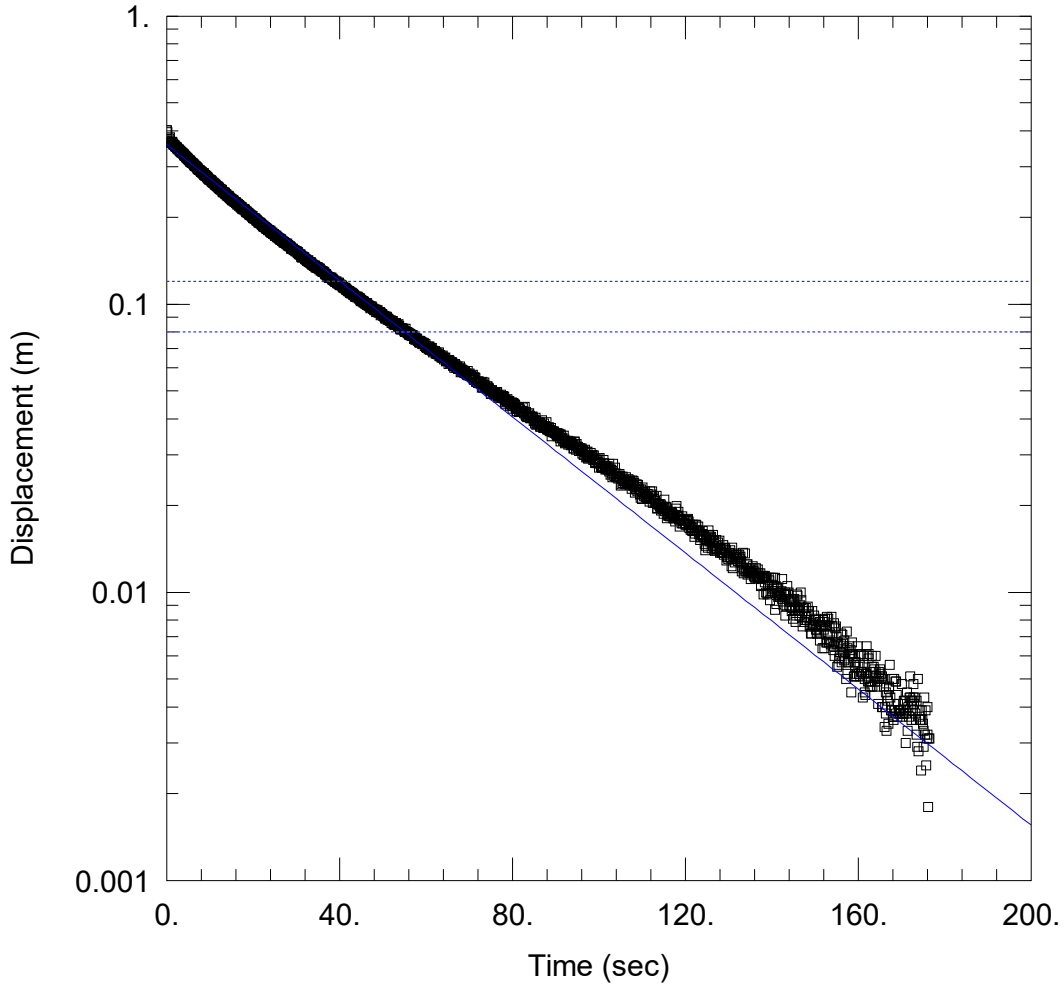
Saturated Thickness: 15.06 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-20D)

Initial Displacement: 0.4971 m
Total Well Penetration Depth: 14.06 m
Casing Radius: 0.025 m
Static Water Column Height: 15.06 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 5.046 m^2/day
S = 0.0003674



GW18-26-20S FHT

Data Set: \...\GW18-26-20S_FHT1.aqt
Date: 05/09/18 Time: 10:29:10

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-20S
Test Date: 15/02/18

AQUIFER DATA

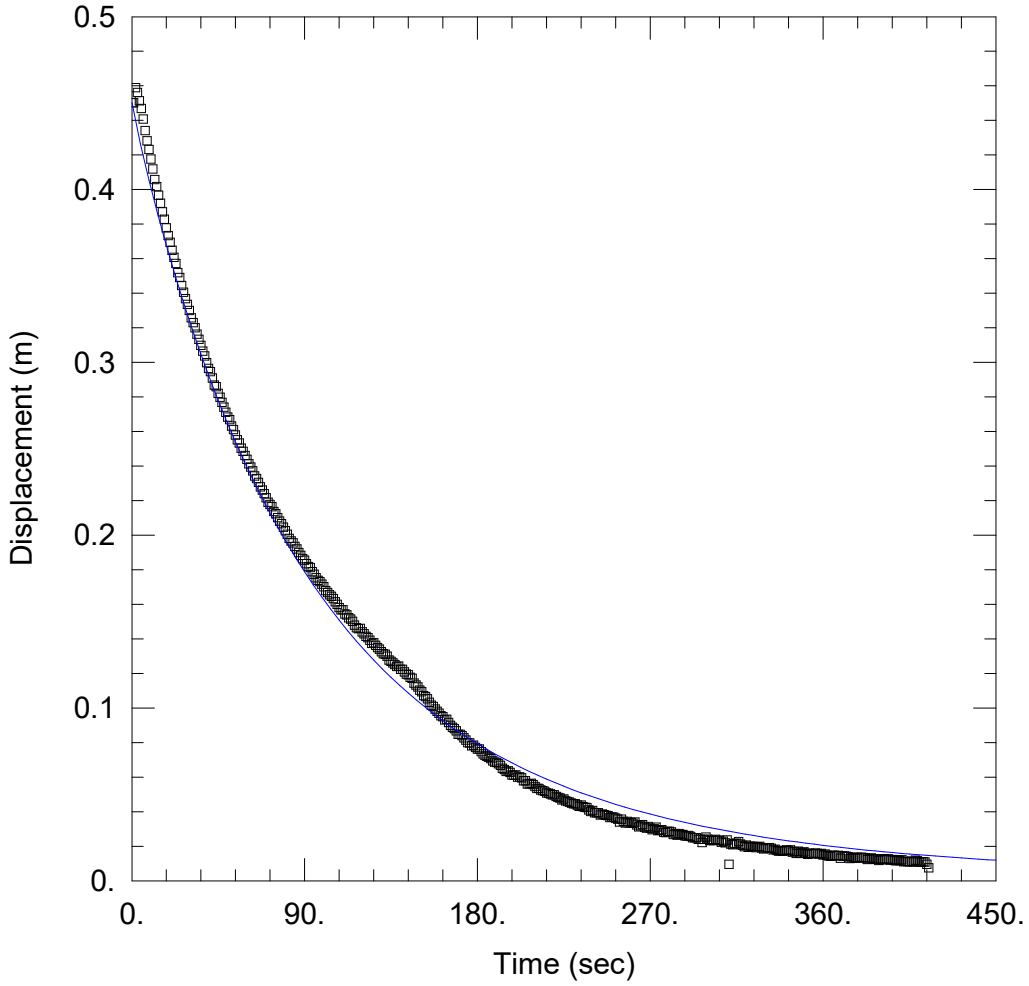
Saturated Thickness: 3.98 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-20S)

Initial Displacement: 0.4002 m Static Water Column Height: 3.98 m
Total Well Penetration Depth: 2.98 m Screen Length: 2.98 m
Casing Radius: 0.025 m Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined Solution Method: Bouwer-Rice
K = 0.6989 m/day y0 = 0.3579 m



GW18-26-21D FHT1

Data Set: \...\21D_FHT1_CBP.aqt
Date: 06/08/18 Time: 10:31:46

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-21D
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 13.21 m Anisotropy Ratio (Kz/Kr): 1.

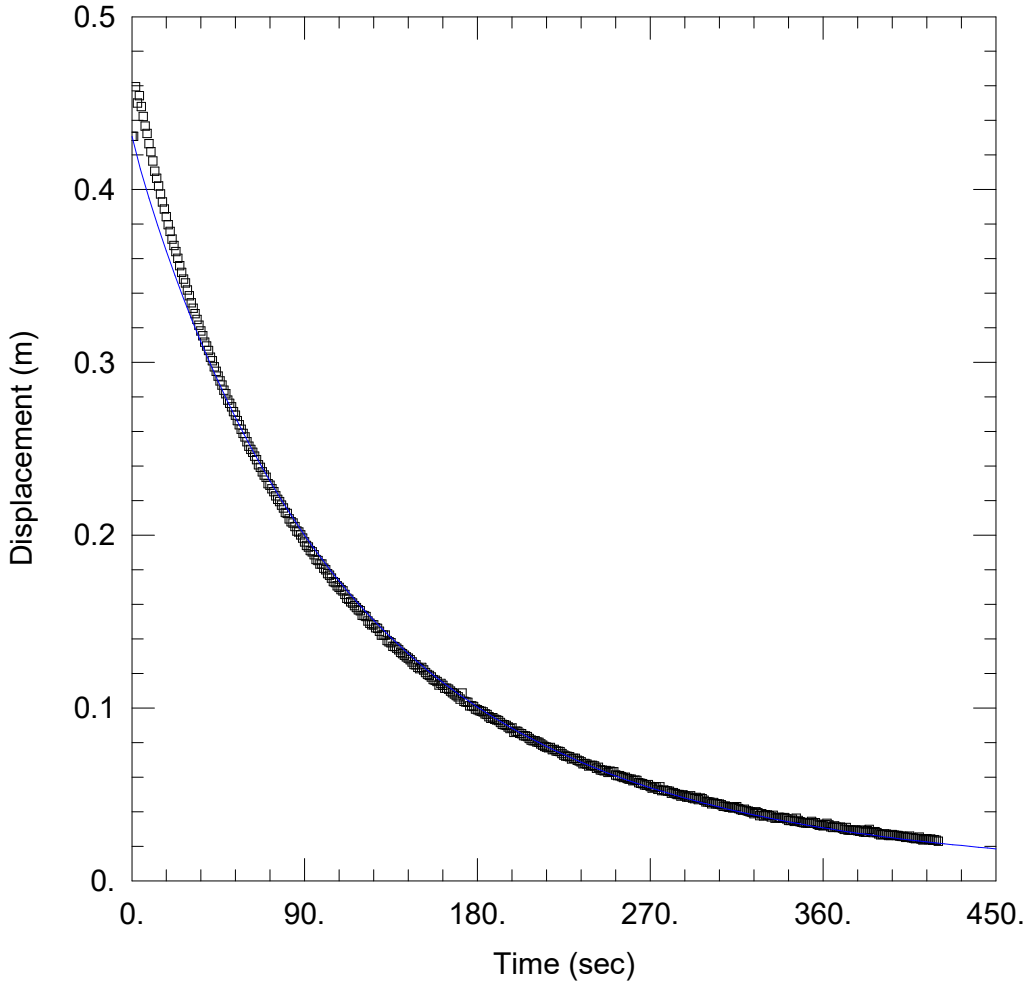
WELL DATA (GW18-26-21D)

Initial Displacement: 0.4502 m
Total Well Penetration Depth: 12.21 m
Casing Radius: 0.025 m
Static Water Column Height: 13.21 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 3.285 m^2/day
S = 1.0E-10



GW18-26-21D FHT2

Data Set: \...\21D_FHT2_CBP.aqt
Date: 06/08/18 Time: 10:32:23

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-21D
Test Date: 22/02/18

AQUIFER DATA

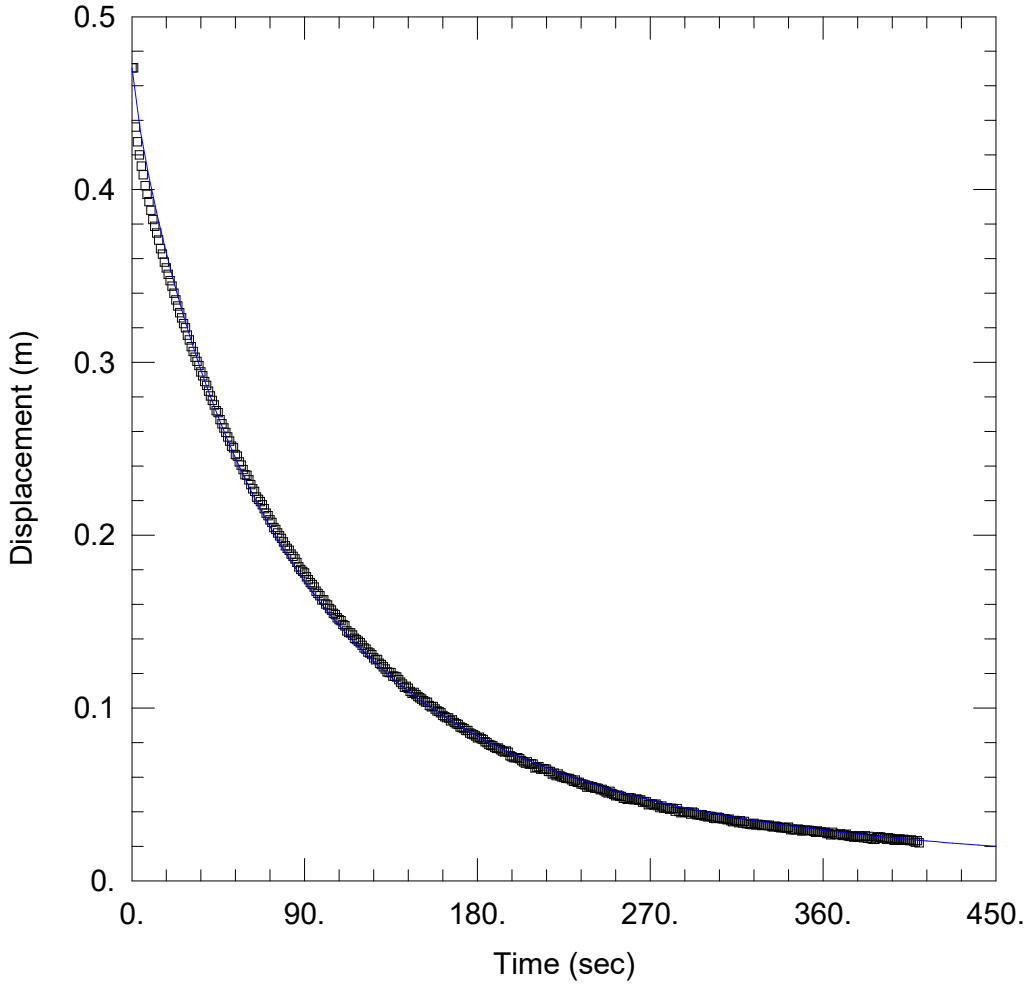
Saturated Thickness: 13.21 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-21D)

Initial Displacement: 0.4309 m
Total Well Penetration Depth: 12.21 m
Casing Radius: 0.025 m
Static Water Column Height: 13.21 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos
T = 2.695 m^2/day
S = 1.0E-10



GW18-26-21D RHT1

Data Set: \...\21D_RHT1_CBP.aqt
Date: 06/08/18 Time: 10:33:01

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-21D
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 13.21 m Anisotropy Ratio (Kz/Kr): 1.

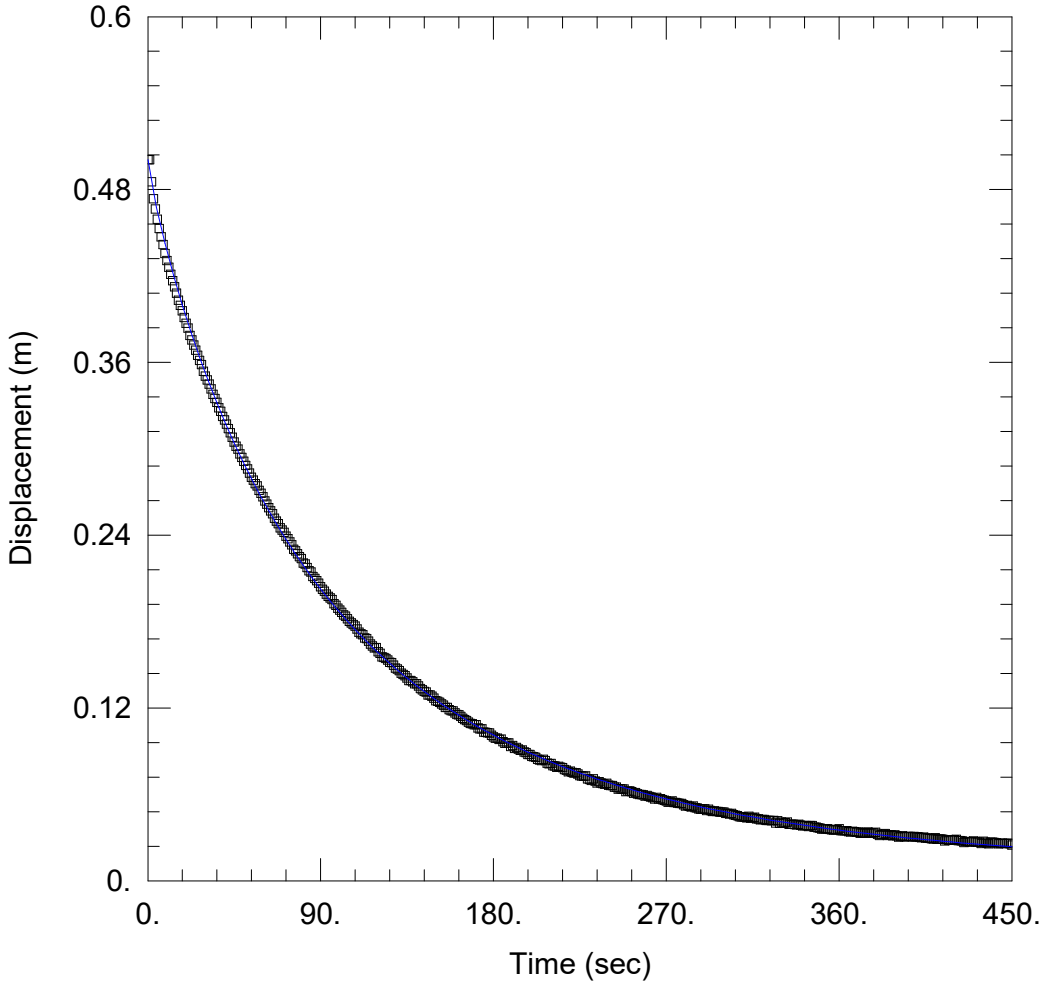
WELL DATA (GW18-26-21D)

Initial Displacement: 0.4705 m
Total Well Penetration Depth: 12.21 m
Casing Radius: 0.025 m
Static Water Column Height: 13.21 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 1.386 m^2/day
S = 9.762E-5



GW18-26-21D RHT2

Data Set: \...\21D_RHT2_CBP.aqt
Date: 06/08/18 Time: 10:33:42

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-21D
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 13.21 m Anisotropy Ratio (Kz/Kr): 1.

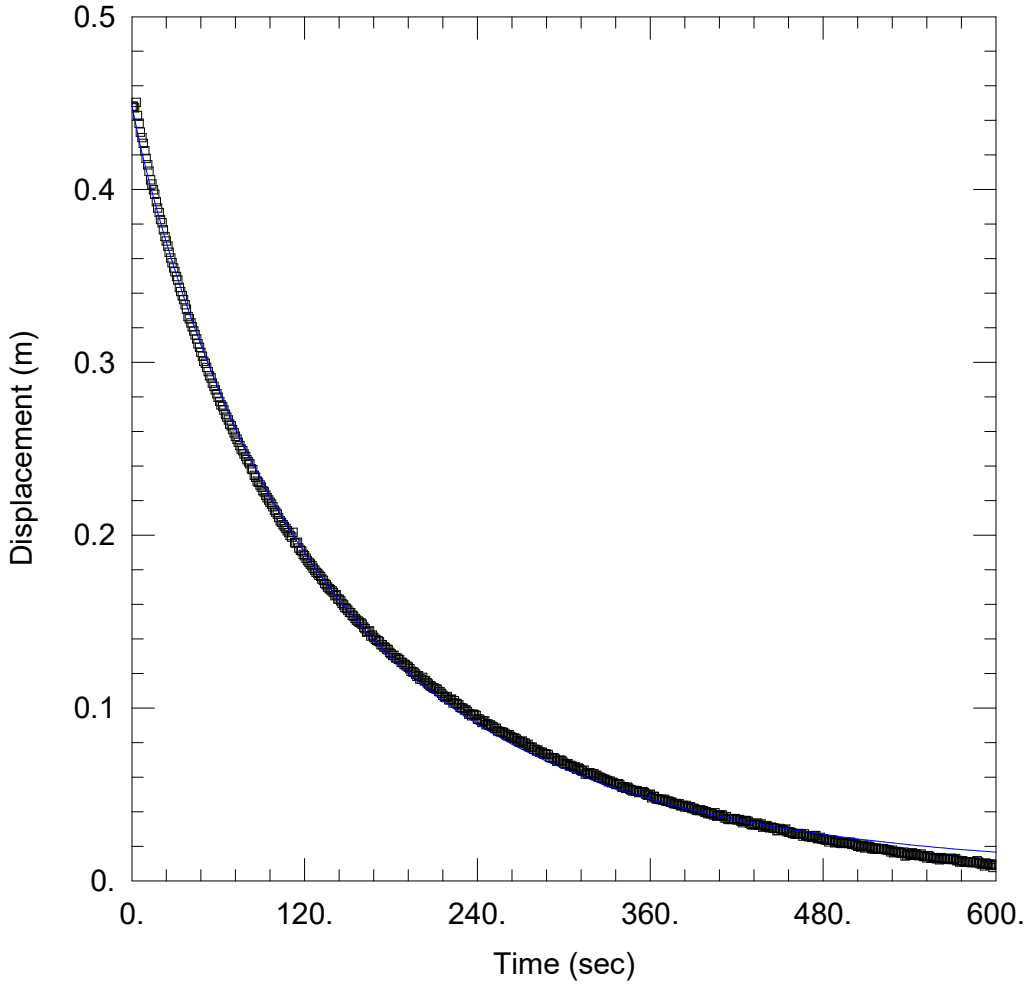
WELL DATA (GW18-26-21D)

Initial Displacement: 0.5008 m
Total Well Penetration Depth: 12.21 m
Casing Radius: 0.025 m
Static Water Column Height: 13.21 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 1.418 m^2/day
S = 2.717E-5



GW18-26-22D FHT1

Data Set: \...\22D_FHT1_CBP.aqt
Date: 06/08/18 Time: 10:34:37

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-22D
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 14.38 m Anisotropy Ratio (Kz/Kr): 1.

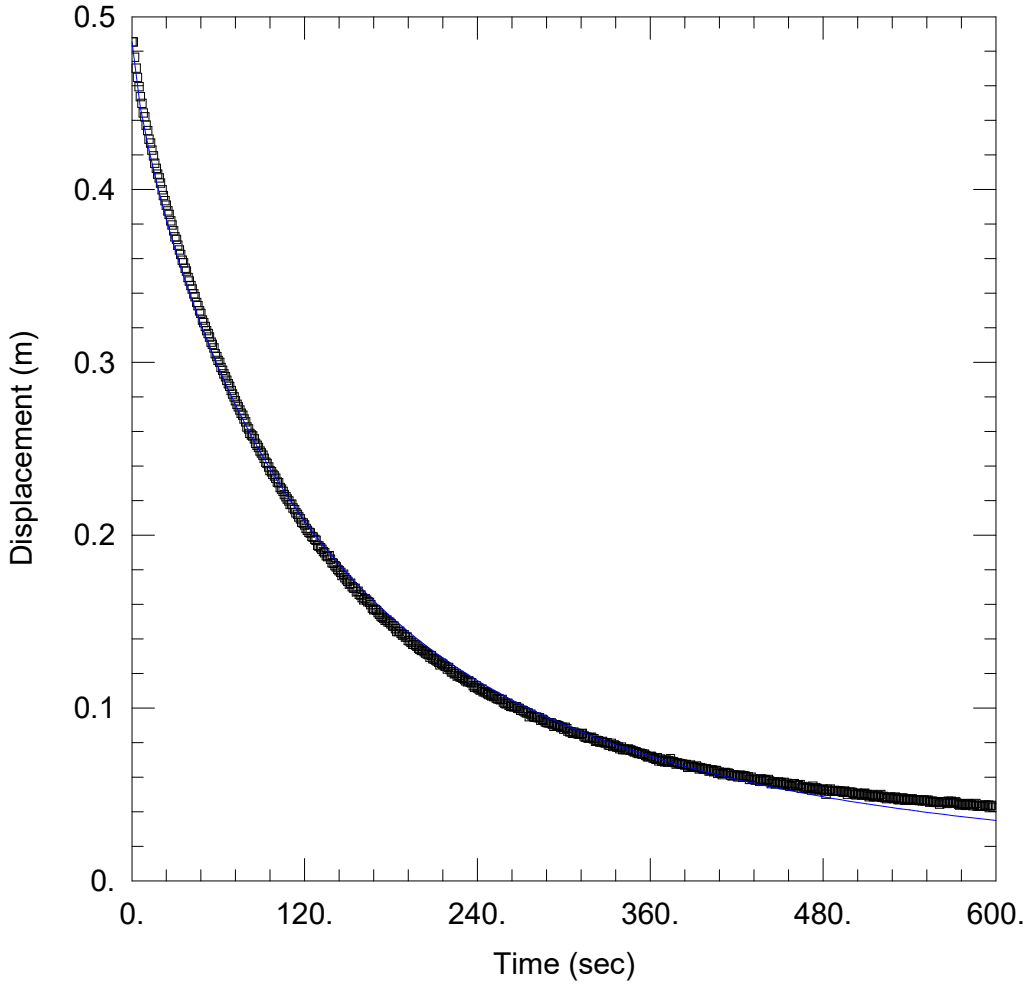
WELL DATA (GW18-26-22D)

Initial Displacement: 0.4482 m
Total Well Penetration Depth: 13.38 m
Casing Radius: 0.025 m
Static Water Column Height: 14.38 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 1.777 m^2/day
S = 1.465E-8



GW18-26-22D RHT1

Data Set: \...\22D_RHT1_CBP.aqt
Date: 06/08/18 Time: 10:35:17

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-22D
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 14.38 m Anisotropy Ratio (Kz/Kr): 1.

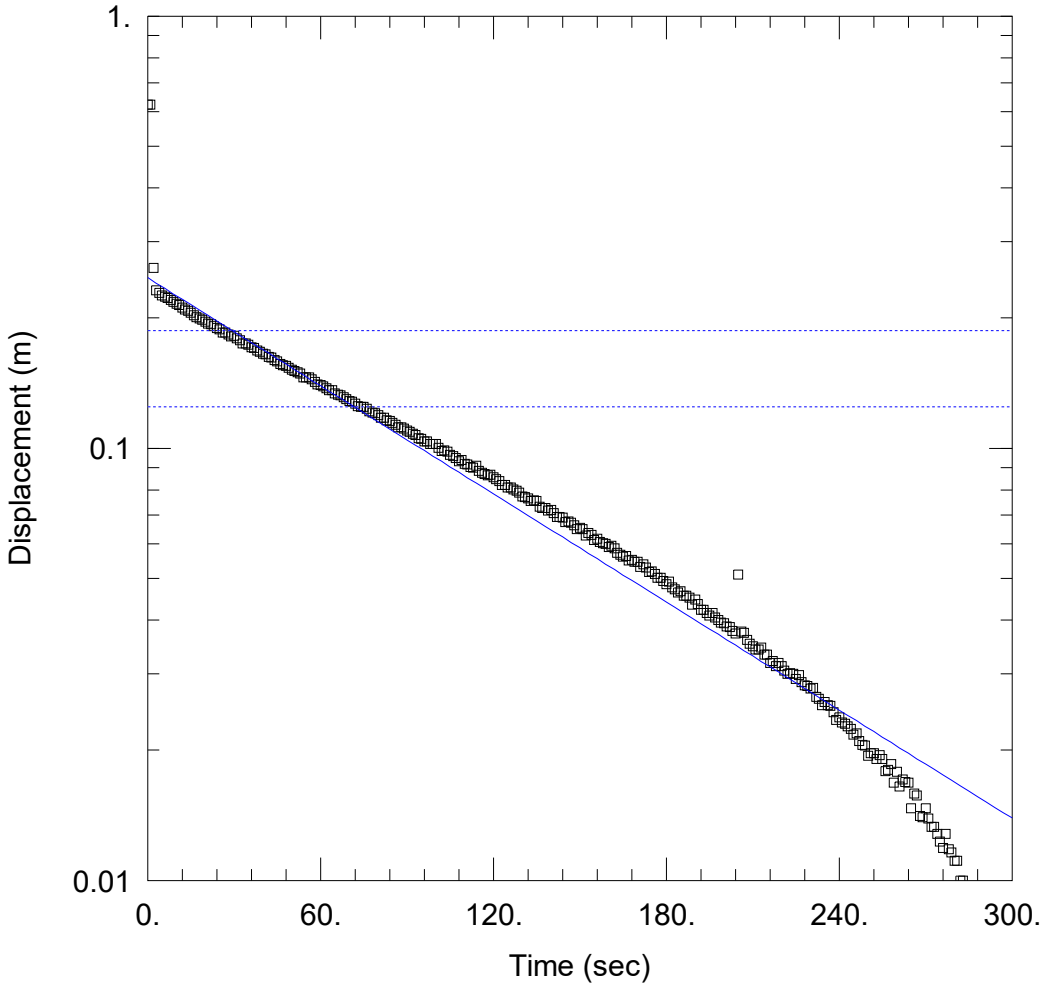
WELL DATA (GW18-26-22D)

Initial Displacement: 0.4855 m
Total Well Penetration Depth: 13.38 m
Casing Radius: 0.025 m
Static Water Column Height: 14.38 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 0.6449 m^2/day
S = 0.0006817



GW18-26-22S FHT1

Data Set: \...\22S_FHT1.aqt
Date: 05/09/18 Time: 11:31:09

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-22S
Test Date: 22/02/18

AQUIFER DATA

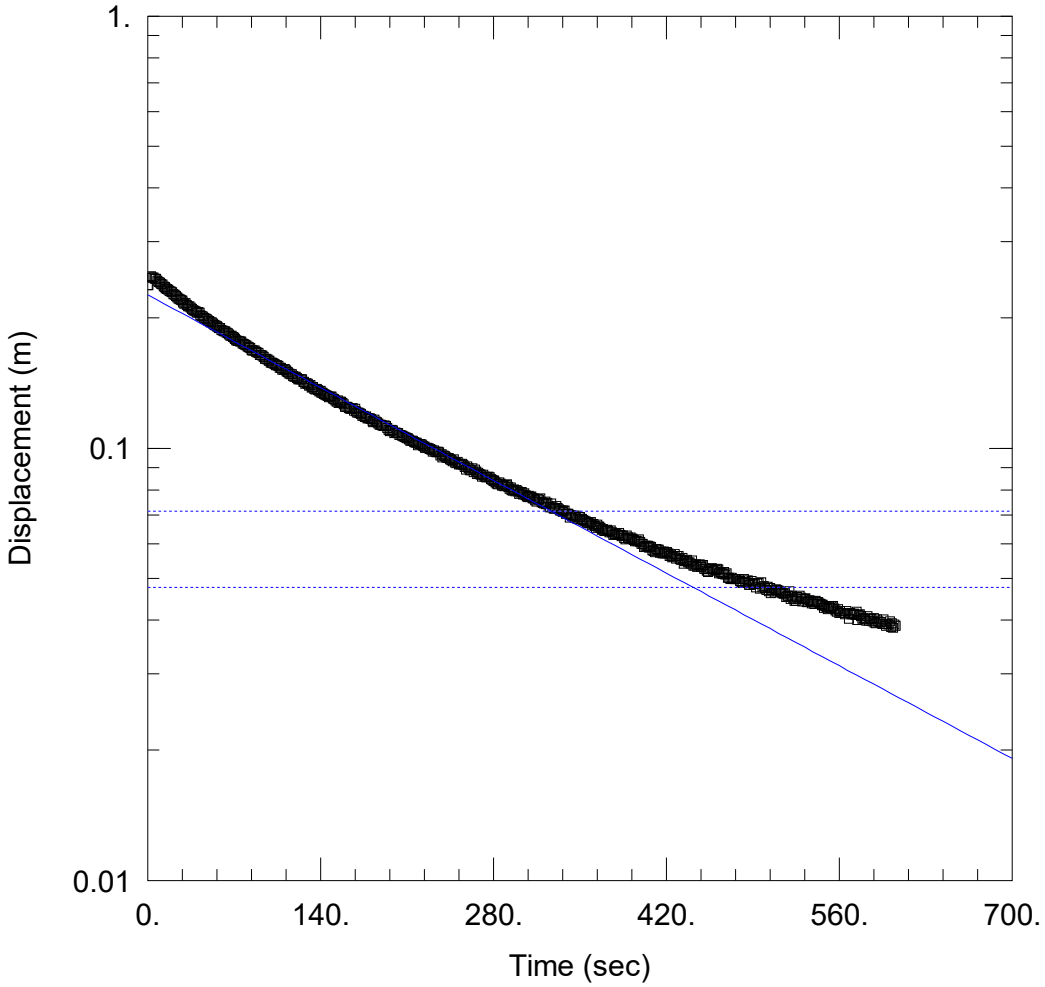
Saturated Thickness: 3.13 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-22S)

Initial Displacement: 0.6227 m
Total Well Penetration Depth: 2.13 m
Casing Radius: 0.025 m
Static Water Column Height: 3.13 m
Screen Length: 2.13 m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
K = 0.3102 m/day
Solution Method: Bouwer-Rice
y0 = 0.248 m



GW18-26-22S FHT2

Data Set: \...\22S_FHT2.aqt
Date: 05/09/18 Time: 11:34:32

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-22S
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 3.13 m Anisotropy Ratio (Kz/Kr): 1.

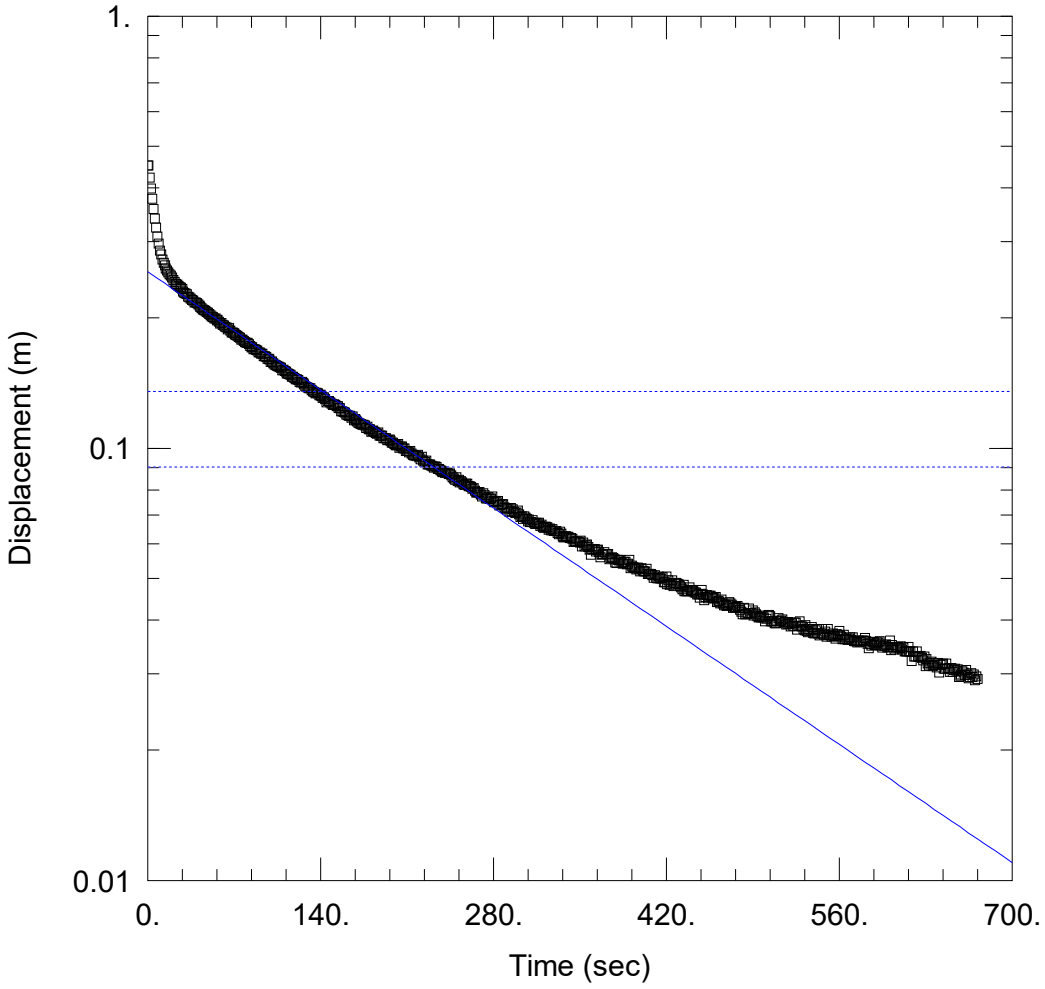
WELL DATA (GW18-26-22S)

Initial Displacement: 0.2383 m
Total Well Penetration Depth: 2.13 m
Casing Radius: 0.025 m
Static Water Column Height: 3.13 m
Screen Length: 2.13 m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.114 m/day
y0 = 0.2262 m



WELL TEST ANALYSIS

Data Set: \...\22S_RHT1.aqt
Date: 05/09/18 Time: 11:46:57

PROJECT INFORMATION

Company: WSP
Test Well: GW18-26-22S

AQUIFER DATA

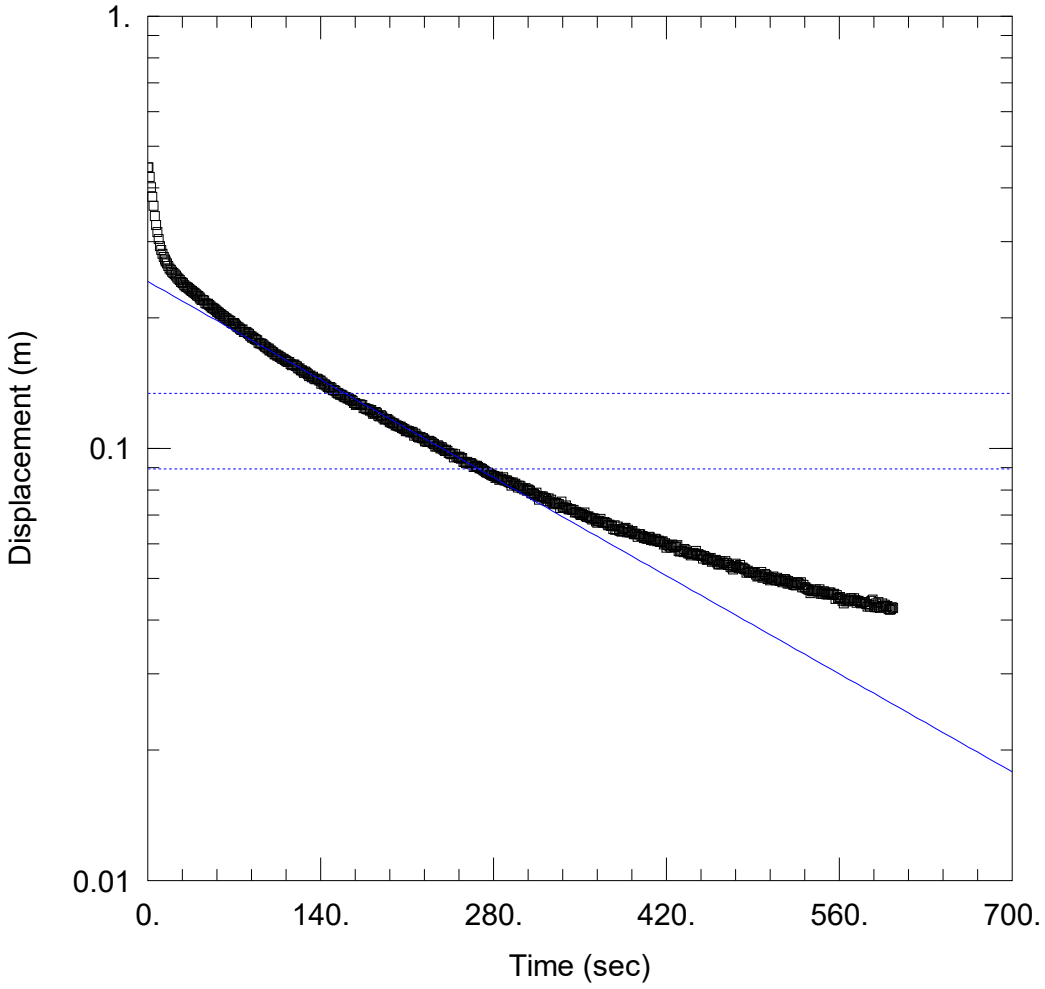
Saturated Thickness: 3.13 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-22S)

Initial Displacement: 0.4514 m
Total Well Penetration Depth: 2.13 m
Casing Radius: 0.025 m
Static Water Column Height: 3.13 m
Screen Length: 2.13 m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.1453 m/day
y0 = 0.2559 m



GW18-26-22S RHT2

Data Set: \...\22S_RHT2.aqt
Date: 05/09/18 Time: 11:39:00

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-22S
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 3.13 m Anisotropy Ratio (Kz/Kr): 1.

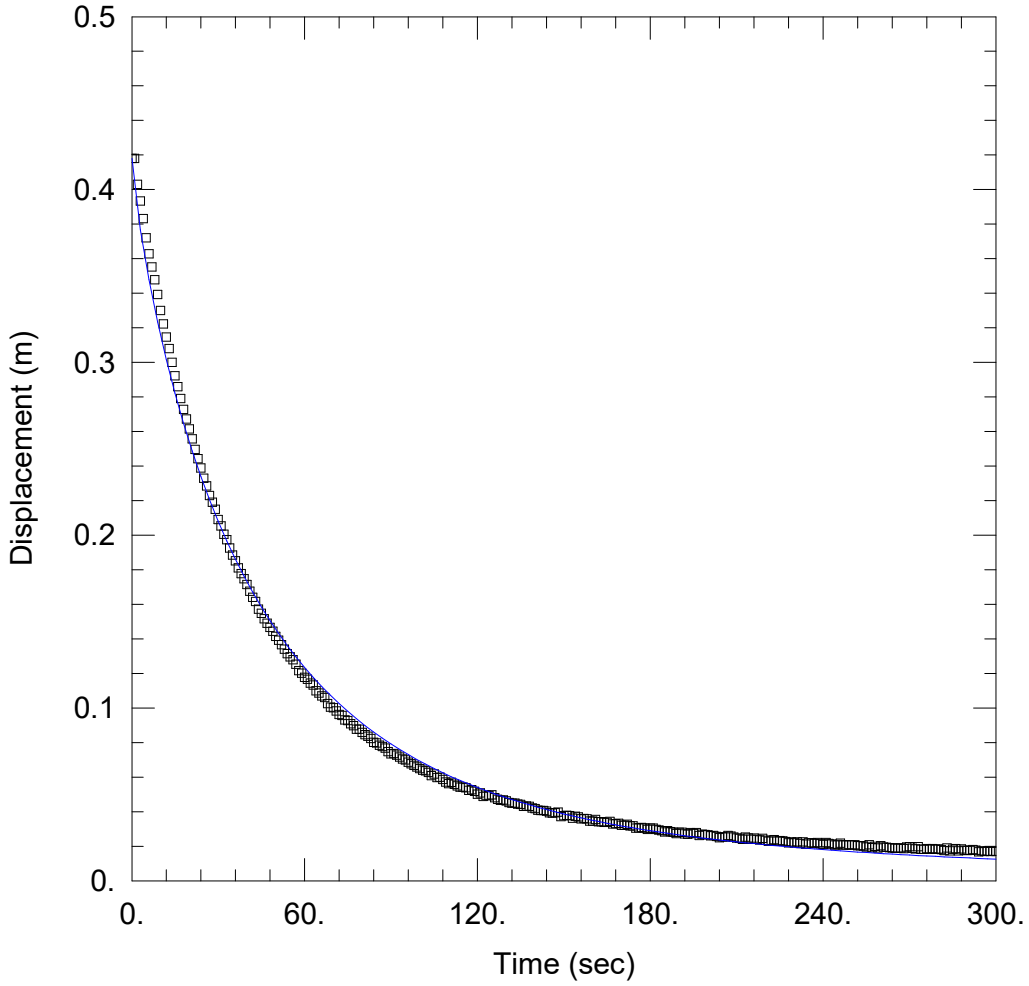
WELL DATA (GW18-26-22S)

Initial Displacement: 0.4469 m
Total Well Penetration Depth: 2.13 m
Casing Radius: 0.025 m
Static Water Column Height: 3.13 m
Screen Length: 2.13 m
Well Radius: 0.025 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.1463 m/day
y0 = 0.2432 m



GW18-26-23D FHT2

Data Set: \...\23D_FHT2_CBP.aqt
Date: 06/08/18 Time: 10:38:31

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-23D
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 14.69 m Anisotropy Ratio (Kz/Kr): 1.

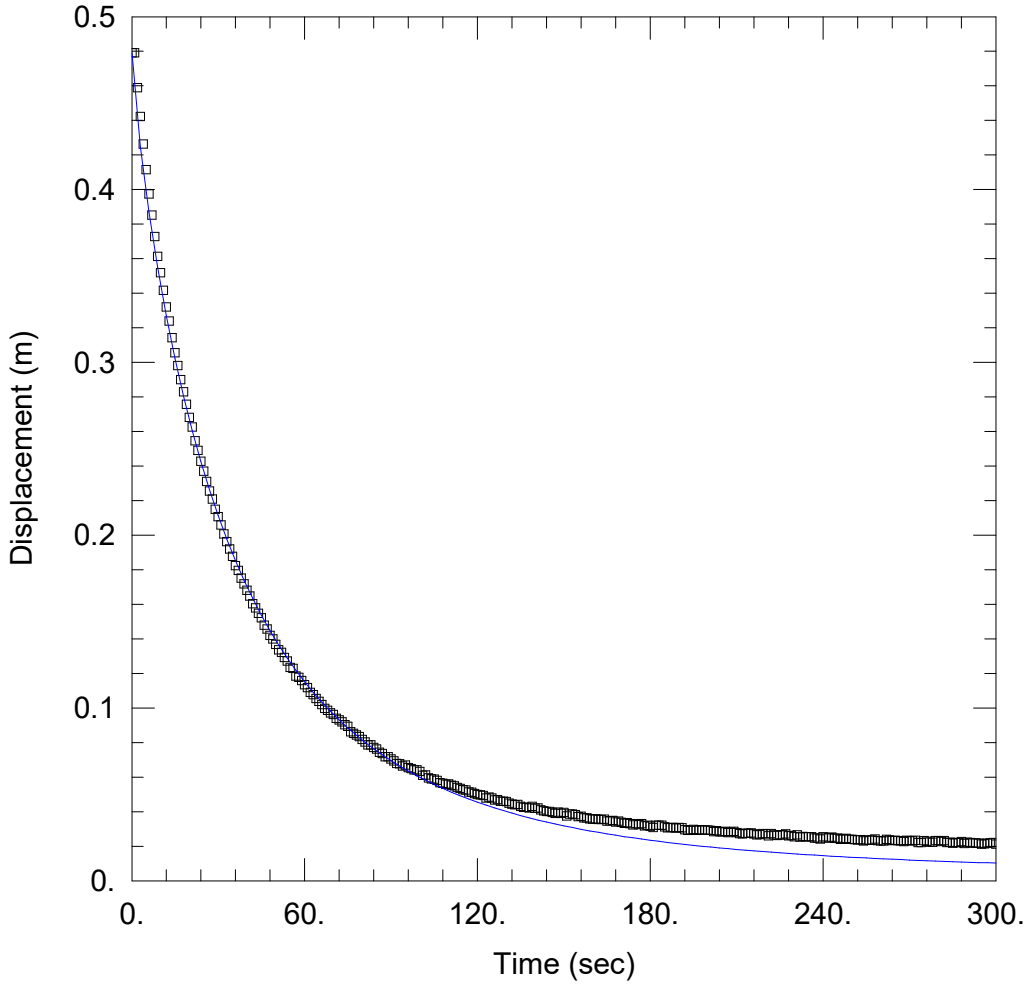
WELL DATA (GW18-26-23D)

Initial Displacement: 0.4181 m
Total Well Penetration Depth: 13.69 m
Casing Radius: 0.025 m
Static Water Column Height: 14.69 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 2.461 m^2/day
S = 0.0001909



GW18-26-23D RHT1

Data Set: \...\23D_RHT1_CBP.aqt
Date: 06/08/18 Time: 10:37:24

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-23D
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 14.69 m Anisotropy Ratio (Kz/Kr): 1.

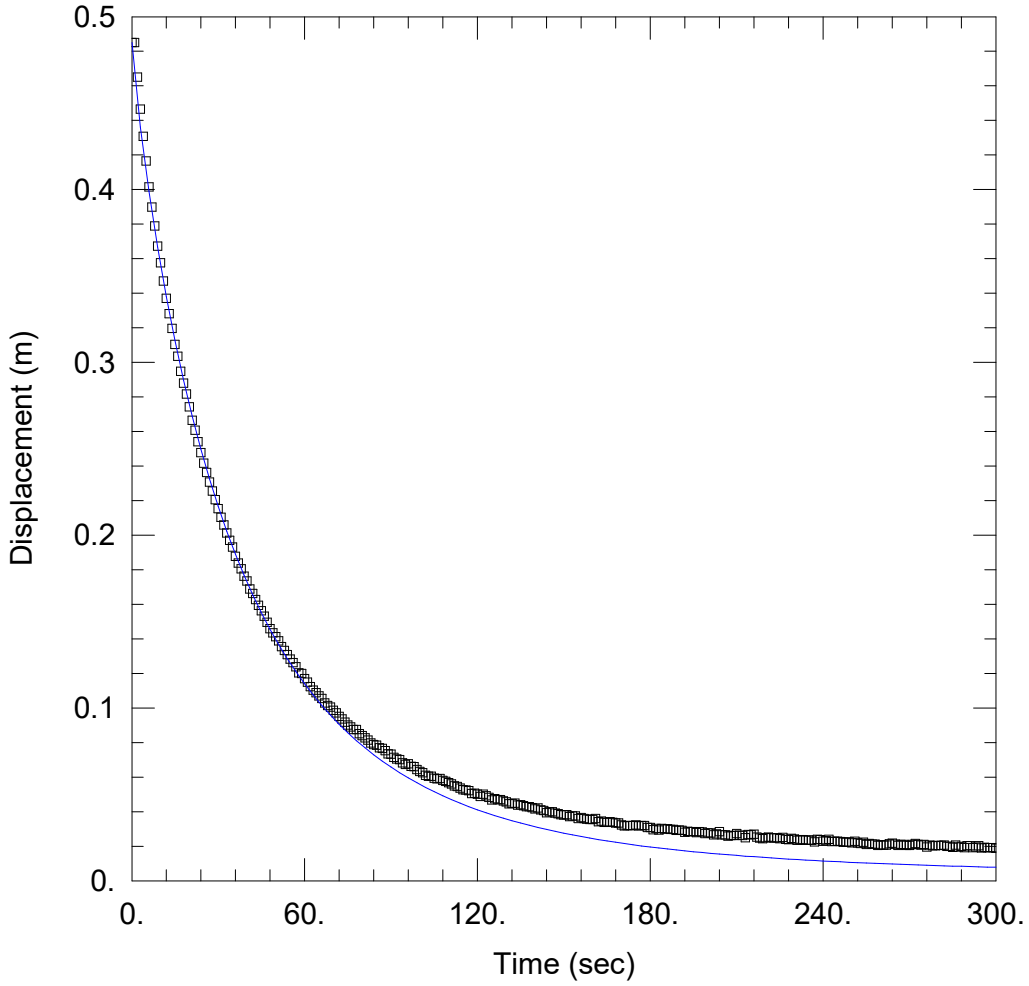
WELL DATA (GW18-26-23D)

Initial Displacement: 0.4792 m
Total Well Penetration Depth: 13.69 m
Casing Radius: 0.025 m
Static Water Column Height: 14.69 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 3.1 m^2/day
S = 0.0001465



GW18-26-23D RHT2

Data Set: \...\23D_RHT2_CBP.aqt
Date: 06/08/18 Time: 10:39:11

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-23D
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 14.69 m Anisotropy Ratio (Kz/Kr): 1.

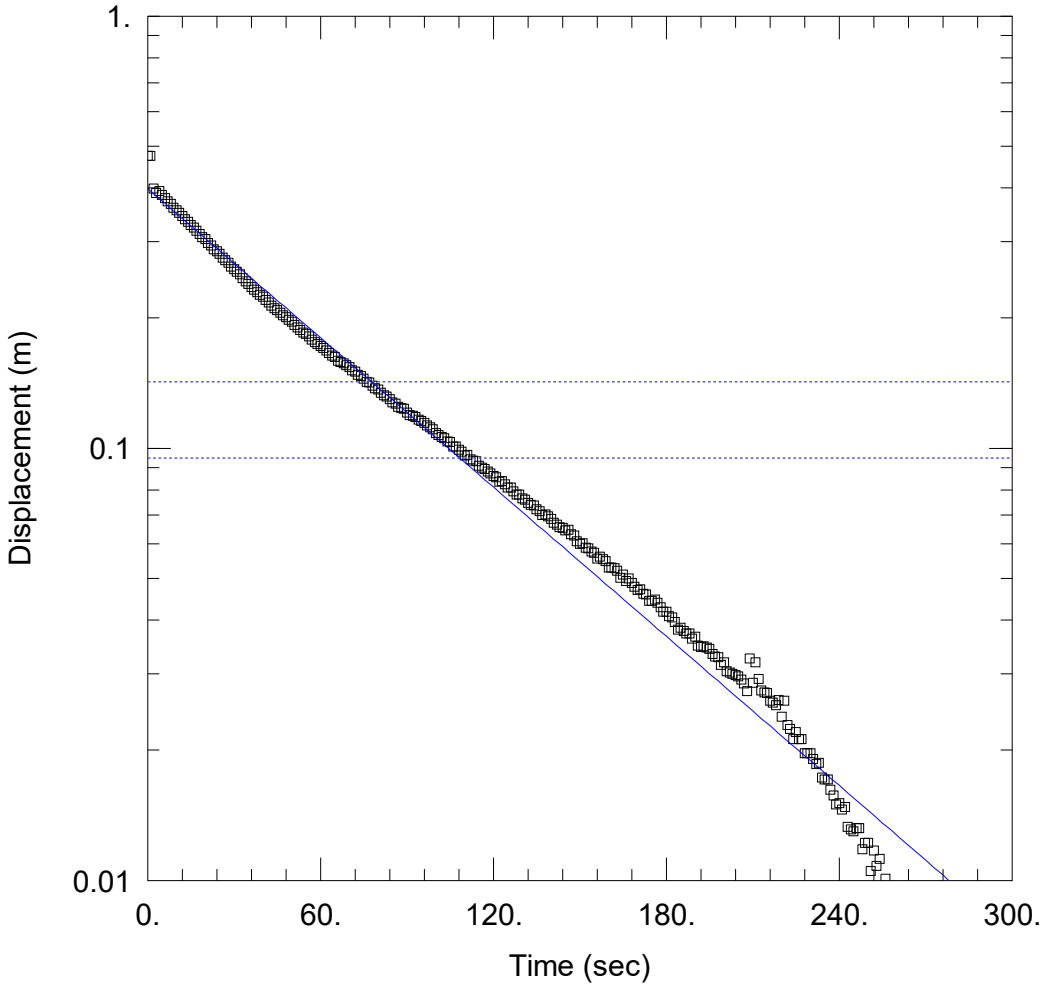
WELL DATA (GW18-26-23D)

Initial Displacement: 0.4851 m
Total Well Penetration Depth: 13.69 m
Casing Radius: 0.025 m
Static Water Column Height: 14.69 m
Screen Length: 9. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Confined
Solution Method: Cooper-Bredehoeft-Papadopulos

T = 4.101 m^2/day
S = 1.01E-5



GW18-26-23S FHT1

Data Set: \...\23S_FHT1.aqt
Date: 05/09/18 Time: 12:11:21

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-23S
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 4.58 m Anisotropy Ratio (Kz/Kr): 1.

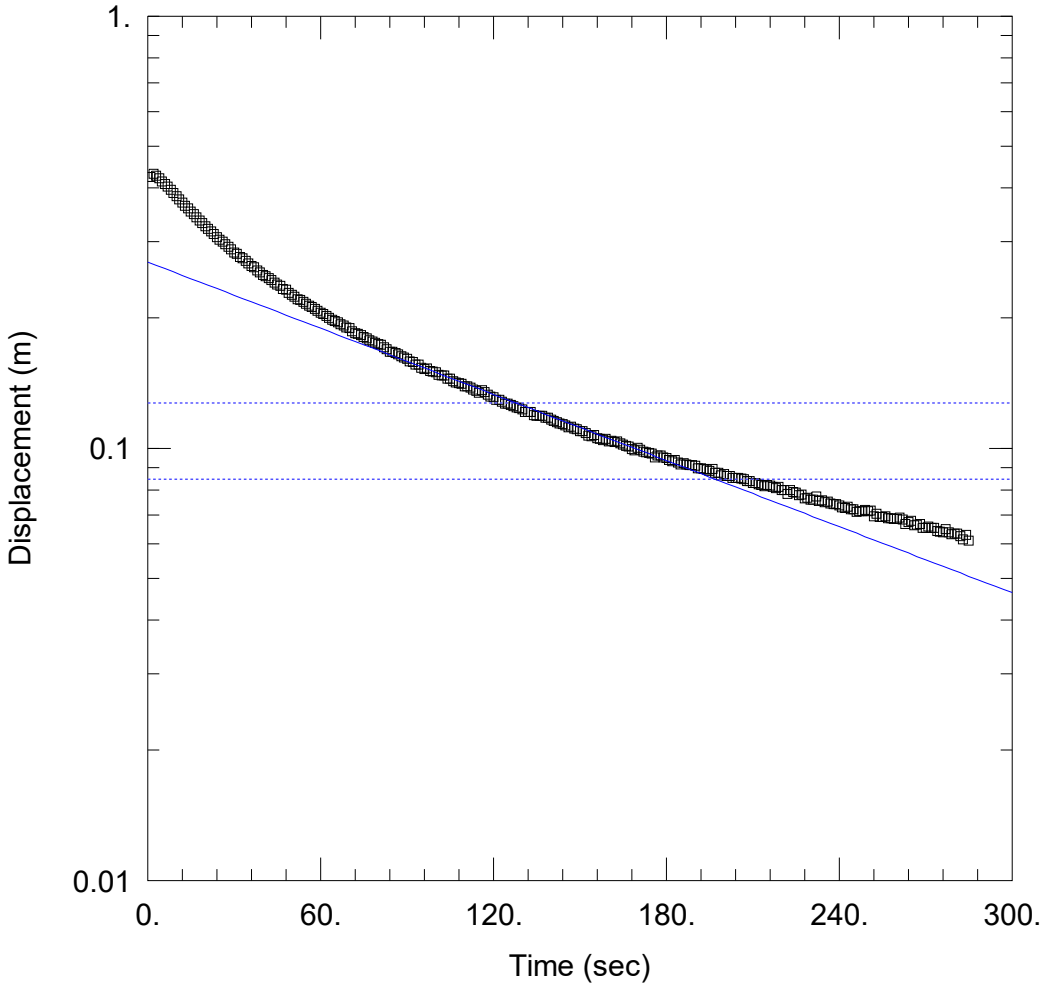
WELL DATA (GW18-26-23S)

Initial Displacement: 0.4745 m
Total Well Penetration Depth: 3.58 m
Casing Radius: 0.025 m
Static Water Column Height: 4.58 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.3501 m/day
y0 = 0.3988 m



GW18-26-23S FHT2

Data Set: \...\23S_FHT2.aqt
Date: 05/09/18 Time: 12:07:36

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-23S
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 4.58 m Anisotropy Ratio (Kz/Kr): 1.

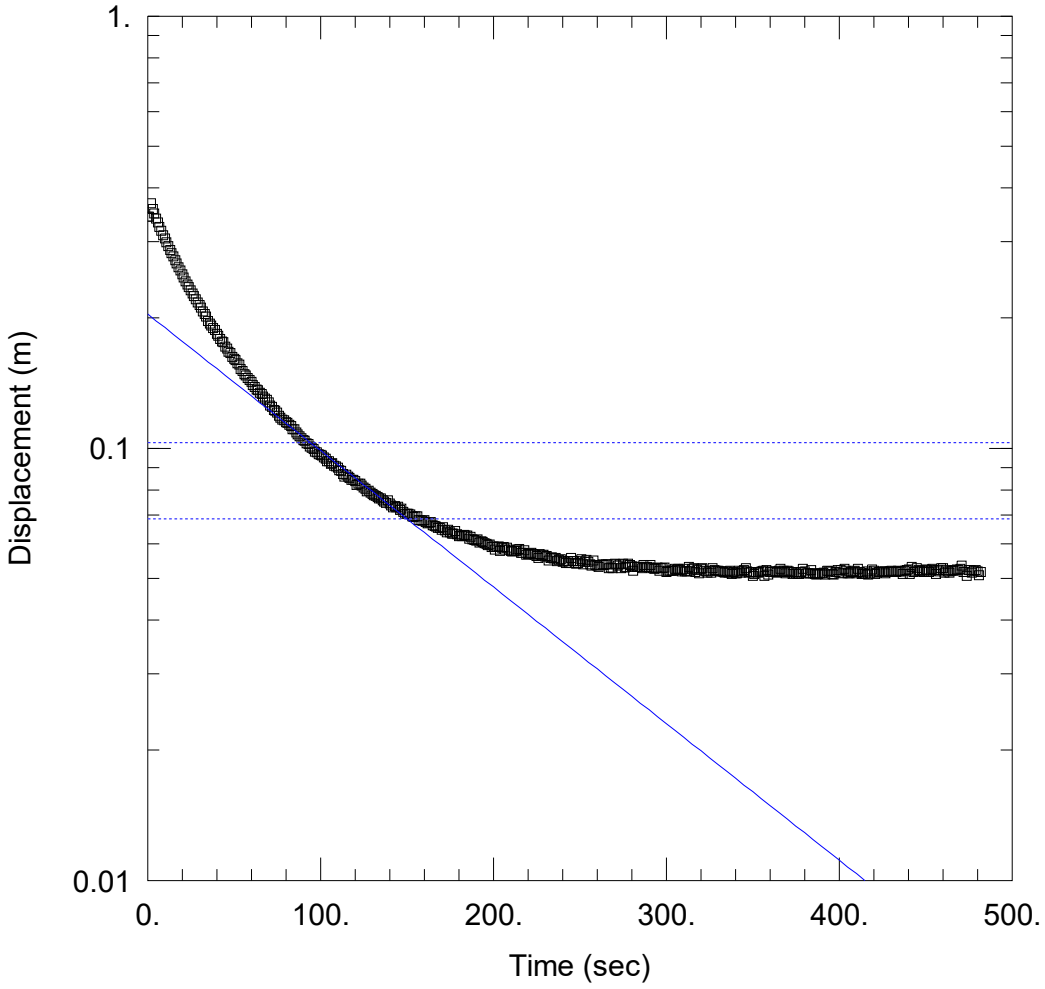
WELL DATA (GW18-26-23S)

Initial Displacement: 0.4242 m
Total Well Penetration Depth: 3.58 m
Casing Radius: 0.025 m
Static Water Column Height: 4.58 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.1551 m/day
y0 = 0.2694 m



GW18-26-23S RHT1

Data Set: \...\23S_RHT1.aqt
Date: 05/09/18 Time: 12:15:33

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-23S
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 4.58 m Anisotropy Ratio (Kz/Kr): 1.

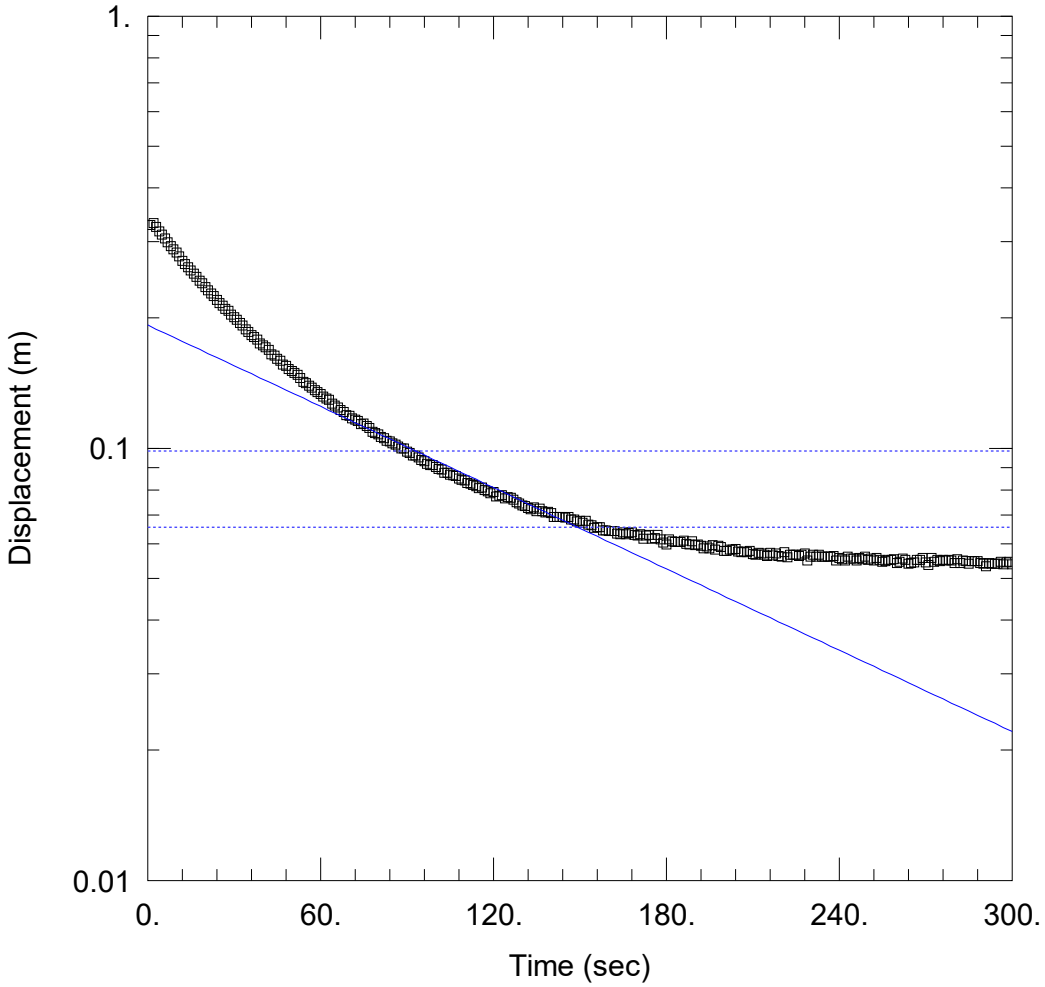
WELL DATA (GW18-26-23S)

Initial Displacement: 0.3429 m
Total Well Penetration Depth: 3.58 m
Casing Radius: 0.025 m
Static Water Column Height: 4.58 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.1921 m/day
y0 = 0.2043 m



GW18-26-23S RHT2

Data Set: \...\23S_RHT2.aqt
Date: 05/09/18 Time: 12:17:36

PROJECT INFORMATION

Company: WSP
Client: VicRoads
Project: PS101340
Location: Mordialloc Bypass
Test Well: GW18-26-23S
Test Date: 22/02/18

AQUIFER DATA

Saturated Thickness: 4.58 m Anisotropy Ratio (Kz/Kr): 1.

WELL DATA (GW18-26-23S)

Initial Displacement: 0.3282 m
Total Well Penetration Depth: 3.58 m
Casing Radius: 0.025 m
Static Water Column Height: 4.58 m
Screen Length: 3. m
Well Radius: 0.05 m

SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

K = 0.1907 m/day
y0 = 0.1927 m

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1711637**	Page	: 1 of 11
Amendment	: **1**		
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Contact	: Steven McGrath
Address	: Level 15, 28 Freshwater Place SOUTHBANK VIC, AUSTRALIA 3006	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 03 9861 1111	Telephone	: +61-3-8549 9600
Project	: 2135645A	Date Samples Received	: 29-Aug-2017 17:30
Order number	: 3219	Date Analysis Commenced	: 29-Aug-2017
C-O-C number	: ----	Issue Date	: 14-Sep-2017 15:17
Sampler	: KELLY-JANE WALLIS		
Site	: ----		
Quote number	: ME-525-16		
No. of samples received	: 8		
No. of samples analysed	: 8		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Nikki Stepniewski	Senior Inorganic Instrument Chemist	Melbourne Inorganics, Springvale, VIC
Xing Lin	Senior Organic Chemist	Melbourne Organics, Springvale, VIC

General Comments

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

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

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

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

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

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

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

- ED093F:EM1711637_005 and 006 have been confirmed for major cations by re-preparation and re-analysis.
- ED041G & ED045G: Results for EM1711637-005 have been confirmed by re-preparation and re-analysis.
- ED041G: Results for EM1711637-006 have been confirmed by re-preparation and re-analysis.
- Ionic Balance out of acceptable limits for sample #5 due to analytes not quantified in this report. Major anions and cations have been confirmed by re-preparation and re-analysis.
- Amendment (14/09/2017): This report has been amended and re-released to allow the reporting of additional analytical data. Dissolved Iron.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW11S	GW11D	GW15D	GW14D	SW08
				Client sampling date / time	28-Aug-2017 00:00	28-Aug-2017 00:00	29-Aug-2017 00:00	29-Aug-2017 00:00	29-Aug-2017 00:00
Compound	CAS Number	LOR	Unit		EM1711637-001	EM1711637-002	EM1711637-003	EM1711637-004	EM1711637-005
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		7.69	7.88	6.59	6.67	7.85
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		2320	6190	4340	3840	581
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	10	mg/L		1510	4020	2820	2500	378
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		345	513	232	335	81
Total Alkalinity as CaCO3	----	1	mg/L		345	513	232	335	81
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		23	238	104	114	23
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		577	1520	1190	1060	123
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		57	152	134	99	15
Magnesium	7439-95-4	1	mg/L		63	123	92	63	12
Sodium	7440-23-5	1	mg/L		275	825	557	525	70
Potassium	7440-09-7	1	mg/L		7	7	7	5	4
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	0.02
Arsenic	7440-38-2	0.001	mg/L		0.026	0.067	0.077	0.096	<0.001
Boron	7440-42-8	0.05	mg/L		0.14	0.20	0.18	0.21	0.08
Barium	7440-39-3	0.001	mg/L		0.264	0.108	0.165	0.086	0.071
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L		0.001	0.002	0.007	0.006	<0.001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		0.311	0.479	0.664	0.707	0.005
Nickel	7440-02-0	0.001	mg/L		0.003	0.002	0.003	0.002	0.001
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW11S	GW11D	GW15D	GW14D	SW08
				Client sampling date / time	28-Aug-2017 00:00	28-Aug-2017 00:00	29-Aug-2017 00:00	29-Aug-2017 00:00	29-Aug-2017 00:00
Compound	CAS Number	LOR	Unit		EM1711637-001	EM1711637-002	EM1711637-003	EM1711637-004	EM1711637-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Zinc	7440-66-6	0.005	mg/L		**0.005**	**0.008**	**0.006**	**0.006**	<0.005
Iron	7439-89-6	0.05	mg/L		**9.59**	**5.09**	**7.35**	**2.05**	**0.15**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.3**	**0.5**	**0.4**	**0.4**	**0.2**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.69**	**0.56**	**0.31**	**0.40**	**0.02**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.01**	<0.01	<0.01	**0.01**	**0.01**
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.01**	**0.02**	**0.02**	**0.01**	**0.01**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.02**	**0.02**	**0.02**	**0.02**	**0.02**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.06**
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**23.6**	**58.1**	**40.4**	**39.0**	**5.57**
Total Cations	----	0.01	meq/L		**20.2**	**53.8**	**38.7**	**33.1**	**4.88**
Ionic Balance	----	0.01	%		**7.94**	**3.85**	**2.16**	**8.16**	**6.54**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5
EP068A: Organochlorine Pesticides (OC)									
alpha-BHC	319-84-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
beta-BHC	319-85-7	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
gamma-BHC	58-89-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
delta-BHC	319-86-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor	76-44-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin	309-00-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide	1024-57-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
trans-Chlordane	5103-74-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
alpha-Endosulfan	959-98-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW11S	GW11D	GW15D	GW14D	SW08
				Client sampling date / time	28-Aug-2017 00:00	28-Aug-2017 00:00	29-Aug-2017 00:00	29-Aug-2017 00:00	29-Aug-2017 00:00
Compound	CAS Number	LOR	Unit		EM1711637-001	EM1711637-002	EM1711637-003	EM1711637-004	EM1711637-005
					Result	Result	Result	Result	Result
EP068A: Organochlorine Pesticides (OC) - Continued									
cis-Chlordane	5103-71-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin	60-57-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDE	72-55-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Endrin	72-20-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
beta-Endosulfan	33213-65-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDD	72-54-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Endrin aldehyde	7421-93-4	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate	1031-07-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDT	50-29-3	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Endrin ketone	53494-70-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Methoxychlor	72-43-5	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
^ Total Chlordane (sum)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Demeton-S-methyl	919-86-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Monocrotophos	6923-22-4	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Dimethoate	60-51-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Diazinon	333-41-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Parathion-methyl	298-00-0	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Malathion	121-75-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Fenthion	55-38-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos	2921-88-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Parathion	56-38-2	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Pirimphos-ethyl	23505-41-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos	470-90-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl	4824-78-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Fenamiphos	22224-92-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Prothiofos	34643-46-4	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Ethion	563-12-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Carbophenothion	786-19-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Azinphos Methyl	86-50-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW11S	GW11D	GW15D	GW14D	SW08
				Client sampling date / time	28-Aug-2017 00:00	28-Aug-2017 00:00	29-Aug-2017 00:00	29-Aug-2017 00:00	29-Aug-2017 00:00
Compound	CAS Number	LOR	Unit		EM1711637-001	EM1711637-002	EM1711637-003	EM1711637-004	EM1711637-005
					Result	Result	Result	Result	Result
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	1330-20-7	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.5	%		**54.1**	**74.4**	**73.5**	**63.2**	**76.6**
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.5	%		**72.1**	**98.6**	**87.4**	**84.8**	**93.8**
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**93.6**	**93.8**	**96.7**	**91.1**	**92.7**
Toluene-D8	2037-26-5	2	%		**77.8**	**77.8**	**78.6**	**72.2**	**76.1**
4-Bromofluorobenzene	460-00-4	2	%		**86.3**	**85.2**	**86.4**	**83.4**	**86.1**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW09	GW08	GW09	----	----
				Client sampling date / time	29-Aug-2017 00:00	29-Aug-2017 00:00	29-Aug-2017 00:00	----	----
Compound	CAS Number	LOR	Unit		EM1711637-006	EM1711637-007	EM1711637-008	--------	--------
					Result	Result	Result	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.50**	**5.23**	**5.93**	----	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**314**	**27700**	**7980**	----	----
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	10	mg/L		**204**	**18000**	**5190**	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**39**	**46**	**106**	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**39**	**46**	**106**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**17**	**3850**	**694**	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**55**	**8730**	**2160**	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**10**	**983**	**278**	----	----
Magnesium	7439-95-4	1	mg/L		**6**	**1640**	**274**	----	----
Sodium	7440-23-5	1	mg/L		**38**	**2840**	**888**	----	----
Potassium	7440-09-7	1	mg/L		**3**	**27**	**6**	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.23**	**2.54**	**0.01**	----	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	**0.147**	**0.002**	----	----
Boron	7440-42-8	0.05	mg/L		**0.06**	**0.20**	**0.08**	----	----
Barium	7440-39-3	0.001	mg/L		**0.034**	**0.022**	**0.038**	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	**0.009**	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	**0.0010**	<0.0001	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	**0.858**	**0.014**	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	**0.002**	<0.001	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	----	----
Manganese	7439-96-5	0.001	mg/L		**0.003**	**8.14**	**0.341**	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	**1.54**	**0.014**	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	**0.003**	<0.001	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW09	GW08	GW09	----	----
				Client sampling date / time	29-Aug-2017 00:00	29-Aug-2017 00:00	29-Aug-2017 00:00	----	----
Compound	CAS Number	LOR	Unit		EM1711637-006	EM1711637-007	EM1711637-008	--------	--------
					Result	Result	Result	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.178**	**0.006**	----	----
Iron	7439-89-6	0.05	mg/L		**0.10**	**290**	**1.60**	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	**0.4**	**0.3**	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.04**	**0.55**	**0.19**	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.01**	**0.06**	**0.02**	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.09**	<0.01	**0.02**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.10**	**0.06**	**0.04**	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**2.68**	**327**	**77.5**	----	----
Total Cations	----	0.01	meq/L		**2.72**	**308**	**75.2**	----	----
Ionic Balance	----	0.01	%		**0.70**	**3.00**	**1.50**	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	----	----
EP068A: Organochlorine Pesticides (OC)									
alpha-BHC	319-84-6	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L		<0.5	<0.5	<0.5	----	----
beta-BHC	319-85-7	0.5	µg/L		<0.5	<0.5	<0.5	----	----
gamma-BHC	58-89-9	0.5	µg/L		<0.5	<0.5	<0.5	----	----
delta-BHC	319-86-8	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Heptachlor	76-44-8	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Aldrin	309-00-2	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Heptachlor epoxide	1024-57-3	0.5	µg/L		<0.5	<0.5	<0.5	----	----
trans-Chlordane	5103-74-2	0.5	µg/L		<0.5	<0.5	<0.5	----	----
alpha-Endosulfan	959-98-8	0.5	µg/L		<0.5	<0.5	<0.5	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW09	GW08	GW09	----	----
				Client sampling date / time	29-Aug-2017 00:00	29-Aug-2017 00:00	29-Aug-2017 00:00	----	----
Compound	CAS Number	LOR	Unit		EM1711637-006	EM1711637-007	EM1711637-008	--------	--------
					Result	Result	Result	----	----
EP068A: Organochlorine Pesticides (OC) - Continued									
cis-Chlordane	5103-71-9	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Dieldrin	60-57-1	0.5	µg/L		<0.5	<0.5	<0.5	----	----
4.4`-DDE	72-55-9	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Endrin	72-20-8	0.5	µg/L		<0.5	<0.5	<0.5	----	----
beta-Endosulfan	33213-65-9	0.5	µg/L		<0.5	<0.5	<0.5	----	----
4.4`-DDD	72-54-8	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Endrin aldehyde	7421-93-4	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Endosulfan sulfate	1031-07-8	0.5	µg/L		<0.5	<0.5	<0.5	----	----
4.4`-DDT	50-29-3	2.0	µg/L		<2.0	<2.0	<2.0	----	----
Endrin ketone	53494-70-5	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Methoxychlor	72-43-5	2.0	µg/L		<2.0	<2.0	<2.0	----	----
^ Total Chlordane (sum)	----	0.5	µg/L		<0.5	<0.5	<0.5	----	----
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L		<0.5	<0.5	<0.5	----	----
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L		<0.5	<0.5	<0.5	----	----
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Demeton-S-methyl	919-86-8	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Monocrotophos	6923-22-4	2.0	µg/L		<2.0	<2.0	<2.0	----	----
Dimethoate	60-51-5	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Diazinon	333-41-5	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Parathion-methyl	298-00-0	2.0	µg/L		<2.0	<2.0	<2.0	----	----
Malathion	121-75-5	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Fenthion	55-38-9	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Chlorpyrifos	2921-88-2	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Parathion	56-38-2	2.0	µg/L		<2.0	<2.0	<2.0	----	----
Pirimphos-ethyl	23505-41-1	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Chlorfenvinphos	470-90-6	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Bromophos-ethyl	4824-78-6	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Fenamiphos	22224-92-6	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Prothiofos	34643-46-4	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Ethion	563-12-2	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Carbophenothion	786-19-6	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Azinphos Methyl	86-50-0	0.5	µg/L		<0.5	<0.5	<0.5	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW09	GW08	GW09	----	----
				Client sampling date / time	29-Aug-2017 00:00	29-Aug-2017 00:00	29-Aug-2017 00:00	----	----
Compound	CAS Number	LOR	Unit		EM1711637-006	EM1711637-007	EM1711637-008	--------	--------
					Result	Result	Result	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	----	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	----	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	----	----
Toluene	108-88-3	2	µg/L		<2	<2	<2	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	----	----
^ Total Xylenes	1330-20-7	2	µg/L		<2	<2	<2	----	----
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	----	----
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.5	%		**79.4**	**72.1**	**66.6**	----	----
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.5	%		**96.9**	**88.6**	**86.6**	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**94.0**	**106**	**97.6**	----	----
Toluene-D8	2037-26-5	2	%		**80.5**	**89.8**	**81.5**	----	----
4-Bromofluorobenzene	460-00-4	2	%		**87.0**	**93.0**	**88.3**	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	49	117
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	51	127
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM1711637**	Page	: 1 of 10
Amendment	: **1**		
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Telephone	: +61-3-8549 9600
Project	: 2135645A	Date Samples Received	: 29-Aug-2017
Site	: ----	Issue Date	: 14-Sep-2017
Sampler	: KELLY-JANE WALLIS	No. of samples received	: 8
Order number	: 3219	No. of samples analysed	: 8

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

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

Summary of Outliers

Outliers : Quality Control Samples

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

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

Outliers : Analysis Holding Time Compliance

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

Outliers : Frequency of Quality Control Samples

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

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Laboratory Control Spike (LCS) Recoveries							
EP068B: Organophosphorus Pesticides (OP)	QC-1085689-001	----	**Monocrotophos**	6923-22-4	3.84 %	10-41%	**Recovery less than lower control limit**
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	EM1711635--002	Anonymous	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
ED045G: Chloride by Discrete Analyser	EM1711635--002	Anonymous	**Chloride**	16887-00-6	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK057G: Nitrite as N by Discrete Analyser	EM1711384--011	Anonymous	**Nitrite as N**	14797-65-0	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK071G: Reactive Phosphorus as P by discrete analyse	EM1711384--011	Anonymous	**Reactive Phosphorus as P**	14265-44-2	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method	Extraction / Preparation			Analysis		
Container / Client Sample ID(s)	Date extracted	Due for extraction	**Days overdue**	Date analysed	Due for analysis	**Days overdue**
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural						
GW11S, GW11D	----	----	----	30-Aug-2017	28-Aug-2017	**2**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
Pesticides by GCMS	0	8	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	1	20	5.00	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
Fluoride by PC Titrator	1	21	4.76	5.00	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	0	8	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	0	20	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

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

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

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

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

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P)							
GW11S, GW11D	**28-Aug-2017**	**----**	----	----	**30-Aug-2017**	28-Aug-2017	×
Clear Plastic Bottle - Natural (EA005-P)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**----**	----	----	**29-Aug-2017**	29-Aug-2017	✓
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
GW11S, GW11D	**28-Aug-2017**	**----**	----	----	**30-Aug-2017**	25-Sep-2017	✓
Clear Plastic Bottle - Natural (EA010-P)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**----**	----	----	**30-Aug-2017**	26-Sep-2017	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
GW11S, GW11D	**28-Aug-2017**	**----**	----	----	**30-Aug-2017**	11-Sep-2017	✓
Clear Plastic Bottle - Natural (ED037-P)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**----**	----	----	**30-Aug-2017**	12-Sep-2017	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
GW11S, GW11D	**28-Aug-2017**	**----**	----	----	**01-Sep-2017**	25-Sep-2017	✓
Clear Plastic Bottle - Natural (ED041G)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**----**	----	----	**01-Sep-2017**	26-Sep-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
GW11S, GW11D	**28-Aug-2017**	**----**	----	----	**01-Sep-2017**	25-Sep-2017	✓
Clear Plastic Bottle - Natural (ED045G)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**----**	----	----	**01-Sep-2017**	26-Sep-2017	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
GW11S, GW11D	**28-Aug-2017**	**----**	----	----	**30-Aug-2017**	25-Sep-2017	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**----**	----	----	**30-Aug-2017**	26-Sep-2017	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
GW11S, GW11D	**28-Aug-2017**	**----**	----	----	**30-Aug-2017**	24-Feb-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**----**	----	----	**30-Aug-2017**	25-Feb-2018	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
GW11S, GW11D	**28-Aug-2017**	**----**	----	----	**31-Aug-2017**	25-Sep-2017	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**----**	----	----	**31-Aug-2017**	26-Sep-2017	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P)							
GW11S, GW11D	**28-Aug-2017**	**----**	----	----	**30-Aug-2017**	25-Sep-2017	✓
Clear Plastic Bottle - Natural (EK040P)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**----**	----	----	**30-Aug-2017**	26-Sep-2017	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
GW11S, GW11D	**28-Aug-2017**	**----**	----	----	**31-Aug-2017**	25-Sep-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**----**	----	----	**31-Aug-2017**	26-Sep-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
GW11S, GW11D	**28-Aug-2017**	**----**	----	----	**30-Aug-2017**	30-Aug-2017	✓
Clear Plastic Bottle - Natural (EK057G)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**----**	----	----	**30-Aug-2017**	31-Aug-2017	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
GW11S, GW11D	**28-Aug-2017**	**----**	----	----	**31-Aug-2017**	25-Sep-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**----**	----	----	**31-Aug-2017**	26-Sep-2017	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
GW11S, GW11D	**28-Aug-2017**	**----**	----	----	**30-Aug-2017**	30-Aug-2017	✓
Clear Plastic Bottle - Natural (EK071G)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**----**	----	----	**30-Aug-2017**	31-Aug-2017	✓
EP020: Oil and Grease (O&G)							
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020)							
GW11S, GW11D	**28-Aug-2017**	**----**	----	----	**01-Sep-2017**	25-Sep-2017	✓
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**----**	----	----	**01-Sep-2017**	26-Sep-2017	✓
EP068A: Organochlorine Pesticides (OC)							
Amber Glass Bottle - Unpreserved (EP068)							
GW11S, GW11D	**28-Aug-2017**	**01-Sep-2017**	04-Sep-2017	✓	**01-Sep-2017**	11-Oct-2017	✓
Amber Glass Bottle - Unpreserved (EP068)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**01-Sep-2017**	05-Sep-2017	✓	**01-Sep-2017**	11-Oct-2017	✓
EP068B: Organophosphorus Pesticides (OP)							
Amber Glass Bottle - Unpreserved (EP068)							
GW11S, GW11D	**28-Aug-2017**	**01-Sep-2017**	04-Sep-2017	✓	**01-Sep-2017**	11-Oct-2017	✓
Amber Glass Bottle - Unpreserved (EP068)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**01-Sep-2017**	05-Sep-2017	✓	**01-Sep-2017**	11-Oct-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071)							
GW11S, GW11D	**28-Aug-2017**	**01-Sep-2017**	04-Sep-2017	✓	**01-Sep-2017**	11-Oct-2017	✓
Amber Glass Bottle - Unpreserved (EP071)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**01-Sep-2017**	05-Sep-2017	✓	**01-Sep-2017**	11-Oct-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW11S, GW11D	**28-Aug-2017**	**30-Aug-2017**	11-Sep-2017	✓	**31-Aug-2017**	11-Sep-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**30-Aug-2017**	12-Sep-2017	✓	**31-Aug-2017**	12-Sep-2017	✓
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Amber Glass Bottle - Unpreserved (EP071)							
GW11S, GW11D	**28-Aug-2017**	**01-Sep-2017**	04-Sep-2017	✓	**01-Sep-2017**	11-Oct-2017	✓
Amber Glass Bottle - Unpreserved (EP071)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**01-Sep-2017**	05-Sep-2017	✓	**01-Sep-2017**	11-Oct-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW11S, GW11D	**28-Aug-2017**	**30-Aug-2017**	11-Sep-2017	✓	**31-Aug-2017**	11-Sep-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**30-Aug-2017**	12-Sep-2017	✓	**31-Aug-2017**	12-Sep-2017	✓
EP080: BTEXN							
Amber VOC Vial - Sulfuric Acid (EP080)							
GW11S, GW11D	**28-Aug-2017**	**30-Aug-2017**	11-Sep-2017	✓	**31-Aug-2017**	11-Sep-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW15D, GW14D, SW08, SW09, GW08, GW09	**29-Aug-2017**	**30-Aug-2017**	12-Sep-2017	✓	**31-Aug-2017**	12-Sep-2017	✓

Quality Control Parameter Frequency Compliance

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

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	4	32	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	3	23	**13.04**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	3	21	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	3	25	**12.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	0	8	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	20	**5.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	2	32	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	23	**8.70**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	25	**8.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	23	**8.70**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	25	**8.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	23	**8.70**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	21	**4.76**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	25	**8.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	0	8	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	20	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

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

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Calculated TDS (from Electrical Conductivity)	EA016	WATER	In house: Calculation from Electrical Conductivity (APHA 2510 B) using a conversion factor specified in the analytical report. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Oil and Grease	EP020	WATER	In house: Referenced to APHA 5520 B. Oil & grease is a gravimetric procedure to determine the amount of oil & grease residue in an aqueous sample. The sample is serially extracted three times n-hexane. The resultant extracts are combined, dehydrated and concentrated prior to gravimetric determination. This method is compliant with NEPM (2013) Schedule B(3)
Pesticides by GCMS	EP068	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ Sydney: 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ Newcastle: 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ Brisbane: 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ Townsville: 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ Melbourne: 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ Adelaide: 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ Perth: 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ Launceston: 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	TURNAROUND REQUIREMENTS : (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	FOR LABORATORY USE ONLY (Circle)	
OFFICE: Melbourne, Southbank		Custody Seal Intact?	Yes / No / N/A
PROJECT: 2135645A	ALS QUOTE NO.: EN/008/16	Free Ice / frozen ice bricks present upon receipt?	Yes / No / N/A
ORDER NUMBER: 3219	COC SEQUENCE NUMBER (Circle) COC 1 2 3 4 5 7	Random Sample Temperature on Receipt:	°C
PROJECT MANAGER: Ray Hatley	CONTACT PH: 0407 250 056 OF: 1 2 3 4 5 7	Other comment:	
SAMPLER: KJW	SAMPLER MOBILE: 0447026695		
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):		
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com			
Email Invoice to : au.accountspayable@wsp.com			

RELINQUISHED BY:	RECEIVED BY:	RELINQUISHED BY:	RECEIVED BY:
KJ Wallis			
DATE/TIME: 5:27 pm	DATE/TIME:	DATE/TIME:	DATE/TIME: 29/8, 17:30

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	IN-1, EA005P	NT1, NT2A	W3F, AI (EG020F)	NT4, EK055G EK071G	EP020	W4	W12		
1	GW11S	28/08/17	Water		8	X	X	X	X	X	X	X		
2	GW11D	28/08/17	"		8	X	X	X	X	X	X	X		
3	GW15D	29/08/17	"		8	X	X	X	X	X	X	X		
4	GW14D	29/08/17	"		8	X	X	X	X	X	X	X		
5	SW08	29/08/17	"		8	X	X	X	X	X	X	X		
6	SW09	29/08/17	"		8	X	X	X	X	X	X	X		
7	GW08	29/08/17	"		8	X	X	X	X	X	X	X		High EC 26600 uS/cm
8	GW09	29/08/17	"		8	X	X	X	X	X	X	X		
			Nitric		18									
				TOTAL	64									

Environmental Division
Melbourne
Work Order Reference
EM1711637

Telephone : +61-3-8549 9600

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1711811**	Page	: 1 of 20
Amendment	: **1**		
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Contact	: Graeme Jablonskas
Address	: Level 15, 28 Freshwater Place SOUTHBANK VIC, AUSTRALIA 3006	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 03 9861 1111	Telephone	: +61-3-8549 9609
Project	: 2135645A	Date Samples Received	: 31-Aug-2017 16:20
Order number	: 3219	Date Analysis Commenced	: 31-Aug-2017
C-O-C number	: ----	Issue Date	: 14-Sep-2017 15:19
Sampler	: KELLY-JANE WALLIS		
Site	: ----		
Quote number	: ME-525-16		
No. of samples received	: 17		
No. of samples analysed	: 17		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Xing Lin	Senior Organic Chemist	Melbourne Organics, Springvale, VIC

General Comments

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

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

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

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

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

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

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

- EK057G: Results for EM1711811-010 to 013 have been confirmed by re-preparation and re-analysis.
- Ionic Balance out of acceptable limits for sample #9 due to analytes not quantified in this report.
- Amendment (14/09/2017): This report has been amended and re-released to allow the reporting of additional analytical data. Dissolved Fe.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- Ionic balances were calculated using: major anions - chloride, alkalinity, sulfate and NOx; and major cations - calcium, magnesium, potassium, sodium for #9.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- ED045G: EM1711811 #2 Poor matrix spike recovery for chloride due to matrix effects.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW10D	GW10S	GW12D	GW12S	SW01
			Client sampling date / time	30-Aug-2017 08:10	30-Aug-2017 08:40	30-Aug-2017 11:00	30-Aug-2017 11:20	30-Aug-2017 12:10
Compound	CAS Number	LOR	Unit	EM1711811-001	EM1711811-002	EM1711811-003	EM1711811-004	EM1711811-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.44	6.97	7.41	6.60	7.04
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	7660	2160	6190	13000	1410
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	4980	1400	4020	8450	916
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	45	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	518	248	329	154	44
Total Alkalinity as CaCO3	----	1	mg/L	564	248	329	154	44
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	288	13	162	1350	204
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	2000	567	1590	4420	246
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	160	49	114	331	41
Magnesium	7439-95-4	1	mg/L	180	46	120	483	26
Sodium	7440-23-5	1	mg/L	1050	260	854	1710	151
Potassium	7440-09-7	1	mg/L	7	7	8	8	14
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	0.03	<0.01	0.02	0.05
Arsenic	7440-38-2	0.001	mg/L	0.025	0.004	0.229	0.004	0.001
Boron	7440-42-8	0.05	mg/L	0.22	0.08	0.13	0.09	0.19
Barium	7440-39-3	0.001	mg/L	0.088	0.297	0.165	0.159	0.068
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.001	0.004	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.061	0.145	0.148	0.179	0.216
Nickel	7440-02-0	0.001	mg/L	<0.001	0.001	<0.001	0.009	0.003
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW10D	GW10S	GW12D	GW12S	SW01
				Client sampling date / time	30-Aug-2017 08:10	30-Aug-2017 08:40	30-Aug-2017 11:00	30-Aug-2017 11:20	30-Aug-2017 12:10
Compound	CAS Number	LOR	Unit		EM1711811-001	EM1711811-002	EM1711811-003	EM1711811-004	EM1711811-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	**0.006**	<0.005
Iron	7439-89-6	0.05	mg/L		**5.32**	**3.05**	**15.5**	**11.3**	**1.76**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**2.6**	**0.3**	**0.3**	**0.1**	**0.2**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.65**	**1.04**	**0.63**	**0.31**	**5.66**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	**0.01**	<0.01	<0.01	**0.02**
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	**0.02**	**0.06**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.01**	<0.01	**0.02**	**0.08**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.01**	<0.01	<0.01	<0.01	**0.10**
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**73.7**	**21.2**	**54.8**	**156**	**12.1**
Total Cations	----	0.01	meq/L		**68.6**	**17.7**	**52.9**	**131**	**11.1**
Ionic Balance	----	0.01	%		**3.54**	**8.99**	**1.75**	**8.72**	**4.12**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5
EP068A: Organochlorine Pesticides (OC)									
alpha-BHC	319-84-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
beta-BHC	319-85-7	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
gamma-BHC	58-89-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
delta-BHC	319-86-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor	76-44-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin	309-00-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide	1024-57-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
trans-Chlordane	5103-74-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
alpha-Endosulfan	959-98-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW10D	GW10S	GW12D	GW12S	SW01
				Client sampling date / time	30-Aug-2017 08:10	30-Aug-2017 08:40	30-Aug-2017 11:00	30-Aug-2017 11:20	30-Aug-2017 12:10
Compound	CAS Number	LOR	Unit		EM1711811-001	EM1711811-002	EM1711811-003	EM1711811-004	EM1711811-005
					Result	Result	Result	Result	Result
EP068A: Organochlorine Pesticides (OC) - Continued									
cis-Chlordane	5103-71-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin	60-57-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDE	72-55-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Endrin	72-20-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
beta-Endosulfan	33213-65-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDD	72-54-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Endrin aldehyde	7421-93-4	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate	1031-07-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDT	50-29-3	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Endrin ketone	53494-70-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Methoxychlor	72-43-5	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
^ Total Chlordane (sum)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Demeton-S-methyl	919-86-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Monocrotophos	6923-22-4	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Dimethoate	60-51-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Diazinon	333-41-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Parathion-methyl	298-00-0	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Malathion	121-75-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Fenthion	55-38-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos	2921-88-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Parathion	56-38-2	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Pirimphos-ethyl	23505-41-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos	470-90-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl	4824-78-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Fenamiphos	22224-92-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Prothiofos	34643-46-4	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Ethion	563-12-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Carbophenothion	786-19-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Azinphos Methyl	86-50-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW10D	GW10S	GW12D	GW12S	SW01
				Client sampling date / time	30-Aug-2017 08:10	30-Aug-2017 08:40	30-Aug-2017 11:00	30-Aug-2017 11:20	30-Aug-2017 12:10
Compound	CAS Number	LOR	Unit		EM1711811-001	EM1711811-002	EM1711811-003	EM1711811-004	EM1711811-005
					Result	Result	Result	Result	Result
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	1330-20-7	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.5	%		**84.3**	**87.4**	**85.4**	**92.0**	**93.5**
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.5	%		**97.2**	**93.9**	**100**	**98.7**	**102**
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**103**	**108**	**96.5**	**110**	**103**
Toluene-D8	2037-26-5	2	%		**103**	**104**	**92.3**	**104**	**96.7**
4-Bromofluorobenzene	460-00-4	2	%		**95.9**	**97.2**	**91.2**	**97.9**	**94.8**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW03	SW04	SW11	SW10	QA01
			Client sampling date / time	30-Aug-2017 13:10	30-Aug-2017 13:32	30-Aug-2017 14:28	30-Aug-2017 14:40	30-Aug-2017 00:00
Compound	CAS Number	LOR	Unit	EM1711811-006	EM1711811-007	EM1711811-008	EM1711811-009	EM1711811-010
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**8.17**	**7.95**	**7.63**	**7.74**	**7.12**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**3500**	**21900**	**373**	**374**	**2210**
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	**2280**	**14200**	**242**	**243**	**1440**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**122**	**223**	**53**	**53**	**254**
Total Alkalinity as CaCO3	----	1	mg/L	**122**	**223**	**53**	**53**	**254**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**562**	**4120**	**38**	**19**	**17**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**650**	**5360**	**42**	**38**	**536**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**144**	**823**	**13**	**13**	**50**
Magnesium	7439-95-4	1	mg/L	**90**	**823**	**6**	**6**	**46**
Sodium	7440-23-5	1	mg/L	**375**	**3370**	**42**	**42**	**260**
Potassium	7440-09-7	1	mg/L	**20**	**94**	**3**	**3**	**7**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.04**	<0.01	**0.05**	<0.01	**0.02**
Arsenic	7440-38-2	0.001	mg/L	**0.002**	**0.004**	<0.001	<0.001	**0.003**
Boron	7440-42-8	0.05	mg/L	**0.24**	**1.61**	<0.05	<0.05	**0.07**
Barium	7440-39-3	0.001	mg/L	**0.071**	**0.091**	**0.017**	**0.017**	**0.288**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	**0.001**	**0.003**	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.037**	**0.113**	**0.009**	**0.009**	**0.142**
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.003**	**0.002**	**0.001**	**0.002**
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW03	SW04	SW11	SW10	QA01
				Client sampling date / time	30-Aug-2017 13:10	30-Aug-2017 13:32	30-Aug-2017 14:28	30-Aug-2017 14:40	30-Aug-2017 00:00
Compound	CAS Number	LOR	Unit		EM1711811-006	EM1711811-007	EM1711811-008	EM1711811-009	EM1711811-010
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Zinc	7440-66-6	0.005	mg/L		**0.005**	<0.005	**0.011**	**0.012**	**0.006**
Iron	7439-89-6	0.05	mg/L		**0.06**	**0.19**	**0.10**	<0.05	**3.03**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	<0.1	**0.1**	<0.1	**0.2**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.05**	**0.05**	**0.02**	**0.06**	**1.06**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	**0.02**	**0.02**	**0.01**
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.04**	**0.01**	**0.37**	**0.38**	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.04**	**0.01**	**0.39**	**0.40**	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**----**	**----**	**----**	**2.56**	**----**
Total Anions	----	0.01	meq/L		**32.5**	**241**	**3.03**	**----**	**20.5**
Total Cations	----	0.01	meq/L		**31.4**	**258**	**3.05**	**3.05**	**17.8**
Ionic Balance	----	0.01	%		**----**	**----**	**----**	**8.75**	**----**
Ionic Balance	----	0.01	%		**1.66**	**3.28**	**0.18**	**----**	**7.25**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5
EP068A: Organochlorine Pesticides (OC)									
alpha-BHC	319-84-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
beta-BHC	319-85-7	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
gamma-BHC	58-89-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
delta-BHC	319-86-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor	76-44-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin	309-00-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide	1024-57-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW03	SW04	SW11	SW10	QA01
				Client sampling date / time	30-Aug-2017 13:10	30-Aug-2017 13:32	30-Aug-2017 14:28	30-Aug-2017 14:40	30-Aug-2017 00:00
Compound	CAS Number	LOR	Unit		EM1711811-006	EM1711811-007	EM1711811-008	EM1711811-009	EM1711811-010
					Result	Result	Result	Result	Result
EP068A: Organochlorine Pesticides (OC) - Continued									
trans-Chlordane	5103-74-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
alpha-Endosulfan	959-98-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
cis-Chlordane	5103-71-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin	60-57-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDE	72-55-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Endrin	72-20-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
beta-Endosulfan	33213-65-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDD	72-54-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Endrin aldehyde	7421-93-4	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate	1031-07-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDT	50-29-3	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Endrin ketone	53494-70-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Methoxychlor	72-43-5	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
^ Total Chlordane (sum)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Demeton-S-methyl	919-86-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Monocrotophos	6923-22-4	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Dimethoate	60-51-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Diazinon	333-41-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Parathion-methyl	298-00-0	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Malathion	121-75-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Fenthion	55-38-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos	2921-88-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Parathion	56-38-2	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Pirimphos-ethyl	23505-41-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos	470-90-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl	4824-78-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Fenamiphos	22224-92-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Prothiofos	34643-46-4	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Ethion	563-12-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW03	SW04	SW11	SW10	QA01
				Client sampling date / time	30-Aug-2017 13:10	30-Aug-2017 13:32	30-Aug-2017 14:28	30-Aug-2017 14:40	30-Aug-2017 00:00
Compound	CAS Number	LOR	Unit		EM1711811-006	EM1711811-007	EM1711811-008	EM1711811-009	EM1711811-010
					Result	Result	Result	Result	Result
EP068B: Organophosphorus Pesticides (OP) - Continued									
Carbophenothion	786-19-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Azinphos Methyl	86-50-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	1330-20-7	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.5	%		**91.7**	**90.0**	**96.2**	**91.8**	**92.1**
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.5	%		**109**	**99.0**	**105**	**100**	**100**
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**97.8**	**118**	**106**	**103**	**104**
Toluene-D8	2037-26-5	2	%		**82.0**	**106**	**100**	**108**	**100**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW03	SW04	SW11	SW10	QA01
				Client sampling date / time	30-Aug-2017 13:10	30-Aug-2017 13:32	30-Aug-2017 14:28	30-Aug-2017 14:40	30-Aug-2017 00:00
Compound	CAS Number	LOR	Unit		EM1711811-006	EM1711811-007	EM1711811-008	EM1711811-009	EM1711811-010
					Result	Result	Result	Result	Result
EP080S: TPH(V)/BTEX Surrogates - Continued									
4-Bromofluorobenzene	460-00-4	2	%		**89.6**	**103**	**96.6**	**124**	**96.9**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW06	SW06	SW07	GW04	GW05
				Client sampling date / time	31-Aug-2017 09:25	31-Aug-2017 09:50	31-Aug-2017 10:30	31-Aug-2017 14:45	31-Aug-2017 15:45
Compound	CAS Number	LOR	Unit		EM1711811-011	EM1711811-012	EM1711811-013	EM1711811-015	EM1711811-016
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		6.45	8.10	7.90	6.94	7.02
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		24400	593	585	17000	30400
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	10	mg/L		15900	385	380	11000	19800
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		194	83	80	220	318
Total Alkalinity as CaCO3	----	1	mg/L		194	83	80	220	318
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		1770	21	20	853	1920
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		7420	89	90	5650	10600
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		852	16	16	860	1370
Magnesium	7439-95-4	1	mg/L		870	12	12	529	898
Sodium	7440-23-5	1	mg/L		3300	67	66	2080	4420
Potassium	7440-09-7	1	mg/L		8	4	3	9	7
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L		0.005	<0.001	<0.001	0.022	0.133
Boron	7440-42-8	0.05	mg/L		0.11	<0.05	<0.05	0.15	0.20
Barium	7440-39-3	0.001	mg/L		0.042	0.074	0.071	0.086	0.049
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L		0.028	<0.001	<0.001	0.024	0.008
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		0.393	0.001	<0.001	0.989	0.675
Nickel	7440-02-0	0.001	mg/L		0.015	<0.001	<0.001	0.007	0.003
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW06	SW06	SW07	GW04	GW05
				Client sampling date / time	31-Aug-2017 09:25	31-Aug-2017 09:50	31-Aug-2017 10:30	31-Aug-2017 14:45	31-Aug-2017 15:45
Compound	CAS Number	LOR	Unit		EM1711811-011	EM1711811-012	EM1711811-013	EM1711811-015	EM1711811-016
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	**0.011**	**0.006**
Iron	7439-89-6	0.05	mg/L		**1.03**	<0.05	<0.05	**7.81**	**6.16**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.2**	**0.2**	**0.4**	**0.5**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.38**	**0.01**	**0.01**	**0.60**	**0.11**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.01**	**0.01**	**0.01**	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	**0.01**	**0.01**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	**0.01**	**0.01**	**0.01**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**250**	**4.61**	**4.55**	**182**	**345**
Total Cations	----	0.01	meq/L		**258**	**4.80**	**4.73**	**177**	**335**
Ionic Balance	----	0.01	%		**1.54**	**2.09**	**1.94**	**1.22**	**1.56**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5
EP068A: Organochlorine Pesticides (OC)									
alpha-BHC	319-84-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
beta-BHC	319-85-7	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
gamma-BHC	58-89-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
delta-BHC	319-86-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor	76-44-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Aldrin	309-00-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Heptachlor epoxide	1024-57-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
trans-Chlordane	5103-74-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
alpha-Endosulfan	959-98-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW06	SW06	SW07	GW04	GW05
				Client sampling date / time	31-Aug-2017 09:25	31-Aug-2017 09:50	31-Aug-2017 10:30	31-Aug-2017 14:45	31-Aug-2017 15:45
Compound	CAS Number	LOR	Unit		EM1711811-011	EM1711811-012	EM1711811-013	EM1711811-015	EM1711811-016
					Result	Result	Result	Result	Result
EP068A: Organochlorine Pesticides (OC) - Continued									
cis-Chlordane	5103-71-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Dieldrin	60-57-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDE	72-55-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Endrin	72-20-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
beta-Endosulfan	33213-65-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDD	72-54-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Endrin aldehyde	7421-93-4	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Endosulfan sulfate	1031-07-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
4.4`-DDT	50-29-3	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Endrin ketone	53494-70-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Methoxychlor	72-43-5	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
^ Total Chlordane (sum)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Demeton-S-methyl	919-86-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Monocrotophos	6923-22-4	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Dimethoate	60-51-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Diazinon	333-41-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Parathion-methyl	298-00-0	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Malathion	121-75-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Fenthion	55-38-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorpyrifos	2921-88-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Parathion	56-38-2	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	<2.0
Pirimphos-ethyl	23505-41-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Chlorfenvinphos	470-90-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Bromophos-ethyl	4824-78-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Fenamiphos	22224-92-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Prothiofos	34643-46-4	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Ethion	563-12-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Carbophenothion	786-19-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5
Azinphos Methyl	86-50-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	<0.5

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW06	SW06	SW07	GW04	GW05
				Client sampling date / time	31-Aug-2017 09:25	31-Aug-2017 09:50	31-Aug-2017 10:30	31-Aug-2017 14:45	31-Aug-2017 15:45
Compound	CAS Number	LOR	Unit		EM1711811-011	EM1711811-012	EM1711811-013	EM1711811-015	EM1711811-016
					Result	Result	Result	Result	Result
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	1330-20-7	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.5	%		**85.8**	**90.2**	**101**	**81.6**	**81.8**
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.5	%		**98.3**	**94.6**	**109**	**89.7**	**89.0**
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**113**	**104**	**103**	**101**	**121**
Toluene-D8	2037-26-5	2	%		**96.8**	**102**	**103**	**89.2**	**111**
4-Bromofluorobenzene	460-00-4	2	%		**94.8**	**98.3**	**97.1**	**90.5**	**104**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	QA02	GW14S	----	----	----
			Client sampling date / time	31-Aug-2017 00:00	30-Aug-2017 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EM1711811-017	EM1711811-018	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.96**	**7.77**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**17600**	**4780**	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	**11400**	**3110**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**223**	**385**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**223**	**385**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**840**	**155**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**5650**	**1240**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**867**	**158**	----	----	----
Magnesium	7439-95-4	1	mg/L	**538**	**123**	----	----	----
Sodium	7440-23-5	1	mg/L	**2110**	**548**	----	----	----
Potassium	7440-09-7	1	mg/L	**9**	**10**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	**0.26**	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.022**	**0.021**	----	----	----
Boron	7440-42-8	0.05	mg/L	**0.15**	**0.12**	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.084**	**0.755**	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.025**	**0.003**	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.988**	**0.212**	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.006**	**0.005**	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	----	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	QA02	GW14S	----	----	----
			Client sampling date / time	31-Aug-2017 00:00	30-Aug-2017 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EM1711811-017	EM1711811-018	--------	--------	--------
				Result	Result	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Zinc	7440-66-6	0.005	mg/L	**0.009**	**0.010**	----	----	----
Iron	7439-89-6	0.05	mg/L	**7.82**	**7.35**	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.4**	**0.4**	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.66**	**0.21**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	**0.01**	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	**0.01**	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	**0.01**	**0.01**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	**0.02**	----	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**181**	**45.9**	----	----	----
Total Cations	----	0.01	meq/L	**180**	**42.1**	----	----	----
Ionic Balance	----	0.01	%	**0.49**	**4.32**	----	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	----	----	----
EP068A: Organochlorine Pesticides (OC)								
alpha-BHC	319-84-6	0.5	µg/L	<0.5	<0.5	----	----	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L	<0.5	<0.5	----	----	----
beta-BHC	319-85-7	0.5	µg/L	<0.5	<0.5	----	----	----
gamma-BHC	58-89-9	0.5	µg/L	<0.5	<0.5	----	----	----
delta-BHC	319-86-8	0.5	µg/L	<0.5	<0.5	----	----	----
Heptachlor	76-44-8	0.5	µg/L	<0.5	<0.5	----	----	----
Aldrin	309-00-2	0.5	µg/L	<0.5	<0.5	----	----	----
Heptachlor epoxide	1024-57-3	0.5	µg/L	<0.5	<0.5	----	----	----
trans-Chlordane	5103-74-2	0.5	µg/L	<0.5	<0.5	----	----	----
alpha-Endosulfan	959-98-8	0.5	µg/L	<0.5	<0.5	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	QA02	GW14S	----	----	----
				Client sampling date / time	31-Aug-2017 00:00	30-Aug-2017 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EM1711811-017	EM1711811-018	--------	--------	--------
					Result	Result	----	----	----
EP068A: Organochlorine Pesticides (OC) - Continued									
cis-Chlordane	5103-71-9	0.5	µg/L		<0.5	<0.5	----	----	----
Dieldrin	60-57-1	0.5	µg/L		<0.5	<0.5	----	----	----
4.4`-DDE	72-55-9	0.5	µg/L		<0.5	<0.5	----	----	----
Endrin	72-20-8	0.5	µg/L		<0.5	<0.5	----	----	----
beta-Endosulfan	33213-65-9	0.5	µg/L		<0.5	<0.5	----	----	----
4.4`-DDD	72-54-8	0.5	µg/L		<0.5	<0.5	----	----	----
Endrin aldehyde	7421-93-4	0.5	µg/L		<0.5	<0.5	----	----	----
Endosulfan sulfate	1031-07-8	0.5	µg/L		<0.5	<0.5	----	----	----
4.4`-DDT	50-29-3	2.0	µg/L		<2.0	<2.0	----	----	----
Endrin ketone	53494-70-5	0.5	µg/L		<0.5	<0.5	----	----	----
Methoxychlor	72-43-5	2.0	µg/L		<2.0	<2.0	----	----	----
^ Total Chlordane (sum)	----	0.5	µg/L		<0.5	<0.5	----	----	----
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L		<0.5	<0.5	----	----	----
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L		<0.5	<0.5	----	----	----
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.5	µg/L		<0.5	<0.5	----	----	----
Demeton-S-methyl	919-86-8	0.5	µg/L		<0.5	<0.5	----	----	----
Monocrotophos	6923-22-4	2.0	µg/L		<2.0	<2.0	----	----	----
Dimethoate	60-51-5	0.5	µg/L		<0.5	<0.5	----	----	----
Diazinon	333-41-5	0.5	µg/L		<0.5	<0.5	----	----	----
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L		<0.5	<0.5	----	----	----
Parathion-methyl	298-00-0	2.0	µg/L		<2.0	<2.0	----	----	----
Malathion	121-75-5	0.5	µg/L		<0.5	<0.5	----	----	----
Fenthion	55-38-9	0.5	µg/L		<0.5	<0.5	----	----	----
Chlorpyrifos	2921-88-2	0.5	µg/L		<0.5	<0.5	----	----	----
Parathion	56-38-2	2.0	µg/L		<2.0	<2.0	----	----	----
Pirimphos-ethyl	23505-41-1	0.5	µg/L		<0.5	<0.5	----	----	----
Chlorfenvinphos	470-90-6	0.5	µg/L		<0.5	<0.5	----	----	----
Bromophos-ethyl	4824-78-6	0.5	µg/L		<0.5	<0.5	----	----	----
Fenamiphos	22224-92-6	0.5	µg/L		<0.5	<0.5	----	----	----
Prothiofos	34643-46-4	0.5	µg/L		<0.5	<0.5	----	----	----
Ethion	563-12-2	0.5	µg/L		<0.5	<0.5	----	----	----
Carbophenothion	786-19-6	0.5	µg/L		<0.5	<0.5	----	----	----
Azinphos Methyl	86-50-0	0.5	µg/L		<0.5	<0.5	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	QA02	GW14S	----	----	----
				Client sampling date / time	31-Aug-2017 00:00	30-Aug-2017 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EM1711811-017	EM1711811-018	--------	--------	--------
					Result	Result	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	----	----	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L		<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	----	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		<20	<20	----	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	----	----	----
Toluene	108-88-3	2	µg/L		<2	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	----	----	----
^ **Total Xylenes**	1330-20-7	2	µg/L		<2	<2	----	----	----
^ **Sum of BTEX**	----	1	µg/L		<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	----	----	----
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.5	%		**79.3**	**79.2**	----	----	----
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.5	%		**87.8**	**90.4**	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**111**	**103**	----	----	----
Toluene-D8	2037-26-5	2	%		**102**	**99.6**	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**99.9**	**93.8**	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	49	117
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	51	127
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM1711811**	Page	: 1 of 13
Amendment	: **1**		
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Telephone	: +61-3-8549 9609
Project	: 2135645A	Date Samples Received	: 31-Aug-2017
Site	: ----	Issue Date	: 14-Sep-2017
Sampler	: KELLY-JANE WALLIS	No. of samples received	: 17
Order number	: 3219	No. of samples analysed	: 17

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

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

Summary of Outliers

Outliers : Quality Control Samples

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

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

Outliers : Analysis Holding Time Compliance

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

Outliers : Frequency of Quality Control Samples

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

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED045G: Chloride by Discrete Analyser	EM1711811--002	GW10S	**Chloride**	16887-00-6	63.6 %	70-130%	**Recovery less than lower data quality objective**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Ar	EM1711384--013	Anonymous	**Nitrite + Nitrate as N**	----	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)		Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural							
GW10D,	GW10S,	----	----	----	05-Sep-2017	30-Aug-2017	**6**
GW12D,	GW12S,						
SW01,	SW03,						
SW04,	SW11,						
SW10,	QA01,						
GW14S							

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
Pesticides by GCMS	0	17	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	0	18	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
Pesticides by GCMS	0	17	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	0	18	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

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

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

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

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

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

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**----**	----	----	**05-Sep-2017**	30-Aug-2017	×
Clear Plastic Bottle - Natural (EA005-P)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**----**	----	----	**31-Aug-2017**	31-Aug-2017	✓
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**----**	----	----	**05-Sep-2017**	27-Sep-2017	✓
Clear Plastic Bottle - Natural (EA010-P)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**----**	----	----	**05-Sep-2017**	28-Sep-2017	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**----**	----	----	**05-Sep-2017**	13-Sep-2017	✓
Clear Plastic Bottle - Natural (ED037-P)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**----**	----	----	**05-Sep-2017**	14-Sep-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**----**	----	----	**06-Sep-2017**	27-Sep-2017	✓
Clear Plastic Bottle - Natural (ED041G)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**----**	----	----	**06-Sep-2017**	28-Sep-2017	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**----**	----	----	**06-Sep-2017**	27-Sep-2017	✓
Clear Plastic Bottle - Natural (ED045G)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**----**	----	----	**06-Sep-2017**	28-Sep-2017	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**----**	----	----	**07-Sep-2017**	27-Sep-2017	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**----**	----	----	**07-Sep-2017**	28-Sep-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020F: Dissolved Metals by ICP-MS								
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)								
GW10D,	GW10S,	**30-Aug-2017**	**----**	----	----	**05-Sep-2017**	26-Feb-2018	✓
GW12D,	GW12S,							
SW01,	SW03,							
SW04,	SW11,							
SW10,	QA01,							
GW14S								
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)								
GW06,	SW06,	**31-Aug-2017**	**----**	----	----	**05-Sep-2017**	27-Feb-2018	✓
SW07,	GW04,							
GW05,	QA02							
EG035F: Dissolved Mercury by FIMS								
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)								
GW10D,	GW10S,	**30-Aug-2017**	**----**	----	----	**07-Sep-2017**	27-Sep-2017	✓
GW12D,	GW12S,							
SW01,	SW03,							
SW04,	SW11,							
SW10,	QA01,							
GW14S								
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)								
GW06,	SW06,	**31-Aug-2017**	**----**	----	----	**07-Sep-2017**	28-Sep-2017	✓
SW07,	GW04,							
GW05,	QA02							
EK040P: Fluoride by PC Titrator								
Clear Plastic Bottle - Natural (EK040P)								
GW10D,	GW10S,	**30-Aug-2017**	**----**	----	----	**05-Sep-2017**	27-Sep-2017	✓
GW12D,	GW12S,							
SW01,	SW03,							
SW04,	SW11,							
SW10,	QA01,							
GW14S								
Clear Plastic Bottle - Natural (EK040P)								
GW06,	SW06,	**31-Aug-2017**	**----**	----	----	**05-Sep-2017**	28-Sep-2017	✓
SW07,	GW04,							
GW05,	QA02							

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**----**	----	----	**05-Sep-2017**	27-Sep-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**----**	----	----	**05-Sep-2017**	28-Sep-2017	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**----**	----	----	**01-Sep-2017**	01-Sep-2017	✓
Clear Plastic Bottle - Natural (EK057G)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**----**	----	----	**01-Sep-2017**	02-Sep-2017	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**----**	----	----	**05-Sep-2017**	27-Sep-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**----**	----	----	**05-Sep-2017**	28-Sep-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**----**	----	----	**01-Sep-2017**	01-Sep-2017	✓
Clear Plastic Bottle - Natural (EK071G)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**----**	----	----	**01-Sep-2017**	02-Sep-2017	✓
EP020: Oil and Grease (O&G)							
Amber Glass Bottle - Sulfuric Acid (EP020)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**----**	----	----	**06-Sep-2017**	27-Sep-2017	✓
Amber Glass Bottle - Sulfuric Acid (EP020)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**----**	----	----	**06-Sep-2017**	28-Sep-2017	✓
EP068A: Organochlorine Pesticides (OC)							
Amber Glass Bottle - Unpreserved (EP068)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**06-Sep-2017**	06-Sep-2017	✓	**06-Sep-2017**	16-Oct-2017	✓
Amber Glass Bottle - Unpreserved (EP068)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**06-Sep-2017**	07-Sep-2017	✓	**06-Sep-2017**	16-Oct-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP068B: Organophosphorus Pesticides (OP)							
Amber Glass Bottle - Unpreserved (EP068)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**06-Sep-2017**	06-Sep-2017	✓	**06-Sep-2017**	16-Oct-2017	✓
Amber Glass Bottle - Unpreserved (EP068)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**06-Sep-2017**	07-Sep-2017	✓	**06-Sep-2017**	16-Oct-2017	✓
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**06-Sep-2017**	06-Sep-2017	✓	**06-Sep-2017**	16-Oct-2017	✓
Amber Glass Bottle - Unpreserved (EP071)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**06-Sep-2017**	07-Sep-2017	✓	**06-Sep-2017**	16-Oct-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**05-Sep-2017**	13-Sep-2017	✓	**05-Sep-2017**	13-Sep-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**05-Sep-2017**	14-Sep-2017	✓	**05-Sep-2017**	14-Sep-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Amber Glass Bottle - Unpreserved (EP071)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**06-Sep-2017**	06-Sep-2017	✓	**06-Sep-2017**	16-Oct-2017	✓
Amber Glass Bottle - Unpreserved (EP071)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**06-Sep-2017**	07-Sep-2017	✓	**06-Sep-2017**	16-Oct-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**05-Sep-2017**	13-Sep-2017	✓	**05-Sep-2017**	13-Sep-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**05-Sep-2017**	14-Sep-2017	✓	**05-Sep-2017**	14-Sep-2017	✓
EP080: BTEXN							
Amber VOC Vial - Sulfuric Acid (EP080)							
GW10D, GW10S, GW12D, GW12S, SW01, SW03, SW04, SW11, SW10, QA01, GW14S	**30-Aug-2017**	**05-Sep-2017**	13-Sep-2017	✓	**05-Sep-2017**	13-Sep-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW06, SW06, SW07, GW04, GW05, QA02	**31-Aug-2017**	**05-Sep-2017**	14-Sep-2017	✓	**05-Sep-2017**	14-Sep-2017	✓

Quality Control Parameter Frequency Compliance

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

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	0	17	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	18	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	0	17	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	18	**0.00**	**5.00**	✗	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

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

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Calculated TDS (from Electrical Conductivity)	EA016	WATER	In house: Calculation from Electrical Conductivity (APHA 2510 B) using a conversion factor specified in the analytical report. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Oil and Grease	EP020	WATER	In house: Referenced to APHA 5520 B. Oil & grease is a gravimetric procedure to determine the amount of oil & grease residue in an aqueous sample. The sample is serially extracted three times n-hexane. The resultant extracts are combined, dehydrated and concentrated prior to gravimetric determination. This method is compliant with NEPM (2013) Schedule B(3)
Pesticides by GCMS	EP068	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

CHAIN OF CUSTODY

ALS Laboratory: **please tick** →

☐ **Sydney**: 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ **Newcastle**: 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ **Brisbane**: 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ **Townsville**: 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne**: 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide**: 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth**: 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston**: 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	**FOR LABORATORY USE ONLY (Circle)**	
OFFICE: Melbourne, Southbank		Custody Seal Intact?	Yes / No / N/A
PROJECT: 213564SA	**ALS QUOTE NO.:** EN/008/16	**COC SEQUENCE NUMBER (Circle)**	Free ice / frozen ice bricks present upon receipt? Yes / No / N/A
ORDER NUMBER: 3219		COC 1 2 3 4 5 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Ray Hatley	**CONTACT PH:** 0407 250 056	OF: 1 2 3 4 5 7	Other comment:
SAMPLER: Kelly-Jane Wallis	**SAMPLER MOBILE:** 0447026695	**RELINQUISHED BY:** KJ Wallis	**RECEIVED BY:**
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**		
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com		DATE/TIME: 16:15 31/8/17	DATE/TIME:
Email Invoice to : au.accountspayable@wsp.com		**RELINQUISHED BY:**	**RECEIVED BY:**
		DATE/TIME:	DATE/TIME: 31/8/17 16:20

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price)

Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		IN-1 EA005P	NT1 NT2A	W3F Al (EG020F)	NT4, EK055G EK071G	EP020	W4	W12	Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES								
1	GW10D	30/8/17 8:10	W		8	X	X	X	X	X	X	X	
2	GW10S	" 8:40	W		8	X							
3	GW12D	" 11:00	W		8	X							
4	GW12S	" 11:20	W		8								
5	SW01	" 12:10	W		8								
6	SW03	" 1:10pm	W		8								
7	SW04	" 1:32pm	W		8								High EC 21,000 uS/cm
8	SW11	" 2:28pm	W		8								
9	SW10	" 2:40pm	W		7								1 nutrients bottle
10	QA01	30/8/17	W		8	✓	✓	✓	✓	✓	✓	✓	
				TOTAL	79								

Environmental Division
Melbourne
Work Order Reference
EM1711811

Telephone : +61-3-8549 9600

31/8/17 SH

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

CHAIN OF CUSTODY

ALS Laboratory: **please tick** →

☐ **Sydney:** 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ **Newcastle:** 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ **Brisbane:** 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ **Townsville:** 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne:** 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide:** 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth:** 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston:** 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	**FOR LABORATORY USE ONLY (Circle)**	
OFFICE: Melb, Southbank		Custody Seal Intact?	Yes / No / N/A
PROJECT: 2135645A	**ALS QUOTE NO.:** EN/008/16	Free ice / frozen ice bricks present upon receipt?	Yes / No / N/A
ORDER NUMBER: 3219	**COC SEQUENCE NUMBER (Circle)** COC 1 2 3 4 5 7	Random Sample Temperature on Receipt:	°C
PROJECT MANAGER: Ray Hatley	**CONTACT PH:** 0407 250 056 OF: 1 2 3 4 5 7	Other comment:	
SAMPLER: Kelly-Jane Walsh	**SAMPLER MOBILE:** 0447 026 695		
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**		
Email Reports to : Kelly-Jane.Walsh@wsp.com, Ray.Hatley@wsp.com			
Email Invoice to : au.accountspayable@wsp.com			

RELINQUISHED BY:	**RECEIVED BY:**	**RELINQUISHED BY:**	**RECEIVED BY:**
KJ Walsh			
DATE/TIME: 16:15 31/8/17	DATE/TIME:	DATE/TIME:	DATE/TIME: 3/9 16:20

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	IN-1 EA000SP	NT1 NT2A	W3F Al (EG020F)	NT4, EK055G EK071G	EP020	W4	W12		
11	GW06	31/8/17 9:25	W		8	X	X	X	X	X	X	X		EC = 22400
12	SW06	" 9:50	W		8	↓	↓	↓	↓	↓	↓	↓		
13	SW07	" 10:30	W		8									
Not required ~~14~~ BN 4/9	GW07	" 11:15	W		8									
15	GW04	14:45	W		8									
16	GW05	" 15:45	W		8									EC = 28,600
17	QA02	31/8/17	W		8									
	Extra sample : BN	4/9												
18	GW14S.	30/8/17	W		8	X	X	X	X	X	X	X	— Analysis as per Duplicate	
														— BN 04/9
				TOTAL	56									

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1711838**	Page	: 1 of 7
Amendment	: **1**		
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Contact	: Steven McGrath
Address	: Level 15, 28 Freshwater Place SOUTHBANK VIC, AUSTRALIA 3006	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 03 9861 1111	Telephone	: +61-3-8549 9600
Project	: 2135645A	Date Samples Received	: 01-Sep-2017 10:25
Order number	: 3219	Date Analysis Commenced	: 01-Sep-2017
C-O-C number	: ----	Issue Date	: 14-Sep-2017 15:20
Sampler	: KELLY-JANE WALLIS		
Site	: ----		
Quote number	: ME-525-16		
No. of samples received	: 4		
No. of samples analysed	: 4		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Xing Lin	Senior Organic Chemist	Melbourne Organics, Springvale, VIC

General Comments

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

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

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

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

When no sampling time is provided, the sampling time will default 00:00 on the date of sampling. If no sampling date is provided, the sampling date will be assumed by the laboratory and displayed in brackets without a time component.

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

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

- EG035F: EM1711384-017 Poor matrix spike recovery for dissolved mercury due to sample matrix. Confirmed by re-extraction and re-analysis.
- Amendment (14/09/2017): This report has been amended and re-released to allow the reporting of additional analytical data. Dissolved Fe.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW15S	GW13S	GW13D	GW07	----
			Client sampling date / time	01-Sep-2017 08:00	01-Sep-2017 09:10	01-Sep-2017 09:30	01-Sep-2017 10:05	----
Compound	CAS Number	LOR	Unit	EM1711838-001	EM1711838-002	EM1711838-003	EM1711838-004	--------
				Result	Result	Result	Result	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.51**	**7.49**	**7.42**	**8.05**	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**6530**	**4240**	**4380**	**18600**	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	**4240**	**2760**	**2850**	**12100**	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**378**	**246**	**284**	**124**	----
Total Alkalinity as CaCO3	----	1	mg/L	**378**	**246**	**284**	**124**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**617**	**130**	**138**	**1290**	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**1540**	**1140**	**1150**	**6140**	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**188**	**46**	**103**	**668**	----
Magnesium	7439-95-4	1	mg/L	**178**	**69**	**85**	**630**	----
Sodium	7440-23-5	1	mg/L	**900**	**704**	**614**	**2550**	----
Potassium	7440-09-7	1	mg/L	**12**	**9**	**6**	**23**	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Arsenic	7440-38-2	0.001	mg/L	**0.002**	**0.105**	**0.186**	**0.016**	----
Boron	7440-42-8	0.05	mg/L	**0.48**	**0.43**	**0.45**	**0.43**	----
Barium	7440-39-3	0.001	mg/L	**0.060**	**0.261**	**0.062**	**0.042**	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Cobalt	7440-48-4	0.001	mg/L	**0.006**	**0.001**	**0.004**	**0.007**	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L	**0.002**	**0.002**	**0.002**	**0.002**	----
Manganese	7439-96-5	0.001	mg/L	**0.351**	**0.035**	**0.288**	**0.286**	----
Nickel	7440-02-0	0.001	mg/L	**0.009**	**0.002**	**0.002**	**0.003**	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW15S	GW13S	GW13D	GW07	----
				Client sampling date / time	01-Sep-2017 08:00	01-Sep-2017 09:10	01-Sep-2017 09:30	01-Sep-2017 10:05	----
Compound	CAS Number	LOR	Unit		EM1711838-001	EM1711838-002	EM1711838-003	EM1711838-004	--------
					Result	Result	Result	Result	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Zinc	7440-66-6	0.005	mg/L		**0.008**	**0.007**	<0.005	**0.009**	----
Iron	7439-89-6	0.05	mg/L		**0.83**	**9.05**	**10.4**	**15.9**	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.4**	**0.2**	**0.2**	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.09**	**0.08**	**0.28**	**0.37**	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.01**	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.02**	<0.01	<0.01	<0.01	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.03**	<0.01	<0.01	<0.01	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**63.8**	**39.8**	**41.0**	**202**	----
Total Cations	----	0.01	meq/L		**63.5**	**38.8**	**39.0**	**197**	----
Ionic Balance	----	0.01	%		**0.28**	**1.21**	**2.49**	**1.46**	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	----
EP068A: Organochlorine Pesticides (OC)									
alpha-BHC	319-84-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Hexachlorobenzene (HCB)	118-74-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
beta-BHC	319-85-7	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
gamma-BHC	58-89-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
delta-BHC	319-86-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Heptachlor	76-44-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Aldrin	309-00-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Heptachlor epoxide	1024-57-3	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
trans-Chlordane	5103-74-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
alpha-Endosulfan	959-98-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW15S	GW13S	GW13D	GW07	----
				Client sampling date / time	01-Sep-2017 08:00	01-Sep-2017 09:10	01-Sep-2017 09:30	01-Sep-2017 10:05	----
Compound	CAS Number	LOR	Unit		EM1711838-001	EM1711838-002	EM1711838-003	EM1711838-004	--------
					Result	Result	Result	Result	----
EP068A: Organochlorine Pesticides (OC) - Continued									
cis-Chlordane	5103-71-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Dieldrin	60-57-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
4.4`-DDE	72-55-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Endrin	72-20-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
beta-Endosulfan	33213-65-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
4.4`-DDD	72-54-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Endrin aldehyde	7421-93-4	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Endosulfan sulfate	1031-07-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
4.4`-DDT	50-29-3	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	----
Endrin ketone	53494-70-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Methoxychlor	72-43-5	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	----
^ Total Chlordane (sum)	----	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
^ Sum of DDD + DDE + DDT	72-54-8/72-55-9/50-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
^ Sum of Aldrin + Dieldrin	309-00-2/60-57-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Demeton-S-methyl	919-86-8	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Monocrotophos	6923-22-4	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	----
Dimethoate	60-51-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Diazinon	333-41-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Parathion-methyl	298-00-0	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	----
Malathion	121-75-5	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Fenthion	55-38-9	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Chlorpyrifos	2921-88-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Parathion	56-38-2	2.0	µg/L		<2.0	<2.0	<2.0	<2.0	----
Pirimphos-ethyl	23505-41-1	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Chlorfenvinphos	470-90-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Bromophos-ethyl	4824-78-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Fenamiphos	22224-92-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Prothiofos	34643-46-4	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Ethion	563-12-2	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Carbophenothion	786-19-6	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----
Azinphos Methyl	86-50-0	0.5	µg/L		<0.5	<0.5	<0.5	<0.5	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW15S	GW13S	GW13D	GW07	----
				Client sampling date / time	01-Sep-2017 08:00	01-Sep-2017 09:10	01-Sep-2017 09:30	01-Sep-2017 10:05	----
Compound	CAS Number	LOR	Unit		EM1711838-001	EM1711838-002	EM1711838-003	EM1711838-004	--------
					Result	Result	Result	Result	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	<100	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	----
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	----
^ Total Xylenes	1330-20-7	2	µg/L		<2	<2	<2	<2	----
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	----
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	----
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.5	%		**76.7**	**83.5**	**83.3**	**81.0**	----
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.5	%		**85.0**	**91.0**	**89.2**	**88.1**	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**103**	**103**	**99.2**	**102**	----
Toluene-D8	2037-26-5	2	%		**95.9**	**95.3**	**88.3**	**91.2**	----
4-Bromofluorobenzene	460-00-4	2	%		**110**	**111**	**109**	**109**	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	49	117
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	51	127
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM1711838**	Page	: 1 of 8
Amendment	: **1**		
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Telephone	: +61-3-8549 9600
Project	: 2135645A	Date Samples Received	: 01-Sep-2017
Site	: ----	Issue Date	: 14-Sep-2017
Sampler	: KELLY-JANE WALLIS	No. of samples received	: 4
Order number	: 3219	No. of samples analysed	: 4

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

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

Summary of Outliers

Outliers : Quality Control Samples

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

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

Outliers : Analysis Holding Time Compliance

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

Outliers : Frequency of Quality Control Samples

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

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	EM1711810--002	Anonymous	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
ED045G: Chloride by Discrete Analyser	EM1711810--002	Anonymous	**Chloride**	16887-00-6	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG035F: Dissolved Mercury by FIMS	EM1711384--017	Anonymous	**Mercury**	7439-97-6	45.4 %	70-120%	**Recovery less than lower data quality objective**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
Pesticides by GCMS	0	7	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	0	14	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
Chloride by Discrete Analyser	1	21	4.76	5.00	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	0	7	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	0	14	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

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

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

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

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

Matrix: **WATER**

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

Method / ***Container*** / *Client Sample ID(s)*	***Sample Date***	*Extraction / Preparation*			*Analysis*		
		Date extracted	*Due for extraction*	*Evaluation*	***Date analysed***	*Due for analysis*	*Evaluation*
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**----**	----	----	**01-Sep-2017**	01-Sep-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**----**	----	----	**04-Sep-2017**	29-Sep-2017	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**----**	----	----	**04-Sep-2017**	15-Sep-2017	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**----**	----	----	**05-Sep-2017**	29-Sep-2017	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**----**	----	----	**05-Sep-2017**	29-Sep-2017	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**----**	----	----	**04-Sep-2017**	29-Sep-2017	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**----**	----	----	**04-Sep-2017**	28-Feb-2018	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**----**	----	----	**07-Sep-2017**	29-Sep-2017	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**----**	----	----	**04-Sep-2017**	29-Sep-2017	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**----**	----	----	**05-Sep-2017**	29-Sep-2017	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**----**	----	----	**01-Sep-2017**	03-Sep-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**----**	----	----	**05-Sep-2017**	29-Sep-2017	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**----**	----	----	**01-Sep-2017**	03-Sep-2017	✓
EP020: Oil and Grease (O&G)							
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**----**	----	----	**07-Sep-2017**	29-Sep-2017	✓
EP068A: Organochlorine Pesticides (OC)							
Amber Glass Bottle - Unpreserved (EP068)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**05-Sep-2017**	08-Sep-2017	✓	**06-Sep-2017**	15-Oct-2017	✓
EP068B: Organophosphorus Pesticides (OP)							
Amber Glass Bottle - Unpreserved (EP068)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**05-Sep-2017**	08-Sep-2017	✓	**06-Sep-2017**	15-Oct-2017	✓
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**05-Sep-2017**	08-Sep-2017	✓	**05-Sep-2017**	15-Oct-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**04-Sep-2017**	15-Sep-2017	✓	**05-Sep-2017**	15-Sep-2017	✓
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Amber Glass Bottle - Unpreserved (EP071)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**05-Sep-2017**	08-Sep-2017	✓	**05-Sep-2017**	15-Oct-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**04-Sep-2017**	15-Sep-2017	✓	**05-Sep-2017**	15-Sep-2017	✓
EP080: BTEXN							
Amber VOC Vial - Sulfuric Acid (EP080)							
GW15S, GW13S, GW13D, GW07	**01-Sep-2017**	**04-Sep-2017**	15-Sep-2017	✓	**05-Sep-2017**	15-Sep-2017	✓

Quality Control Parameter Frequency Compliance

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

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	4	33	**12.12**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	3	21	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	0	7	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	4	33	**12.12**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	14	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	2	33	**6.06**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	4	21	**19.05**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Conductivity by PC Titrator	EA010-P	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	21	**4.76**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	0	7	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	14	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

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

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Calculated TDS (from Electrical Conductivity)	EA016	WATER	In house: Calculation from Electrical Conductivity (APHA 2510 B) using a conversion factor specified in the analytical report. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Oil and Grease	EP020	WATER	In house: Referenced to APHA 5520 B. Oil & grease is a gravimetric procedure to determine the amount of oil & grease residue in an aqueous sample. The sample is serially extracted three times n-hexane. The resultant extracts are combined, dehydrated and concentrated prior to gravimetric determination. This method is compliant with NEPM (2013) Schedule B(3)
Pesticides by GCMS	EP068	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

CHAIN OF CUSTODY

ALS Laboratory: **please tick** →

☐ **Sydney:** 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ **Newcastle:** 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ **Brisbane:** 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ **Townsville:** 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne:** 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide:** 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth:** 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston:** 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	**FOR LABORATORY USE ONLY (Circle)**	
OFFICE: Melbourne, Southbank		Custody Seal Intact?	Yes / No / N/A
PROJECT: 213564SA	**ALS QUOTE NO.:** EN/008/16	Free ice / frozen ice bricks present upon receipt?	Yes / No / N/A
ORDER NUMBER: 3219	**COC SEQUENCE NUMBER (Circle)** COC 1 2 3 4 5 7	Random Sample Temperature on Receipt:	°C
PROJECT MANAGER: Ray Hatley	**CONTACT PH:** 0407250056 OF: 1 2 3 4 5 7	Other comment:	
SAMPLER: Kelly-Jane Wallis	**SAMPLER MOBILE:** 0447026695		
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**		
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com			
Email Invoice to : au.accountspayable@wsp.com			

RELINQUISHED BY:	**RECEIVED BY:**	**RELINQUISHED BY:**	**RECEIVED BY:**
KJ Wallis	Scott (ALS)		
DATE/TIME: 1/9/17 10:25am	DATE/TIME: 1/9/17, 10:25.	DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).								Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	IN-1 EA000SP	NT1 NT2A	W3F Al (EG020F)	NT4, EK055G EK071G	EP020	W4	W12		
1	GW15S	1/9/17 8:00	W		8	X	X	X	X	X	X	X		
2	GW13S	" 9:10	W		8	X	X	X	X	X	X	X		
3	GW13D	" 9:30	W		8	X	X	X	X	X	X	X		
4	GW07	" 10:05	W		8	X	X	X	X	X	X	X		
				Nitrite NP 1/9.										
				TOTAL	32									

Environmental Division Melbourne
Work Order Reference
EM1711838

Telephone : +61-3-8549 9600

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1713546**	Page	: 1 of 18
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: OLFA NAZARIO	Contact	: Graeme Jablonskas
Address	: Level 15, 28 Freshwater Place SOUTHBANK VIC, AUSTRALIA 3006	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 03 9861 1111	Telephone	: +61-3-8549 9609
Project	: 2271345A	Date Samples Received	: 03-Oct-2017 15:50
Order number	: ----	Date Analysis Commenced	: 03-Oct-2017
C-O-C number	: 85167	Issue Date	: 09-Oct-2017 14:55
Sampler	: ----		
Site	: Mordialloc		
Quote number	: EN/008/15		
No. of samples received	: 6		
No. of samples analysed	: 6		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Edwandy Fadjar	Organic Coordinator	Sydney Organics, Smithfield, NSW
Nancy Wang	Senior Semivolatile Instrument Chemist	Melbourne Organics, Springvale, VIC

General Comments

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

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

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

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

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

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

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

- TDS by method EA-015 for EM1713546 #2,3 may bias high due to the presence of fine particulate matter, which may pass through the prescribed GF/C paper.
- EA015H: EM1713546 #5. TDS has been confirmed via re-analysis
- EK026SF:EM1713523-002 Poor matrix spike recovery for TCN due to matrix effects. This has been confirmed by re-analysis.
- Sample LEACHATE was filtered through a 0.45um filter prior to the dissolved metals analysis.
- Ionic Balance out of acceptable limits for sample #1 due to analytes not quantified in this report.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- Ionic balances were calculated using: major anions - chloride, alkalinity, sulfate ; and major cations - calcium, magnesium, potassium, sodium and ammonia #5.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- EG035F: EM1713502-002 Poor matrix spike recovery for dissolved mercury due to sample matrix. Confirmed by re-extraction and re-analysis.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)			Client sample ID	GW17-26-01	GW172602-D	GW17-26-02	----	----
			Client sampling date / time	03-Oct-2017 00:00	03-Oct-2017 00:00	03-Oct-2017 00:00	----	----
Compound	CAS Number	LOR	Unit	EM1713546-001	EM1713546-002	EM1713546-003	--------	--------
				Result	Result	Result	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**4.80**	**4.12**	**4.13**	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Total Dissolved Solids @180°C	----	10	mg/L	**559**	**1170**	**1150**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**39**	<1	<1	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**39**	<1	<1	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**89**	**175**	**179**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**173**	**407**	**408**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**17**	**5**	**5**	----	----
Magnesium	7439-95-4	1	mg/L	**9**	**26**	**26**	----	----
Sodium	7440-23-5	1	mg/L	**118**	**245**	**243**	----	----
Potassium	7440-09-7	1	mg/L	**1**	<1	<1	----	----
EG020F: Dissolved Metals by ICP-MS								
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.002**	**0.002**	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	----	----
Barium	7440-39-3	0.001	mg/L	**0.035**	**0.010**	**0.010**	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L	**0.0001**	**0.0002**	**0.0001**	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.008**	**0.022**	**0.023**	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	**0.001**	**0.001**	----	----
Copper	7440-50-8	0.001	mg/L	**0.004**	**0.001**	**0.001**	----	----
Manganese	7439-96-5	0.001	mg/L	**0.086**	**0.039**	**0.039**	----	----
Nickel	7440-02-0	0.001	mg/L	**0.058**	**0.032**	**0.031**	----	----
Lead	7439-92-1	0.001	mg/L	**0.002**	**0.002**	**0.002**	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	<0.01	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	**0.01**	**0.01**	----	----
Zinc	7440-66-6	0.005	mg/L	**0.892**	**0.168**	**0.169**	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	GW17-26-01	GW172602-D	GW17-26-02	----	----
				Client sampling date / time	03-Oct-2017 00:00	03-Oct-2017 00:00	03-Oct-2017 00:00	----	----
Compound	CAS Number	LOR	Unit		EM1713546-001	EM1713546-002	EM1713546-003	--------	--------
					Result	Result	Result	----	----
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		<0.004	<0.004	<0.004	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.12**	**0.04**	**0.04**	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.15**	**0.04**	**0.04**	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**6.50**	**4.94**	**4.86**	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**6.65**	**4.98**	**4.90**	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**7.51**	**15.1**	**15.2**	----	----
Total Cations	----	0.01	meq/L		**6.75**	**13.0**	**13.0**	----	----
Ionic Balance	----	0.01	%		**5.36**	**7.38**	**8.08**	----	----
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**19**	**8**	**10**	----	----
EP033: C1 - C4 Hydrocarbon Gases									
Methane	74-82-8	10	µg/L		**124**	<10	<10	----	----
EP074A: Monocyclic Aromatic Hydrocarbons									
Styrene	100-42-5	5	µg/L		<5	<5	<5	----	----
Isopropylbenzene	98-82-8	5	µg/L		<5	<5	<5	----	----
n-Propylbenzene	103-65-1	5	µg/L		<5	<5	<5	----	----
1.3.5-Trimethylbenzene	108-67-8	5	µg/L		<5	<5	<5	----	----
sec-Butylbenzene	135-98-8	5	µg/L		<5	<5	<5	----	----
1.2.4-Trimethylbenzene	95-63-6	5	µg/L		<5	<5	<5	----	----
tert-Butylbenzene	98-06-6	5	µg/L		<5	<5	<5	----	----
p-Isopropyltoluene	99-87-6	5	µg/L		<5	<5	<5	----	----
n-Butylbenzene	104-51-8	5	µg/L		<5	<5	<5	----	----
EP074B: Oxygenated Compounds									
Vinyl Acetate	108-05-4	50	µg/L		<50	<50	<50	----	----
2-Butanone (MEK)	78-93-3	50	µg/L		<50	<50	<50	----	----
4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L		<50	<50	<50	----	----
2-Hexanone (MBK)	591-78-6	50	µg/L		<50	<50	<50	----	----
EP074C: Sulfonated Compounds									

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	GW17-26-01	GW172602-D	GW17-26-02	----	----
				Client sampling date / time	03-Oct-2017 00:00	03-Oct-2017 00:00	03-Oct-2017 00:00	----	----
Compound	CAS Number	LOR	Unit		EM1713546-001	EM1713546-002	EM1713546-003	--------	--------
					Result	Result	Result	----	----
EP074C: Sulfonated Compounds - Continued									
Carbon disulfide	75-15-0	5	µg/L		<5	<5	<5	----	----
EP074D: Fumigants									
2.2-Dichloropropane	594-20-7	5	µg/L		<5	<5	<5	----	----
1.2-Dichloropropane	78-87-5	5	µg/L		<5	<5	<5	----	----
cis-1.3-Dichloropropylene	10061-01-5	5	µg/L		<5	<5	<5	----	----
trans-1.3-Dichloropropylene	10061-02-6	5	µg/L		<5	<5	<5	----	----
1.2-Dibromoethane (EDB)	106-93-4	5	µg/L		<5	<5	<5	----	----
EP074E: Halogenated Aliphatic Compounds									
Dichlorodifluoromethane	75-71-8	50	µg/L		<50	<50	<50	----	----
Chloromethane	74-87-3	50	µg/L		<50	<50	<50	----	----
Vinyl chloride	75-01-4	50	µg/L		<50	<50	<50	----	----
Bromomethane	74-83-9	50	µg/L		<50	<50	<50	----	----
Chloroethane	75-00-3	50	µg/L		<50	<50	<50	----	----
Trichlorofluoromethane	75-69-4	50	µg/L		<50	<50	<50	----	----
1.1-Dichloroethene	75-35-4	5	µg/L		<5	<5	<5	----	----
Iodomethane	74-88-4	5	µg/L		<5	<5	<5	----	----
trans-1.2-Dichloroethene	156-60-5	5	µg/L		<5	<5	<5	----	----
1.1-Dichloroethane	75-34-3	5	µg/L		<5	<5	<5	----	----
cis-1.2-Dichloroethene	156-59-2	5	µg/L		<5	<5	<5	----	----
1.1.1-Trichloroethane	71-55-6	5	µg/L		<5	<5	<5	----	----
1.1-Dichloropropylene	563-58-6	5	µg/L		<5	<5	<5	----	----
Carbon Tetrachloride	56-23-5	5	µg/L		<5	<5	<5	----	----
1.2-Dichloroethane	107-06-2	5	µg/L		<5	<5	<5	----	----
Trichloroethene	79-01-6	5	µg/L		<5	<5	<5	----	----
Dibromomethane	74-95-3	5	µg/L		<5	<5	<5	----	----
1.1.2-Trichloroethane	79-00-5	5	µg/L		<5	<5	<5	----	----
1.3-Dichloropropane	142-28-9	5	µg/L		<5	<5	<5	----	----
Tetrachloroethene	127-18-4	5	µg/L		<5	<5	<5	----	----
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L		<5	<5	<5	----	----
trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L		<5	<5	<5	----	----
cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L		<5	<5	<5	----	----
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L		<5	<5	<5	----	----
1.2.3-Trichloropropane	96-18-4	5	µg/L		<5	<5	<5	----	----
Pentachloroethane	76-01-7	5	µg/L		<5	<5	<5	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	GW17-26-01	GW172602-D	GW17-26-02	----	----
				Client sampling date / time	03-Oct-2017 00:00	03-Oct-2017 00:00	03-Oct-2017 00:00	----	----
Compound	CAS Number	LOR	Unit		EM1713546-001	EM1713546-002	EM1713546-003	--------	--------
					Result	Result	Result	----	----
EP074E: Halogenated Aliphatic Compounds - Continued									
1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L		<5	<5	<5	----	----
Hexachlorobutadiene	87-68-3	5	µg/L		<5	<5	<5	----	----
EP074F: Halogenated Aromatic Compounds									
Chlorobenzene	108-90-7	5	µg/L		<5	<5	<5	----	----
Bromobenzene	108-86-1	5	µg/L		<5	<5	<5	----	----
2-Chlorotoluene	95-49-8	5	µg/L		<5	<5	<5	----	----
4-Chlorotoluene	106-43-4	5	µg/L		<5	<5	<5	----	----
1.3-Dichlorobenzene	541-73-1	5	µg/L		<5	<5	<5	----	----
1.4-Dichlorobenzene	106-46-7	5	µg/L		<5	<5	<5	----	----
1.2-Dichlorobenzene	95-50-1	5	µg/L		<5	<5	<5	----	----
1.2.4-Trichlorobenzene	120-82-1	5	µg/L		<5	<5	<5	----	----
1.2.3-Trichlorobenzene	87-61-6	5	µg/L		<5	<5	<5	----	----
EP074G: Trihalomethanes									
Chloroform	67-66-3	5	µg/L		<5	<5	<5	----	----
Bromodichloromethane	75-27-4	5	µg/L		<5	<5	<5	----	----
Dibromochloromethane	124-48-1	5	µg/L		<5	<5	<5	----	----
Bromoform	75-25-2	5	µg/L		<5	<5	<5	----	----
EP075(SIM)A: Phenolic Compounds									
Phenol	108-95-2	1.0	µg/L		<1.0	<1.0	<1.0	----	----
2-Chlorophenol	95-57-8	1.0	µg/L		<1.0	<1.0	<1.0	----	----
2-Methylphenol	95-48-7	1.0	µg/L		<1.0	<1.0	<1.0	----	----
3- & 4-Methylphenol	1319-77-3	2.0	µg/L		<2.0	<2.0	<2.0	----	----
2-Nitrophenol	88-75-5	1.0	µg/L		<1.0	<1.0	<1.0	----	----
2.4-Dimethylphenol	105-67-9	1.0	µg/L		<1.0	<1.0	<1.0	----	----
2.4-Dichlorophenol	120-83-2	1.0	µg/L		<1.0	<1.0	<1.0	----	----
2.6-Dichlorophenol	87-65-0	1.0	µg/L		<1.0	<1.0	<1.0	----	----
4-Chloro-3-methylphenol	59-50-7	1.0	µg/L		<1.0	<1.0	<1.0	----	----
2.4.6-Trichlorophenol	88-06-2	1.0	µg/L		<1.0	<1.0	<1.0	----	----
2.4.5-Trichlorophenol	95-95-4	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Pentachlorophenol	87-86-5	2.0	µg/L		<2.0	<2.0	<2.0	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	GW17-26-01	GW172602-D	GW17-26-02	----	----
				Client sampling date / time	03-Oct-2017 00:00	03-Oct-2017 00:00	03-Oct-2017 00:00	----	----
Compound	CAS Number	LOR	Unit		EM1713546-001	EM1713546-002	EM1713546-003	--------	--------
					Result	Result	Result	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued									
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	----	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		<0.5	<0.5	<0.5	----	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		<0.5	<0.5	<0.5	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	----	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	----	----
C15 - C28 Fraction	----	100	µg/L		**130**	<100	<100	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		**130**	<50	<50	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	----	----
>C16 - C34 Fraction	----	100	µg/L		**130**	<100	<100	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		**130**	<100	<100	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	----	----
Toluene	108-88-3	2	µg/L		<2	<2	<2	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	----	----

Analytical Results

Sub-Matrix: GROUNDWATER (Matrix: WATER)				Client sample ID	GW17-26-01	GW172602-D	GW17-26-02	----	----
				Client sampling date / time	03-Oct-2017 00:00	03-Oct-2017 00:00	03-Oct-2017 00:00	----	----
Compound	CAS Number	LOR	Unit		EM1713546-001	EM1713546-002	EM1713546-003	--------	--------
					Result	Result	Result	----	----
EP080: BTEXN - Continued									
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	----	----
^ Total Xylenes	1330-20-7	2	µg/L		<2	<2	<2	----	----
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	----	----
EP074S: VOC Surrogates									
1.2-Dichloroethane-D4	17060-07-0	5	%		94.4	91.6	88.8	----	----
Toluene-D8	2037-26-5	5	%		91.2	91.6	84.8	----	----
4-Bromofluorobenzene	460-00-4	5	%		92.2	91.9	88.9	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		30.2	33.2	27.7	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%		81.5	88.5	67.6	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%		75.1	73.7	70.0	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		66.7	77.7	57.7	----	----
Anthracene-d10	1719-06-8	1.0	%		91.7	90.7	87.2	----	----
4-Terphenyl-d14	1718-51-0	1.0	%		83.5	87.3	72.2	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		98.2	95.4	92.2	----	----
Toluene-D8	2037-26-5	2	%		87.0	87.3	80.8	----	----
4-Bromofluorobenzene	460-00-4	2	%		91.4	90.5	86.9	----	----

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	LEACHATE	----	----	----	----
				Client sampling date / time	03-Oct-2017 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM1713546-005	--------	--------	--------	--------
					Result	----	----	----	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**6.78**	----	----	----	----
EA015: Total Dissolved Solids dried at 180 ± 5 °C									
Total Dissolved Solids @180°C	----	10	mg/L		**1580**	----	----	----	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**1670**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L		**1670**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		<1	----	----	----	----
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		**387**	----	----	----	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**56**	----	----	----	----
Magnesium	7439-95-4	1	mg/L		**43**	----	----	----	----
Sodium	7440-23-5	1	mg/L		**356**	----	----	----	----
Potassium	7440-09-7	1	mg/L		**96**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		**0.003**	----	----	----	----
Boron	7440-42-8	0.05	mg/L		**38.0**	----	----	----	----
Barium	7440-39-3	0.001	mg/L		**0.886**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		**0.020**	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		**0.023**	----	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		**0.081**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		**0.134**	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.037**	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	LEACHATE	----	----	----	----
				Client sampling date / time	03-Oct-2017 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM1713546-005	--------	--------	--------	--------
					Result	----	----	----	----
EK026SF: Total CN by Segmented Flow Analyser									
Total Cyanide	57-12-5	0.004	mg/L		<0.004	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**231**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.02**	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.02**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.04**	----	----	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**44.3**	----	----	----	----
Total Cations	----	0.01	meq/L		**40.8**	----	----	----	----
Ionic Balance	----	0.01	%		**4.16**	----	----	----	----
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**137**	----	----	----	----
EP033: C1 - C4 Hydrocarbon Gases									
Methane	74-82-8	10	µg/L		**8280**	----	----	----	----
EP074A: Monocyclic Aromatic Hydrocarbons									
Styrene	100-42-5	5	µg/L		<5	----	----	----	----
Isopropylbenzene	98-82-8	5	µg/L		**35**	----	----	----	----
n-Propylbenzene	103-65-1	5	µg/L		**9**	----	----	----	----
1.3.5-Trimethylbenzene	108-67-8	5	µg/L		<5	----	----	----	----
sec-Butylbenzene	135-98-8	5	µg/L		<5	----	----	----	----
1.2.4-Trimethylbenzene	95-63-6	5	µg/L		<5	----	----	----	----
tert-Butylbenzene	98-06-6	5	µg/L		<5	----	----	----	----
p-Isopropyltoluene	99-87-6	5	µg/L		<5	----	----	----	----
n-Butylbenzene	104-51-8	5	µg/L		<5	----	----	----	----
EP074B: Oxygenated Compounds									
Vinyl Acetate	108-05-4	50	µg/L		<50	----	----	----	----
2-Butanone (MEK)	78-93-3	50	µg/L		<50	----	----	----	----
4-Methyl-2-pentanone (MIBK)	108-10-1	50	µg/L		<50	----	----	----	----
2-Hexanone (MBK)	591-78-6	50	µg/L		<50	----	----	----	----
EP074C: Sulfonated Compounds									

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	LEACHATE	----	----	----	----
				Client sampling date / time	03-Oct-2017 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM1713546-005	--------	--------	--------	--------
					Result	----	----	----	----
EP074C: Sulfonated Compounds - Continued									
Carbon disulfide	75-15-0	5	µg/L		<5	----	----	----	----
EP074D: Fumigants									
2.2-Dichloropropane	594-20-7	5	µg/L		<5	----	----	----	----
1.2-Dichloropropane	78-87-5	5	µg/L		<5	----	----	----	----
cis-1.3-Dichloropropylene	10061-01-5	5	µg/L		<5	----	----	----	----
trans-1.3-Dichloropropylene	10061-02-6	5	µg/L		<5	----	----	----	----
1.2-Dibromoethane (EDB)	106-93-4	5	µg/L		<5	----	----	----	----
EP074E: Halogenated Aliphatic Compounds									
Dichlorodifluoromethane	75-71-8	50	µg/L		<50	----	----	----	----
Chloromethane	74-87-3	50	µg/L		<50	----	----	----	----
Vinyl chloride	75-01-4	50	µg/L		<50	----	----	----	----
Bromomethane	74-83-9	50	µg/L		<50	----	----	----	----
Chloroethane	75-00-3	50	µg/L		<50	----	----	----	----
Trichlorofluoromethane	75-69-4	50	µg/L		<50	----	----	----	----
1.1-Dichloroethene	75-35-4	5	µg/L		<5	----	----	----	----
Iodomethane	74-88-4	5	µg/L		<5	----	----	----	----
trans-1.2-Dichloroethene	156-60-5	5	µg/L		<5	----	----	----	----
1.1-Dichloroethane	75-34-3	5	µg/L		<5	----	----	----	----
cis-1.2-Dichloroethene	156-59-2	5	µg/L		<5	----	----	----	----
1.1.1-Trichloroethane	71-55-6	5	µg/L		<5	----	----	----	----
1.1-Dichloropropylene	563-58-6	5	µg/L		<5	----	----	----	----
Carbon Tetrachloride	56-23-5	5	µg/L		<5	----	----	----	----
1.2-Dichloroethane	107-06-2	5	µg/L		<5	----	----	----	----
Trichloroethene	79-01-6	5	µg/L		<5	----	----	----	----
Dibromomethane	74-95-3	5	µg/L		<5	----	----	----	----
1.1.2-Trichloroethane	79-00-5	5	µg/L		<5	----	----	----	----
1.3-Dichloropropane	142-28-9	5	µg/L		<5	----	----	----	----
Tetrachloroethene	127-18-4	5	µg/L		<5	----	----	----	----
1.1.1.2-Tetrachloroethane	630-20-6	5	µg/L		<5	----	----	----	----
trans-1.4-Dichloro-2-butene	110-57-6	5	µg/L		<5	----	----	----	----
cis-1.4-Dichloro-2-butene	1476-11-5	5	µg/L		<5	----	----	----	----
1.1.2.2-Tetrachloroethane	79-34-5	5	µg/L		<5	----	----	----	----
1.2.3-Trichloropropane	96-18-4	5	µg/L		<5	----	----	----	----
Pentachloroethane	76-01-7	5	µg/L		<5	----	----	----	----

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	LEACHATE	----	----	----	----
				Client sampling date / time	03-Oct-2017 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM1713546-005	--------	--------	--------	--------
					Result	----	----	----	----
EP074E: Halogenated Aliphatic Compounds - Continued									
1.2-Dibromo-3-chloropropane	96-12-8	5	µg/L		<5	----	----	----	----
Hexachlorobutadiene	87-68-3	5	µg/L		<5	----	----	----	----
EP074F: Halogenated Aromatic Compounds									
Chlorobenzene	108-90-7	5	µg/L		**6**	----	----	----	----
Bromobenzene	108-86-1	5	µg/L		<5	----	----	----	----
2-Chlorotoluene	95-49-8	5	µg/L		<5	----	----	----	----
4-Chlorotoluene	106-43-4	5	µg/L		<5	----	----	----	----
1.3-Dichlorobenzene	541-73-1	5	µg/L		<5	----	----	----	----
1.4-Dichlorobenzene	106-46-7	5	µg/L		<5	----	----	----	----
1.2-Dichlorobenzene	95-50-1	5	µg/L		<5	----	----	----	----
1.2.4-Trichlorobenzene	120-82-1	5	µg/L		<5	----	----	----	----
1.2.3-Trichlorobenzene	87-61-6	5	µg/L		<5	----	----	----	----
EP074G: Trihalomethanes									
Chloroform	67-66-3	5	µg/L		<5	----	----	----	----
Bromodichloromethane	75-27-4	5	µg/L		<5	----	----	----	----
Dibromochloromethane	124-48-1	5	µg/L		<5	----	----	----	----
Bromoform	75-25-2	5	µg/L		<5	----	----	----	----
EP075(SIM)A: Phenolic Compounds									
Phenol	108-95-2	1.0	µg/L		<1.0	----	----	----	----
2-Chlorophenol	95-57-8	1.0	µg/L		<1.0	----	----	----	----
2-Methylphenol	95-48-7	1.0	µg/L		<1.0	----	----	----	----
3- & 4-Methylphenol	1319-77-3	2.0	µg/L		<2.0	----	----	----	----
2-Nitrophenol	88-75-5	1.0	µg/L		<1.0	----	----	----	----
2.4-Dimethylphenol	105-67-9	1.0	µg/L		<1.0	----	----	----	----
2.4-Dichlorophenol	120-83-2	1.0	µg/L		<1.0	----	----	----	----
2.6-Dichlorophenol	87-65-0	1.0	µg/L		<1.0	----	----	----	----
4-Chloro-3-methylphenol	59-50-7	1.0	µg/L		<1.0	----	----	----	----
2.4.6-Trichlorophenol	88-06-2	1.0	µg/L		<1.0	----	----	----	----
2.4.5-Trichlorophenol	95-95-4	1.0	µg/L		<1.0	----	----	----	----
Pentachlorophenol	87-86-5	2.0	µg/L		<2.0	----	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		**3.6**	----	----	----	----
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	----	----	----	----
Acenaphthene	83-32-9	1.0	µg/L		**3.3**	----	----	----	----

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	LEACHATE	----	----	----	----
				Client sampling date / time	03-Oct-2017 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM1713546-005	--------	--------	--------	--------
					Result	----	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued									
Fluorene	86-73-7	1.0	µg/L		**1.7**	----	----	----	----
Phenanthrene	85-01-8	1.0	µg/L		**3.3**	----	----	----	----
Anthracene	120-12-7	1.0	µg/L		<1.0	----	----	----	----
Fluoranthene	206-44-0	1.0	µg/L		<1.0	----	----	----	----
Pyrene	129-00-0	1.0	µg/L		<1.0	----	----	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	----	----	----	----
Chrysene	218-01-9	1.0	µg/L		<1.0	----	----	----	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		<1.0	----	----	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	----	----	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	----	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	----	----	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	----	----	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	----	----	----	----
^ **Sum of polycyclic aromatic hydrocarbons**	----	0.5	µg/L		**11.9**	----	----	----	----
^ **Benzo(a)pyrene TEQ (zero)**	----	0.5	µg/L		<0.5	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		**160**	----	----	----	----
C10 - C14 Fraction	----	50	µg/L		**740**	----	----	----	----
C15 - C28 Fraction	----	100	µg/L		**2440**	----	----	----	----
C29 - C36 Fraction	----	50	µg/L		**140**	----	----	----	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L		**3320**	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		**180**	----	----	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		**110**	----	----	----	----
>C10 - C16 Fraction	----	100	µg/L		**940**	----	----	----	----
>C16 - C34 Fraction	----	100	µg/L		**2260**	----	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	----	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		**3200**	----	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		**940**	----	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		**39**	----	----	----	----
Toluene	108-88-3	2	µg/L		**4**	----	----	----	----
Ethylbenzene	100-41-4	2	µg/L		**4**	----	----	----	----

Analytical Results

Sub-Matrix: LEACHATE (Matrix: WATER)				Client sample ID	LEACHATE	----	----	----	----
				Client sampling date / time	03-Oct-2017 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM1713546-005	--------	--------	--------	--------
					Result	----	----	----	----
EP080: BTEXN - Continued									
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		18	----	----	----	----
ortho-Xylene	95-47-6	2	µg/L		3	----	----	----	----
^ Total Xylenes	1330-20-7	2	µg/L		21	----	----	----	----
^ Sum of BTEX	----	1	µg/L		68	----	----	----	----
Naphthalene	91-20-3	5	µg/L		5	----	----	----	----
EP074S: VOC Surrogates									
1.2-Dichloroethane-D4	17060-07-0	5	%		109	----	----	----	----
Toluene-D8	2037-26-5	5	%		100	----	----	----	----
4-Bromofluorobenzene	460-00-4	5	%		91.5	----	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		14.0	----	----	----	----
2-Chlorophenol-D4	93951-73-6	1.0	%		77.5	----	----	----	----
2.4.6-Tribromophenol	118-79-6	1.0	%		93.8	----	----	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		68.6	----	----	----	----
Anthracene-d10	1719-06-8	1.0	%		74.9	----	----	----	----
4-Terphenyl-d14	1718-51-0	1.0	%		75.8	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		109	----	----	----	----
Toluene-D8	2037-26-5	2	%		112	----	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		110	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	RINSATE BLANK	TRIP BLANK	----	----	----
				Client sampling date / time	03-Oct-2017 00:00	03-Oct-2017 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EM1713546-004	EM1713546-006	--------	--------	--------
					Result	Result	----	----	----
EG020T: Total Metals by ICP-MS									
Arsenic	7440-38-2	0.001	mg/L		<0.001	----	----	----	----
Boron	7440-42-8	0.05	mg/L		<0.05	----	----	----	----
Barium	7440-39-3	0.001	mg/L		<0.001	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L		<0.001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L		<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L		<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L		<0.001	----	----	----	----
Nickel	7440-02-0	0.001	mg/L		<0.001	----	----	----	----
Lead	7439-92-1	0.001	mg/L		<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	----	----	----	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		----	<20	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		----	<20	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		----	<20	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		----	<1	----	----	----
Toluene	108-88-3	2	µg/L		----	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L		----	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		----	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L		----	<2	----	----	----
^ Total Xylenes	1330-20-7	2	µg/L		----	<2	----	----	----
^ Sum of BTEX	----	1	µg/L		----	<1	----	----	----
Naphthalene	91-20-3	5	µg/L		----	<5	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		----	91.2	----	----	----
Toluene-D8	2037-26-5	2	%		----	88.3	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	RINSATE BLANK	TRIP BLANK	-----	-----	-----
				Client sampling date / time	03-Oct-2017 00:00	03-Oct-2017 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EM1713546-004	EM1713546-006	--------	--------	--------
					Result	Result	----	----	----
EP080S: TPH(V)/BTEX Surrogates - Continued									
4-Bromofluorobenzene	460-00-4	2	%		----	**94.9**	----	----	----

Surrogate Control Limits

Sub-Matrix: **GROUNDWATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP074S: VOC Surrogates			
1.2-Dichloroethane-D4	17060-07-0	72	132
Toluene-D8	2037-26-5	77	132
4-Bromofluorobenzene	460-00-4	67	131
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	46
2-Chlorophenol-D4	93951-73-6	23	104
2.4.6-Tribromophenol	118-79-6	28	130
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	36	114
Anthracene-d10	1719-06-8	51	119
4-Terphenyl-d14	1718-51-0	49	127
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

Sub-Matrix: **LEACHATE**

Compound	CAS Number	Recovery Limits (%) Low	High
EP074S: VOC Surrogates			
1.2-Dichloroethane-D4	17060-07-0	72	132
Toluene-D8	2037-26-5	77	132
4-Bromofluorobenzene	460-00-4	67	131
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	46
2-Chlorophenol-D4	93951-73-6	23	104
2.4.6-Tribromophenol	118-79-6	28	130
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	36	114
Anthracene-d10	1719-06-8	51	119
4-Terphenyl-d14	1718-51-0	49	127
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates - Continued			
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM1713546**	Page	: 1 of 10
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: OLFA NAZARIO	Telephone	: +61-3-8549 9609
Project	: 2271345A	Date Samples Received	: 03-Oct-2017
Site	: Mordialloc	Issue Date	: 09-Oct-2017
Sampler	: ----	No. of samples received	: 6
Order number	: ----	No. of samples analysed	: 6

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

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

Summary of Outliers

Outliers : Quality Control Samples

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

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

Outliers : Analysis Holding Time Compliance

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

Outliers : Frequency of Quality Control Samples

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

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
EG020F: Dissolved Metals by ICP-MS	EM1713546--005	LEACHATE	**Barium**	7440-39-3	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG035F: Dissolved Mercury by FIMS	EM1713502--002	Anonymous	**Mercury**	7439-97-6	33.2 %	70-120%	**Recovery less than lower data quality objective**
EK026SF: Total CN by Segmented Flow Analyser	EM1713523--002	Anonymous	**Total Cyanide**	57-12-5	50.1 %	70-130%	**Recovery less than lower data quality objective**
EP033: C1 - C4 Hydrocarbon Gases	ES1724423--001	Anonymous	**Methane**	74-82-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
pH by PC Titrator	1	11	9.09	10.00	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	1	16	6.25	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
PAH/Phenols (GC/MS - SIM)	0	9	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	0	16	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

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

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

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

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

Matrix: **WATER**

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

Method / *Container / Client Sample ID(s)*		*Sample Date*	*Extraction / Preparation*			*Analysis*		
			Date extracted	*Due for extraction*	*Evaluation*	*Date analysed*	*Due for analysis*	*Evaluation*
EA005P: pH by PC Titrator								
Clear Plastic Bottle - Natural (EA005-P)								
GW17-26-01, GW17-26-02,	GW172602-D, LEACHATE	**03-Oct-2017**	**----**	----	----	**03-Oct-2017**	03-Oct-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA015: Total Dissolved Solids dried at 180 ± 5 °C								
Clear Plastic Bottle - Natural (EA015H)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**----**	----	----	**04-Oct-2017**	10-Oct-2017	✓
GW17-26-02,	LEACHATE							
ED037P: Alkalinity by PC Titrator								
Clear Plastic Bottle - Natural (ED037-P)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**----**	----	----	**04-Oct-2017**	17-Oct-2017	✓
GW17-26-02,	LEACHATE							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Clear Plastic Bottle - Natural (ED041G)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**----**	----	----	**06-Oct-2017**	31-Oct-2017	✓
GW17-26-02,	LEACHATE							
ED045G: Chloride by Discrete Analyser								
Clear Plastic Bottle - Natural (ED045G)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**----**	----	----	**06-Oct-2017**	31-Oct-2017	✓
GW17-26-02,	LEACHATE							
ED093F: Dissolved Major Cations								
Clear Plastic Bottle - Natural (ED093F)								
LEACHATE		**03-Oct-2017**	**----**	----	----	**04-Oct-2017**	10-Oct-2017	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**----**	----	----	**04-Oct-2017**	31-Oct-2017	✓
GW17-26-02								
EG020F: Dissolved Metals by ICP-MS								
Clear Plastic Bottle - Natural (EG020A-F)								
LEACHATE		**03-Oct-2017**	**----**	----	----	**05-Oct-2017**	01-Apr-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**----**	----	----	**04-Oct-2017**	01-Apr-2018	✓
GW17-26-02								
EG020T: Total Metals by ICP-MS								
Clear Plastic Bottle - Nitric Acid; Unspecified (EG020A-T)								
RINSATE BLANK		**03-Oct-2017**	**04-Oct-2017**	01-Apr-2018	✓	**04-Oct-2017**	01-Apr-2018	✓
EG035F: Dissolved Mercury by FIMS								
Clear Plastic Bottle - Natural (EG035F)								
LEACHATE		**03-Oct-2017**	**----**	----	----	**05-Oct-2017**	31-Oct-2017	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**----**	----	----	**04-Oct-2017**	31-Oct-2017	✓
GW17-26-02								
EG035T: Total Recoverable Mercury by FIMS								
Clear Plastic Bottle - Nitric Acid; Unspecified (EG035T)								
RINSATE BLANK		**03-Oct-2017**	**----**	----	----	**05-Oct-2017**	31-Oct-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK026SF: Total CN by Segmented Flow Analyser								
Opaque plastic bottle - NaOH (EK026SF)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**----**	----	----	**04-Oct-2017**	17-Oct-2017	✓
GW17-26-02,	LEACHATE							
EK055G: Ammonia as N by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK055G)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**----**	----	----	**04-Oct-2017**	31-Oct-2017	✓
GW17-26-02,	LEACHATE							
EK057G: Nitrite as N by Discrete Analyser								
Clear Plastic Bottle - Natural (EK057G)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**----**	----	----	**04-Oct-2017**	05-Oct-2017	✓
GW17-26-02,	LEACHATE							
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK059G)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**----**	----	----	**04-Oct-2017**	31-Oct-2017	✓
GW17-26-02,	LEACHATE							
EP005: Total Organic Carbon (TOC)								
Amber TOC Vial - Sulfuric Acid (EP005)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**----**	----	----	**05-Oct-2017**	31-Oct-2017	✓
GW17-26-02,	LEACHATE							
EP033: C1 - C4 Hydrocarbon Gases								
Amber VOC Vial - Sulfuric Acid (EP033)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**----**	----	----	**05-Oct-2017**	17-Oct-2017	✓
GW17-26-02,	LEACHATE							
EP074A: Monocyclic Aromatic Hydrocarbons								
Amber VOC Vial - Sulfuric Acid (EP074)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**04-Oct-2017**	17-Oct-2017	✓	**04-Oct-2017**	17-Oct-2017	✓
GW17-26-02,	LEACHATE							
EP074B: Oxygenated Compounds								
Amber VOC Vial - Sulfuric Acid (EP074)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**04-Oct-2017**	17-Oct-2017	✓	**04-Oct-2017**	17-Oct-2017	✓
GW17-26-02,	LEACHATE							
EP074C: Sulfonated Compounds								
Amber VOC Vial - Sulfuric Acid (EP074)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**04-Oct-2017**	17-Oct-2017	✓	**04-Oct-2017**	17-Oct-2017	✓
GW17-26-02,	LEACHATE							
EP074D: Fumigants								
Amber VOC Vial - Sulfuric Acid (EP074)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**04-Oct-2017**	17-Oct-2017	✓	**04-Oct-2017**	17-Oct-2017	✓
GW17-26-02,	LEACHATE							

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP074E: Halogenated Aliphatic Compounds								
Amber VOC Vial - Sulfuric Acid (EP074)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**04-Oct-2017**	17-Oct-2017	✓	**04-Oct-2017**	17-Oct-2017	✓
GW17-26-02,	LEACHATE							
EP074F: Halogenated Aromatic Compounds								
Amber VOC Vial - Sulfuric Acid (EP074)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**04-Oct-2017**	17-Oct-2017	✓	**04-Oct-2017**	17-Oct-2017	✓
GW17-26-02,	LEACHATE							
EP074G: Trihalomethanes								
Amber VOC Vial - Sulfuric Acid (EP074)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**04-Oct-2017**	17-Oct-2017	✓	**04-Oct-2017**	17-Oct-2017	✓
GW17-26-02,	LEACHATE							
EP075(SIM)A: Phenolic Compounds								
Amber Glass Bottle - Unpreserved (EP075(SIM))								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**05-Oct-2017**	10-Oct-2017	✓	**05-Oct-2017**	14-Nov-2017	✓
GW17-26-02,	LEACHATE							
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Amber Glass Bottle - Unpreserved (EP075(SIM))								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**05-Oct-2017**	10-Oct-2017	✓	**05-Oct-2017**	14-Nov-2017	✓
GW17-26-02,	LEACHATE							
EP080/071: Total Petroleum Hydrocarbons								
Amber Glass Bottle - Unpreserved (EP071)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**05-Oct-2017**	10-Oct-2017	✓	**05-Oct-2017**	14-Nov-2017	✓
GW17-26-02,	LEACHATE							
Amber VOC Vial - Sulfuric Acid (EP080)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**04-Oct-2017**	17-Oct-2017	✓	**04-Oct-2017**	17-Oct-2017	✓
GW17-26-02,	LEACHATE,							
TRIP BLANK								
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
Amber Glass Bottle - Unpreserved (EP071)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**05-Oct-2017**	10-Oct-2017	✓	**05-Oct-2017**	14-Nov-2017	✓
GW17-26-02,	LEACHATE							
Amber VOC Vial - Sulfuric Acid (EP080)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**04-Oct-2017**	17-Oct-2017	✓	**04-Oct-2017**	17-Oct-2017	✓
GW17-26-02,	LEACHATE,							
TRIP BLANK								
EP080: BTEXN								
Amber VOC Vial - Sulfuric Acid (EP080)								
GW17-26-01,	GW172602-D,	**03-Oct-2017**	**04-Oct-2017**	17-Oct-2017	✓	**04-Oct-2017**	17-Oct-2017	✓
GW17-26-02,	LEACHATE,							
TRIP BLANK								

Quality Control Parameter Frequency Compliance

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

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	6	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
C1 - C4 Gases	EP033	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	4	30	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	5	38	**13.16**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	6	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	9	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	1	11	**9.09**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	3	22	**13.64**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	4	**25.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	16	**6.25**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	5	36	**13.89**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Volatile Organic Compounds	EP074	3	13	**23.08**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
C1 - C4 Gases	EP033	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	3	30	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	3	38	**7.89**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	2	9	**22.22**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	4	22	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Control Samples (LCS) - Continued							
Total Organic Carbon	EP005	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	2	16	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	3	36	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Volatile Organic Compounds	EP074	2	13	**15.38**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
C1 - C4 Gases	EP033	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	3	30	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	3	38	**7.89**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	2	9	**22.22**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Dissolved Solids (High Level)	EA015H	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	2	16	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	3	36	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Volatile Organic Compounds	EP074	2	13	**15.38**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	6	**16.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
C1 - C4 Gases	EP033	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	3	30	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	3	38	**7.89**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	0	9	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Cyanide by Segmented Flow Analyser	EK026SF	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Organic Carbon	EP005	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	16	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	36	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Volatile Organic Compounds	EP074	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

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

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Total Dissolved Solids (High Level)	EA015H	WATER	In house: Referenced to APHA 2540C. A gravimetric procedure that determines the amount of `filterable` residue in an aqueous sample. A well-mixed sample is filtered through a glass fibre filter (1.2um). The filtrate is evaporated to dryness and dried to constant weight at 180+/-5C. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Cyanide by Segmented Flow Analyser	EK026SF	WATER	In house: Referenced to APHA 4500-CN C / ASTM D7511. Sodium hydroxide preserved samples are introduced into an automated segmented flow analyser. Complex bound cyanide is decomposed in a continuously flowing stream, at a pH of 3.8, by the effect of UV light. A UV-B lamp (312 nm) and a decomposition spiral of borosilicate glass are used to filter out UV light with a wavelength of less than 290 nm thus preventing the conversion of thiocyanate into cyanide. The hydrogen cyanide present at a pH of 3.8 is separated by gas dialysis. The hydrogen cyanide is then determined photometrically, based on the reaction of cyanide with chloramine-T to form cyanogen chloride. This then reacts with 4-pyridine carboxylic acid and 1,3-dimethylbarbituric acid to give a red colour which is measured at 600 nm. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Total Organic Carbon	EP005	WATER	In house: Referenced to APHA 5310 B, The automated TOC analyzer determines Total and Inorganic Carbon by IR cell. TOC is calculated as the difference. This method is compliant with NEPM (2013) Schedule B(3)
C1 - C4 Gases	EP033	WATER	Technical Guidance for the Natural Attenuation Indicators: Methane, Ethane, and Ethene, US EPA - Region 1, EPA New England, July 2001. Automated static headspace, dual column GC/FID. A 12 mL sample is pipetted into a 20 mL headspace vial containing 3g of sodium chloride and sealed. Each sample is equilibrated with shaking at 40 degrees C for 10 minutes prior to analysis by GC/FID using a pair of PLOT columns of different polarity.
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Volatile Organic Compounds	EP074	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

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Pink Page - Remains in Book

Adelaide Level 1, 1 King William Street, GPO Box 398 Adelaide SA 5001 Tel: (08) 8405 4300 Fax: (08) 8405 4301

Brisbane Level 3, Northbank Plaza 69 Ann Street, GPO Box 2907 Brisbane QLD 4001 Tel: (07) 3854 6200 Fax: (07) 3854 6500

Melbourne Level 15, 28 Freshwater Place, Tel: (03) 9861 1111 Fax: (03) 9861 1144

Sydney Level 27, Ernst & Young Centre 680 George Street, GPO Box 5394, Sydney NSW 2001 Tel: (02) 9272 5100 Fax: (02) 9272 5101

Perth Level 5, 503 Murray Street, PO Box 7181 Cloisters Square WA 6850 Tel: (08) 9489 9700 Fax: (08) 9489 9777

Singleton 188 John Street, PO Box 115 Singleton NSW 2330 Tel: (02) 6572 3377 Fax: (02) 6572 4080

Newcastle Level 3, 51-55 Bolton Street, Suite 1 PO Box 1162 Newcastle NSW, 2300 Tel: (02) 4929 8300 Fax: (02) 4929 8382

Chain of Custody

Order No: 85167

| | | |

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1715957**	Page	: 1 of 15
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Contact	: Graeme Jablonskas
Address	: Level 15, 28 Freshwater Place SOUTHBANK VIC, AUSTRALIA 3006	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 03 9861 1111	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 21-Nov-2017 17:00
Order number	: 187	Date Analysis Commenced	: 21-Nov-2017
C-O-C number	: ----	Issue Date	: 28-Nov-2017 13:16
Sampler	: Kelly-Jane Wallis		
Site	: ----		
Quote number	: EN/008/15		
No. of samples received	: 20		
No. of samples analysed	: 19		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ashesh Patel	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Chris Lemaitre	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Herman Lin	Laboratory Manager	Melbourne Inorganics, Springvale, VIC
Nikki Stepniewski	Senior Inorganic Instrument Chemist	Melbourne Inorganics, Springvale, VIC
Xing Lin	Senior Organic Chemist	Melbourne Organics, Springvale, VIC

General Comments

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

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

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

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

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

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

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

- ED093F: EM1715957 #1, results for Cations have been confirmed by re-preparation and re-analysis.
- It is recognised that Nitrite and Nitrate as N (NOx) is less than Nitrite as N for samples EM1715957 #10, 11, 12, 14 and 16. However, the difference is within experimental variation of the methods.
- EK040P: EM1715974 #10 Poor matrix spike precision for Fluoride by PC titrator due to sample heterogeneity. Confirmed by re-analysis.
- EK057G: Results for EM1715957-010, 011, 012, 014 and 016 have been confirmed by re-preparation and re-analysis.
- ED093F:EM1715957_002,006,009 have been confirmed for major cations by re-preparatin and re-analysis.
- ED041G & ED045G: Results for EM1715957-021 and 022 have been confirmed by re-preparation and re-analysis.
- Ionic Balance out of acceptable limits for sample #6, #9 and #21 due to analytes not quantified in this report. Major cations and major anions have been confirmed by re-preparation and re-analysis.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- EG020F: EM1715957-015 required dilution prior to dissolved metals analysis due to sample matrix interference. LOR values have been adjusted accordingly.
- EK059G: Results for EM1715957-010, 011, 012, 014 and 016 have been confirmed by re-preparation and re-analysis.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW17-26-05	GW17-26-04	GW17-26-07	SW17-26-06	QA10
			Client sampling date / time	20-Nov-2017 10:30	20-Nov-2017 12:50	20-Nov-2017 15:10	20-Nov-2017 16:35	20-Nov-2017 00:00
Compound	CAS Number	LOR	Unit	EM1715957-001	EM1715957-002	EM1715957-003	EM1715957-006	EM1715957-007
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.43	7.54	7.29	8.24	7.33
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	30600	16800	18300	660	18800
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	19900	10900	11900	429	12200
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	21.1	12.3	7.61	0.256	7.56
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	307	179	266	94	269
Total Alkalinity as CaCO3	----	1	mg/L	307	179	266	94	269
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	2170	864	1290	26	1310
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	11800	6790	7110	159	7080
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	1330	820	689	18	766
Magnesium	7439-95-4	1	mg/L	863	519	638	13	706
Sodium	7440-23-5	1	mg/L	4540	2140	2670	76	2960
Potassium	7440-09-7	1	mg/L	<5	5	12	3	15
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	0.139	0.021	0.049	0.001	0.049
Boron	7440-42-8	0.05	mg/L	0.21	0.13	0.15	<0.05	0.14
Barium	7440-39-3	0.001	mg/L	0.053	0.078	0.051	0.080	0.052
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	0.009	0.025	0.006	<0.001	0.005
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.005	0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.642	0.996	0.386	<0.001	0.383
Nickel	7440-02-0	0.001	mg/L	0.004	0.008	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW17-26-05	GW17-26-04	GW17-26-07	SW17-26-06	QA10
				Client sampling date / time	20-Nov-2017 10:30	20-Nov-2017 12:50	20-Nov-2017 15:10	20-Nov-2017 16:35	20-Nov-2017 00:00
Compound	CAS Number	LOR	Unit		EM1715957-001	EM1715957-002	EM1715957-003	EM1715957-006	EM1715957-007
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.007**	**0.008**	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.8**	**0.4**	**0.6**	**0.3**	**0.6**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.16**	**0.52**	**0.26**	**0.04**	**0.28**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**384**	**213**	**233**	**6.90**	**232**
Total Cations	----	0.01	meq/L		**335**	**177**	**203**	**5.35**	**225**
Ionic Balance	----	0.01	%		**6.86**	**9.30**	**6.74**	**12.7**	**1.51**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW17-26-05	GW17-26-04	GW17-26-07	SW17-26-06	QA10
				Client sampling date / time	20-Nov-2017 10:30	20-Nov-2017 12:50	20-Nov-2017 15:10	20-Nov-2017 16:35	20-Nov-2017 00:00
Compound	CAS Number	LOR	Unit		EM1715957-001	EM1715957-002	EM1715957-003	EM1715957-006	EM1715957-007
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ **Total Xylenes**	1330-20-7	2	µg/L		<2	<2	<2	<2	<2
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**102**	**102**	**98.5**	**92.1**	**100**
Toluene-D8	2037-26-5	2	%		**88.9**	**88.4**	**80.7**	**78.3**	**91.7**
4-Bromofluorobenzene	460-00-4	2	%		**92.9**	**96.0**	**89.3**	**90.5**	**96.7**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW17-26-12S	SW17-26-01E	SW17-26-03E	SW17-26-04E	SW17-26-12E
			Client sampling date / time	21-Nov-2017 09:40	21-Nov-2017 10:25	21-Nov-2017 11:15	21-Nov-2017 11:35	21-Nov-2017 11:55
Compound	CAS Number	LOR	Unit	EM1715957-009	EM1715957-010	EM1715957-011	EM1715957-012	EM1715957-013
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	6.89	7.92	7.98	8.44	8.07
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	12700	1450	3420	23200	2290
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	8260	942	2220	15100	1490
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	2.66	2.00	1.88	13.4	2.79
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	10	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	140	215	71	80	294
Total Alkalinity as CaCO3	----	1	mg/L	140	215	71	91	294
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	1380	1	640	5310	26
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	4260	425	876	7310	666
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	291	42	137	893	61
Magnesium	7439-95-4	1	mg/L	435	27	99	949	44
Sodium	7440-23-5	1	mg/L	1560	205	441	3890	321
Potassium	7440-09-7	1	mg/L	3	16	24	72	39
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.02	0.01	0.02	<0.01	0.03
Arsenic	7440-38-2	0.001	mg/L	0.006	0.004	0.004	0.006	0.006
Boron	7440-42-8	0.05	mg/L	0.09	0.24	0.27	1.57	0.17
Barium	7440-39-3	0.001	mg/L	0.163	0.052	0.064	0.083	0.158
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	0.004	<0.001	<0.001	<0.001	0.002
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.192	0.142	0.054	0.087	0.607
Nickel	7440-02-0	0.001	mg/L	0.009	0.004	<0.001	0.002	0.004
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW17-26-12S	SW17-26-01E	SW17-26-03E	SW17-26-04E	SW17-26-12E
				Client sampling date / time	21-Nov-2017 09:40	21-Nov-2017 10:25	21-Nov-2017 11:15	21-Nov-2017 11:35	21-Nov-2017 11:55
Compound	CAS Number	LOR	Unit		EM1715957-009	EM1715957-010	EM1715957-011	EM1715957-012	EM1715957-013
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	**0.4**	**0.3**	**0.3**	**0.3**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.22**	**0.15**	**0.04**	**0.05**	**0.07**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	**0.01**	**0.01**	**0.01**	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	**0.34**	**0.03**	<0.01	**1.00**
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**152**	**16.3**	**39.4**	**318**	**25.2**
Total Cations	----	0.01	meq/L		**118**	**13.6**	**34.8**	**294**	**21.6**
Ionic Balance	----	0.01	%		**12.4**	**8.88**	**6.30**	**4.06**	**7.64**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	**340**	<100	**150**	**220**
C29 - C36 Fraction	----	50	µg/L		<50	**120**	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	**460**	<50	**150**	**220**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW17-26-12S	SW17-26-01E	SW17-26-03E	SW17-26-04E	SW17-26-12E
				Client sampling date / time	21-Nov-2017 09:40	21-Nov-2017 10:25	21-Nov-2017 11:15	21-Nov-2017 11:35	21-Nov-2017 11:55
Compound	CAS Number	LOR	Unit		EM1715957-009	EM1715957-010	EM1715957-011	EM1715957-012	EM1715957-013
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	**430**	<100	**150**	**230**
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	**430**	<100	**150**	**230**
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ **Total Xylenes**	1330-20-7	2	µg/L		<2	<2	<2	<2	<2
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**103**	**97.3**	**101**	**99.3**	**96.3**
Toluene-D8	2037-26-5	2	%		**85.9**	**91.8**	**93.3**	**89.2**	**88.4**
4-Bromofluorobenzene	460-00-4	2	%		**92.8**	**96.0**	**96.4**	**94.8**	**92.4**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW17-26-13E	SW17-26-Dog Pond	SW17-27-14E	GW17-26-13S	GW17-26-13D
			Client sampling date / time	21-Nov-2017 12:25	21-Nov-2017 12:50	21-Nov-2017 13:30	21-Nov-2017 15:40	21-Nov-2017 16:15
Compound	CAS Number	LOR	Unit	EM1715957-014	EM1715957-015	EM1715957-016	EM1715957-017	EM1715957-018
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	8.18	8.35	8.19	7.45	7.50
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	3770	69900	1370	4390	4350
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	2450	45400	890	2850	2830
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	2.03	58.0	0.617	2.78	2.73
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	8	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	82	153	99	263	283
Total Alkalinity as CaCO3	----	1	mg/L	82	153	99	263	283
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	678	12500	187	124	131
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	910	28400	306	1310	1320
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	151	1090	67	51	116
Magnesium	7439-95-4	1	mg/L	101	3170	30	71	90
Sodium	7440-23-5	1	mg/L	477	14600	149	712	620
Potassium	7440-09-7	1	mg/L	26	252	7	9	6
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.02	<0.02	0.03	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	0.004	0.014	0.001	0.164	0.251
Boron	7440-42-8	0.05	mg/L	0.28	5.02	0.17	0.08	0.13
Barium	7440-39-3	0.001	mg/L	0.051	0.079	0.043	0.296	0.071
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.002	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0002	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.002	<0.001	0.002	0.006
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.002	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.002	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.056	0.037	0.113	0.042	0.442
Nickel	7440-02-0	0.001	mg/L	<0.001	0.010	0.001	0.001	0.002
Lead	7439-92-1	0.001	mg/L	<0.001	<0.002	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW17-26-13E	SW17-26-Dog Pond	SW17-27-14E	GW17-26-13S	GW17-26-13D
			Client sampling date / time	21-Nov-2017 12:25	21-Nov-2017 12:50	21-Nov-2017 13:30	21-Nov-2017 15:40	21-Nov-2017 16:15
Compound	CAS Number	LOR	Unit	EM1715957-014	EM1715957-015	EM1715957-016	EM1715957-017	EM1715957-018
				Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued								
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.02	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.02	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.010	<0.005	**0.010**	<0.005
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.3**	**0.5**	**0.2**	**0.4**	**0.2**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.03**	**0.68**	**0.24**	**0.16**	**0.39**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	**0.01**	<0.01	**0.01**	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**41.4**	**1060**	**14.5**	**44.8**	**45.6**
Total Cations	----	0.01	meq/L	**37.3**	**957**	**12.5**	**39.6**	**40.3**
Ionic Balance	----	0.01	%	**5.29**	**5.32**	**7.53**	**6.16**	**6.17**
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	<5	<5	<5
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L	<100	**330**	**140**	<100	<100
C29 - C36 Fraction	----	50	µg/L	<50	**50**	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	**380**	**140**	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	<20	<20	<20

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW17-26-13E	SW17-26-Dog Pond	SW17-27-14E	GW17-26-13S	GW17-26-13D
				Client sampling date / time	21-Nov-2017 12:25	21-Nov-2017 12:50	21-Nov-2017 13:30	21-Nov-2017 15:40	21-Nov-2017 16:15
Compound	CAS Number	LOR	Unit		EM1715957-014	EM1715957-015	EM1715957-016	EM1715957-017	EM1715957-018
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	**350**	**160**	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	**350**	**160**	<100	<100
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ **Total Xylenes**	1330-20-7	2	µg/L		<2	<2	<2	<2	<2
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**96.2**	**121**	**96.8**	**103**	**94.6**
Toluene-D8	2037-26-5	2	%		**85.5**	**97.4**	**86.2**	**95.8**	**81.7**
4-Bromofluorobenzene	460-00-4	2	%		**90.1**	**103**	**89.0**	**95.8**	**89.6**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	QA11	SW17-26-07	GW17-26-06	GW17-26-12D	----
			Client sampling date / time	21-Nov-2017 00:00	20-Nov-2017 15:30	20-Nov-2017 16:25	21-Nov-2017 09:05	----
Compound	CAS Number	LOR	Unit	EM1715957-019	EM1715957-021	EM1715957-022	EM1715957-023	--------
				Result	Result	Result	Result	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.48**	**8.06**	**6.97**	**7.23**	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**4310**	**686**	**23400**	**6390**	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	**2800**	**446**	**15200**	**4150**	----
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	**2.77**	**0.261**	**8.55**	**2.77**	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**283**	**90**	**196**	**306**	----
Total Alkalinity as CaCO3	----	1	mg/L	**283**	**90**	**196**	**306**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**131**	**26**	**1740**	**176**	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**1360**	**160**	**8740**	**1890**	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**117**	**22**	**841**	**90**	----
Magnesium	7439-95-4	1	mg/L	**90**	**15**	**920**	**114**	----
Sodium	7440-23-5	1	mg/L	**617**	**82**	**3350**	**916**	----
Potassium	7440-09-7	1	mg/L	**6**	**3**	**11**	**1**	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	----
Arsenic	7440-38-2	0.001	mg/L	**0.252**	**0.001**	**0.006**	**0.158**	----
Boron	7440-42-8	0.05	mg/L	**0.14**	<0.05	**0.12**	**0.10**	----
Barium	7440-39-3	0.001	mg/L	**0.074**	**0.094**	**0.044**	**0.131**	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Cobalt	7440-48-4	0.001	mg/L	**0.006**	<0.001	**0.027**	<0.001	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	**0.444**	**0.001**	**0.492**	**0.108**	----
Nickel	7440-02-0	0.001	mg/L	**0.002**	<0.001	**0.013**	<0.001	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	QA11	SW17-26-07	GW17-26-06	GW17-26-12D	----
				Client sampling date / time	21-Nov-2017 00:00	20-Nov-2017 15:30	20-Nov-2017 16:25	21-Nov-2017 09:05	----
Compound	CAS Number	LOR	Unit		EM1715957-019	EM1715957-021	EM1715957-022	EM1715957-023	--------
					Result	Result	Result	Result	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	**0.007**	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.3**	**0.2**	**0.3**	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.39**	<0.01	**0.24**	**0.64**	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	**0.01**	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**0.01**	<0.01	**0.01**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.02**	<0.01	**0.01**	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**46.7**	**6.85**	**287**	**63.1**	----
Total Cations	----	0.01	meq/L		**40.2**	**5.98**	**264**	**53.7**	----
Ionic Balance	----	0.01	%		**7.48**	**6.84**	**4.18**	**8.00**	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	QA11	SW17-26-07	GW17-26-06	GW17-26-12D	----
				Client sampling date / time	21-Nov-2017 00:00	20-Nov-2017 15:30	20-Nov-2017 16:25	21-Nov-2017 09:05	----
Compound	CAS Number	LOR	Unit		EM1715957-019	EM1715957-021	EM1715957-022	EM1715957-023	--------
					Result	Result	Result	Result	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	<100	<100	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	----
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	----
^ **Total Xylenes**	1330-20-7	2	µg/L		<2	<2	<2	<2	----
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	----
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**98.3**	**94.4**	**93.2**	**95.3**	----
Toluene-D8	2037-26-5	2	%		**89.6**	**81.4**	**79.1**	**87.8**	----
4-Bromofluorobenzene	460-00-4	2	%		**92.1**	**96.8**	**94.3**	**101**	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM1715957**	Page	: 1 of 17
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 21-Nov-2017
Site	: ----	Issue Date	: 28-Nov-2017
Sampler	: Kelly-Jane Wallis	No. of samples received	: 20
Order number	: 187	No. of samples analysed	: 19

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

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

Summary of Outliers

Outliers : Quality Control Samples

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

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

Outliers : Analysis Holding Time Compliance

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

Outliers : Frequency of Quality Control Samples

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

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED009: Anions	EM1715793--001	Anonymous	**Bromide**	24959-67-9	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
ED009: Anions	EM1715957--012	SW17-26-04E	**Bromide**	24959-67-9	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	EM1715957--022	GW17-26-06	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
ED045G: Chloride by Discrete Analyser	EM1715957--022	GW17-26-06	**Chloride**	16887-00-6	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK055G: Ammonia as N by Discrete Analyser	EM1715914--003	Anonymous	**Ammonia as N**	7664-41-7	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)		Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural							
GW17-26-05, GW17-26-07, QA10	GW17-26-04, SW17-26-06,	----	----	----	21-Nov-2017	20-Nov-2017	**1**
Clear Plastic Bottle - Natural							
SW17-26-07,	GW17-26-06	----	----	----	23-Nov-2017	20-Nov-2017	**3**
Clear Plastic Bottle - Natural							
GW17-26-12D		----	----	----	23-Nov-2017	21-Nov-2017	**2**
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural							
SW17-26-07,	GW17-26-06	----	----	----	23-Nov-2017	22-Nov-2017	**1**
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural							
SW17-26-07,	GW17-26-06	----	----	----	23-Nov-2017	22-Nov-2017	**1**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
TRH - Semivolatile Fraction	1	31	3.23	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
TRH - Semivolatile Fraction	1	31	3.23	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

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

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

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

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

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P) GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**----**	----	----	**21-Nov-2017**	20-Nov-2017	×
Clear Plastic Bottle - Natural (EA005-P) SW17-26-07, GW17-26-06	**20-Nov-2017**	**----**	----	----	**23-Nov-2017**	20-Nov-2017	×
Clear Plastic Bottle - Natural (EA005-P) GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**----**	----	----	**21-Nov-2017**	21-Nov-2017	✓
Clear Plastic Bottle - Natural (EA005-P) GW17-26-12D	**21-Nov-2017**	**----**	----	----	**23-Nov-2017**	21-Nov-2017	×

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**----**	----	----	**22-Nov-2017**	18-Dec-2017	✓
Clear Plastic Bottle - Natural (EA010-P)							
SW17-26-07, GW17-26-06	**20-Nov-2017**	**----**	----	----	**23-Nov-2017**	18-Dec-2017	✓
Clear Plastic Bottle - Natural (EA010-P)							
GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**----**	----	----	**22-Nov-2017**	19-Dec-2017	✓
Clear Plastic Bottle - Natural (EA010-P)							
GW17-26-12D	**21-Nov-2017**	**----**	----	----	**23-Nov-2017**	19-Dec-2017	✓
ED009: Anions							
Clear Plastic Bottle - Natural (ED009-X)							
GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10, SW17-26-07, GW17-26-06	**20-Nov-2017**	**----**	----	----	**24-Nov-2017**	18-Dec-2017	✓
Clear Plastic Bottle - Natural (ED009-X)							
GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11, GW17-26-12D	**21-Nov-2017**	**----**	----	----	**24-Nov-2017**	19-Dec-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**----**	----	----	**22-Nov-2017**	04-Dec-2017	✓
Clear Plastic Bottle - Natural (ED037-P)							
SW17-26-07, GW17-26-06	**20-Nov-2017**	**----**	----	----	**23-Nov-2017**	04-Dec-2017	✓
Clear Plastic Bottle - Natural (ED037-P)							
GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**----**	----	----	**22-Nov-2017**	05-Dec-2017	✓
Clear Plastic Bottle - Natural (ED037-P)							
GW17-26-12D	**21-Nov-2017**	**----**	----	----	**23-Nov-2017**	05-Dec-2017	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**----**	----	----	**22-Nov-2017**	18-Dec-2017	✓
Clear Plastic Bottle - Natural (ED041G)							
SW17-26-07, GW17-26-06	**20-Nov-2017**	**----**	----	----	**23-Nov-2017**	18-Dec-2017	✓
Clear Plastic Bottle - Natural (ED041G)							
GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**----**	----	----	**22-Nov-2017**	19-Dec-2017	✓
Clear Plastic Bottle - Natural (ED041G)							
GW17-26-12D	**21-Nov-2017**	**----**	----	----	**23-Nov-2017**	19-Dec-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**----**	----	----	**22-Nov-2017**	18-Dec-2017	✓
Clear Plastic Bottle - Natural (ED045G)							
SW17-26-07, GW17-26-06	**20-Nov-2017**	**----**	----	----	**23-Nov-2017**	18-Dec-2017	✓
Clear Plastic Bottle - Natural (ED045G)							
GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**----**	----	----	**22-Nov-2017**	19-Dec-2017	✓
Clear Plastic Bottle - Natural (ED045G)							
GW17-26-12D	**21-Nov-2017**	**----**	----	----	**23-Nov-2017**	19-Dec-2017	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10, SW17-26-07, GW17-26-06	**20-Nov-2017**	**----**	----	----	**23-Nov-2017**	18-Dec-2017	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11, GW17-26-12D	**21-Nov-2017**	**----**	----	----	**23-Nov-2017**	19-Dec-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**----**	----	----	**22-Nov-2017**	19-May-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
SW17-26-07, GW17-26-06	**20-Nov-2017**	**----**	----	----	**23-Nov-2017**	19-May-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**----**	----	----	**22-Nov-2017**	20-May-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
GW17-26-12D	**21-Nov-2017**	**----**	----	----	**23-Nov-2017**	20-May-2018	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10, SW17-26-07, GW17-26-06	**20-Nov-2017**	**----**	----	----	**23-Nov-2017**	18-Dec-2017	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11, GW17-26-12D	**21-Nov-2017**	**----**	----	----	**23-Nov-2017**	19-Dec-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P)							
GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**----**	----	----	**22-Nov-2017**	18-Dec-2017	✓
Clear Plastic Bottle - Natural (EK040P)							
SW17-26-07, GW17-26-06	**20-Nov-2017**	**----**	----	----	**23-Nov-2017**	18-Dec-2017	✓
Clear Plastic Bottle - Natural (EK040P)							
GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**----**	----	----	**22-Nov-2017**	19-Dec-2017	✓
Clear Plastic Bottle - Natural (EK040P)							
GW17-26-12D	**21-Nov-2017**	**----**	----	----	**23-Nov-2017**	19-Dec-2017	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**----**	----	----	**22-Nov-2017**	18-Dec-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
SW17-26-07, GW17-26-06	**20-Nov-2017**	**----**	----	----	**23-Nov-2017**	18-Dec-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**----**	----	----	**22-Nov-2017**	19-Dec-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
GW17-26-12D	**21-Nov-2017**	**----**	----	----	**23-Nov-2017**	19-Dec-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**----**	----	----	**21-Nov-2017**	22-Nov-2017	✓
Clear Plastic Bottle - Natural (EK057G)							
SW17-26-07, GW17-26-06	**20-Nov-2017**	**----**	----	----	**23-Nov-2017**	22-Nov-2017	×
Clear Plastic Bottle - Natural (EK057G)							
GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**----**	----	----	**21-Nov-2017**	23-Nov-2017	✓
Clear Plastic Bottle - Natural (EK057G)							
GW17-26-12D	**21-Nov-2017**	**----**	----	----	**23-Nov-2017**	23-Nov-2017	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**----**	----	----	**22-Nov-2017**	18-Dec-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
SW17-26-07, GW17-26-06	**20-Nov-2017**	**----**	----	----	**23-Nov-2017**	18-Dec-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**----**	----	----	**22-Nov-2017**	19-Dec-2017	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
GW17-26-12D	**21-Nov-2017**	**----**	----	----	**23-Nov-2017**	19-Dec-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**----**	----	----	**21-Nov-2017**	22-Nov-2017	✓
Clear Plastic Bottle - Natural (EK071G)							
SW17-26-07, GW17-26-06	**20-Nov-2017**	**----**	----	----	**23-Nov-2017**	22-Nov-2017	×
Clear Plastic Bottle - Natural (EK071G)							
GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**----**	----	----	**21-Nov-2017**	23-Nov-2017	✓
Clear Plastic Bottle - Natural (EK071G)							
GW17-26-12D	**21-Nov-2017**	**----**	----	----	**23-Nov-2017**	23-Nov-2017	✓
EP020: Oil and Grease (O&G)							
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020)							
GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10, SW17-26-07, GW17-26-06	**20-Nov-2017**	**----**	----	----	**24-Nov-2017**	18-Dec-2017	✓
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020)							
GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11, GW17-26-12D	**21-Nov-2017**	**----**	----	----	**24-Nov-2017**	19-Dec-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071) GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**22-Nov-2017**	27-Nov-2017	✓	**23-Nov-2017**	01-Jan-2018	✓
Amber Glass Bottle - Unpreserved (EP071) SW17-26-07, GW17-26-06	**20-Nov-2017**	**23-Nov-2017**	27-Nov-2017	✓	**23-Nov-2017**	02-Jan-2018	✓
Amber Glass Bottle - Unpreserved (EP071) GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**22-Nov-2017**	28-Nov-2017	✓	**23-Nov-2017**	01-Jan-2018	✓
Amber Glass Bottle - Unpreserved (EP071) GW17-26-12D	**21-Nov-2017**	**23-Nov-2017**	28-Nov-2017	✓	**23-Nov-2017**	02-Jan-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080) GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**22-Nov-2017**	04-Dec-2017	✓	**22-Nov-2017**	04-Dec-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080) SW17-26-07, GW17-26-06	**20-Nov-2017**	**23-Nov-2017**	04-Dec-2017	✓	**23-Nov-2017**	04-Dec-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080) GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**22-Nov-2017**	05-Dec-2017	✓	**22-Nov-2017**	05-Dec-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080) GW17-26-12D	**21-Nov-2017**	**23-Nov-2017**	05-Dec-2017	✓	**23-Nov-2017**	05-Dec-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Amber Glass Bottle - Unpreserved (EP071) GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**22-Nov-2017**	27-Nov-2017	✓	**23-Nov-2017**	01-Jan-2018	✓
Amber Glass Bottle - Unpreserved (EP071) SW17-26-07, GW17-26-06	**20-Nov-2017**	**23-Nov-2017**	27-Nov-2017	✓	**23-Nov-2017**	02-Jan-2018	✓
Amber Glass Bottle - Unpreserved (EP071) GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**22-Nov-2017**	28-Nov-2017	✓	**23-Nov-2017**	01-Jan-2018	✓
Amber Glass Bottle - Unpreserved (EP071) GW17-26-12D	**21-Nov-2017**	**23-Nov-2017**	28-Nov-2017	✓	**23-Nov-2017**	02-Jan-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080) GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**22-Nov-2017**	04-Dec-2017	✓	**22-Nov-2017**	04-Dec-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080) SW17-26-07, GW17-26-06	**20-Nov-2017**	**23-Nov-2017**	04-Dec-2017	✓	**23-Nov-2017**	04-Dec-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080) GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**22-Nov-2017**	05-Dec-2017	✓	**22-Nov-2017**	05-Dec-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080) GW17-26-12D	**21-Nov-2017**	**23-Nov-2017**	05-Dec-2017	✓	**23-Nov-2017**	05-Dec-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080: BTEXN							
Amber VOC Vial - Sulfuric Acid (EP080)							
GW17-26-05, GW17-26-04, GW17-26-07, SW17-26-06, QA10	**20-Nov-2017**	**22-Nov-2017**	04-Dec-2017	✓	**22-Nov-2017**	04-Dec-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
SW17-26-07, GW17-26-06	**20-Nov-2017**	**23-Nov-2017**	04-Dec-2017	✓	**23-Nov-2017**	04-Dec-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW17-26-12S, SW17-26-01E, SW17-26-03E, SW17-26-04E, SW17-26-12E, SW17-26-13E, SW17-26-Dog Pond, SW17-27-14E, GW17-26-13S, GW17-26-13D, QA11	**21-Nov-2017**	**22-Nov-2017**	05-Dec-2017	✓	**22-Nov-2017**	05-Dec-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW17-26-12D	**21-Nov-2017**	**23-Nov-2017**	05-Dec-2017	✓	**23-Nov-2017**	05-Dec-2017	✓

Quality Control Parameter Frequency Compliance

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

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	8	76	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	5	42	**11.90**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	5	47	**10.64**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	6	51	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	5	46	**10.87**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	6	56	**10.71**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	6	59	**10.17**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	6	55	**10.91**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	6	55	**10.91**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	6	51	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	6	56	**10.71**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	6	50	**12.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	6	60	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	31	**3.23**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	4	39	**10.26**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	4	76	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	3	42	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	6	47	**12.77**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	3	51	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	3	46	**6.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	3	56	**5.36**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	3	59	**5.08**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	3	55	**5.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	3	55	**5.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	3	51	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	3	50	**6.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	6	60	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	2	31	**6.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	3	42	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	3	47	**6.38**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Conductivity by PC Titrator	EA010-P	3	51	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	3	46	**6.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	3	56	**5.36**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	3	59	**5.08**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	3	55	**5.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	3	55	**5.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	3	51	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	3	50	**6.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	3	60	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	2	31	**6.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	3	42	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	3	47	**6.38**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	3	46	**6.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	3	56	**5.36**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	3	59	**5.08**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	3	55	**5.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	3	51	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	3	50	**6.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	3	60	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	31	**3.23**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	39	**5.13**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

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

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Calculated TDS (from Electrical Conductivity)	EA016	WATER	In house: Calculation from Electrical Conductivity (APHA 2510 B) using a conversion factor specified in the analytical report. This method is compliant with NEPM (2013) Schedule B(3)
Standard Anions -by IC (Extended Method)	ED009-X	WATER	In house: Referenced to APHA 4110B. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Oil and Grease	EP020	WATER	In house: Referenced to APHA 5520 B. Oil & grease is a gravimetric procedure to determine the amount of oil & grease residue in an aqueous sample. The sample is serially extracted three times n-hexane. The resultant extracts are combined, dehydrated and concentrated prior to gravimetric determination. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

CHAIN OF CUSTODY

ALS Laboratory: **please tick** →

☐ **Sydney:** 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ **Newcastle:** 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ **Brisbane:** 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ **Townsville:** 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne:** 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide:** 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth:** 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston:** 27 Wellington St, Launceston TAS 7250 Ph:03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	**TURNAROUND REQUIREMENTS :** Standard (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	**FOR LABORATORY USE ONLY (Circle)**	
OFFICE: Melbourne, Southbank		Custody Seal Intact?	Yes / No / N/A
PROJECT: PS101340	**ALS QUOTE NO.:** EN/008/17	Free ice / frozen ice bricks present upon receipt?	Yes / No / N/A
ORDER NUMBER: 187	**COC SEQUENCE NUMBER (Circle)** COC: (1) 2 3 4 5 6 7	Random Sample Temperature on Receipt:	°C
PROJECT MANAGER: Ray Hatley	**CONTACT PH:** 02 92725234	OF: 1 (2) 3 4 5 6 7	Other comment:
SAMPLER: Kelly-Jane Wallis	**SAMPLER MOBILE:** 0447026695	**RELINQUISHED BY:** KJ Wallis	**RECEIVED BY:** Ray Hatley
COC emailed to ALS? (YES / (NO)	**EDD FORMAT (or default):**	DATE/TIME: 21/11/17	DATE/TIME: 21/11/17 5-00pm
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com, Alistair.Stewart@wsp.com		**RELINQUISHED BY:**	**RECEIVED BY:**
Email Invoice to : au.accountspayable@wsp.com		DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).											Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	IN-1	EA005	NT-1	NT-2A	ED009X	NT- 4	EK055	EK071	W-3F, Al(EG020F)	EP020	W-4	21/11/2017
1	GW17-26-05	20/11/17 10:30	W	10	~~10~~	X	X	X	X	X	X	X	X	X	X	X	QA TPH
2	GW17-26-04	" 12:50	W		8												
3	GW17-26-07	" 3:10	W														
~~4~~ R	SW17-26-07	" 3:30	W														
~~5~~ R	GW17-26-06	" 4:25	W														
6	SW17-26-06	" 4:35	W														
7	QA10	20/11/17	W														
~~8~~ R	GW17-26-12D	21/11/17 9:05	W														
9	GW17-26-12S	" 9:40	W														
10	SW17-26-01E	" 10:25	W														
11	SW17-26-03E	" 11:15	W														
12	SW17-26-04E	" ~~11:35~~	W														
				TOTAL													

Environmental Division
Melbourne
Work Order Reference
EM1715957

Telephone : + 61-3-8549 9600

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

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☐ **Launceston:** 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	**TURNAROUND REQUIREMENTS :** Standard (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: Melbourne, Southbank		Custody Seal Intact? Yes No N/A
PROJECT: PS101340	**ALS QUOTE NO.: EN/008/17**	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER: 187	**COC SEQUENCE NUMBER (Circle)** COC: 1 (2) 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Ray Hatley	**CONTACT PH: 02 92725234** OF: 1 (2) 3 4 5 6 7	Other comment:

SAMPLER: Kelly-Jane Wallis	**SAMPLER MOBILE: 0447026695**	**RELINQUISHED BY:** KJ Wallis	**RECEIVED BY:** Ruth
COC emailed to ALS? (YES / (NO)	**EDD FORMAT (or default):**	DATE/TIME: 21/11/17 4:50	DATE/TIME: 21/11/17
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com, Alistair.Stewart@wsp.com		**RELINQUISHED BY:**	**RECEIVED BY:**
Email Invoice to : au.accountspayable@wsp.com		DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL: 5 cap

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).											Additional Information		
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	IN-1	EA005	NT-1	NT-2A	ED009X	NT- 4	EK055	EK071	W-3F, Al(EG020F)	EP020	W-4			
13	SW17-26-12E	21/11/17 11:55	W		8	X	X	X	X	X	X	X	X	X	X	X			
14	SW17-26-13E	" 12:25	W																
15	SW17-26-Dog Pond	" 12:50	W																
16	SW17-26-14E	" 1:30	W																
17	GW17-26-13S	" 3:40	W																
18	GW17-26-13D	" 4:15	W																
19	QA11	21/11/17	W																
20	Trip blank																		
				TOTAL															

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyd
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

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☐ Brisbane: 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ Townsville: 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville environmental@alsenviro.com
☐ Melbourne: 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
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☐ Perth: 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ Launceston: 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	TURNAROUND REQUIREMENTS: Standard (Standard TAT may be longer for some tests e.g., Ultra Trace Organics)	FOR LABORATORY USE ONLY (Circle): Custody Seal Intact? Yes / No / N/A; Free ice / frozen ice bricks present upon receipt? Yes / No / N/A; Random Sample Temperature on Receipt: °C; Other comments:
OFFICE: Melbourne, Southbank	ALS QUOTE NO.: EN/008/17	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7 OF: 1 2 3 4 5 6 7
PROJECT: PS101340		
ORDER NUMBER: 187		
PROJECT MANAGER: Ray Hatley	CONTACT PH: 02 92725234	
SAMPLER: Kelly-Jane Wallis	SAMPLER MOBILE: 0447026695	RELINQUISHED BY: KJ Wallis; DATE/TIME: 21/11/17
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	RECEIVED BY: [signature]; DATE/TIME: 21/11/17 5:40pm
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com, Alistair.Stewart@wsp.com		RELINQUISHED BY: ; DATE/TIME:
Email Invoice to : au.accountspayable@wsp.com		RECEIVED BY: ; DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS (MATRIX: Solid(S) Water(W))			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price). Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).											Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	IN-1	EA005	NT-1	NT-2A	ED009X	NT- 4	EK055	EK071	W-3F, Al(EG020F)	EP020	W-4	21/11/2017
1	GW17-26-05	20/11/17 10:30	W	10	8	X	X	X	X	X	X	X	X	X	X	X	QA TPH
2	GW17-26-04	" 12:50	W														
3	GW17-26-07	" 3:10	W														
R 4 (21)	SW17-26-07	" 3:30	W	Samples													
R 5 (22)	GW17-26-06	" 4:25	W	not received													
6	SW17-26-06	" 4:35	W	on 22/11/17													
7	QA10	20/11/17	W	@													
R 8 (23)	GW17-26-12D	21/11/17 9:05	W	4:40pm													
9	GW17-26-12S	" 9:40	W														
10	SW17-26-01E	" 10:25	W														
11	SW17-26-03E	" 11:15	W														
12	SW17-26-04E	" ~~11:05~~	W														
				TOTAL													

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic; V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde; Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1716035**	Page	: 1 of 9
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Contact	: Graeme Jablonskas
Address	: Level 15, 28 Freshwater Place SOUTHBANK VIC, AUSTRALIA 3006	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 03 9861 1111	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 22-Nov-2017 16:45
Order number	: 187	Date Analysis Commenced	: 22-Nov-2017
C-O-C number	: ----	Issue Date	: 28-Nov-2017 13:52
Sampler	: KELLY-JANE WALLIS		
Site	: ----		
Quote number	: EN/008/17		
No. of samples received	: 7		
No. of samples analysed	: 7		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ashesh Patel	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Nancy Wang	Senior Semivolatile Instrument Chemist	Melbourne Organics, Springvale, VIC

General Comments

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

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

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

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

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

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

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

- ED093F: EM1716035 #4-7, results for Cations have been confirmed by re-preparation and re-analysis.
- EK040P: EM1716013 #5 Poor matrix spike precision for Fluoride by PC titrator due to sample heterogeneity. Confirmed by re-analysis.
- ED041G & ED045G: Results for EM1716035-004, 005, 006 and 007 have been confirmed by re-preparation and re-analysis.
- Ionic Balance out of acceptable limits for sample #6 & #7 due to analytes not quantified in this report.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW17-26-15D	GW17-26-15S	GW17-26-14S	GW17-26-14D	GW17-26-10S
			Client sampling date / time	22-Nov-2017 10:55	22-Nov-2017 11:15	22-Nov-2017 12:10	22-Nov-2017 12:40	22-Nov-2017 15:25
Compound	CAS Number	LOR	Unit	EM1716035-001	EM1716035-002	EM1716035-003	EM1716035-004	EM1716035-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.41	7.29	7.61	7.50	7.35
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	4440	6760	4880	4050	2470
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	2890	4390	3170	2630	1600
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	2.90	4.02	2.28	2.38	1.35
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	264	461	351	315	265
Total Alkalinity as CaCO3	----	1	mg/L	264	461	351	315	265
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	102	681	160	115	47
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	1380	1870	1480	1200	720
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	123	168	149	115	49
Magnesium	7439-95-4	1	mg/L	93	172	129	76	54
Sodium	7440-23-5	1	mg/L	599	954	612	594	364
Potassium	7440-09-7	1	mg/L	7	5	11	6	7
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	0.01	<0.01	<0.01	0.01
Arsenic	7440-38-2	0.001	mg/L	0.080	0.020	0.013	0.118	0.006
Boron	7440-42-8	0.05	mg/L	0.16	0.16	0.12	0.19	0.09
Barium	7440-39-3	0.001	mg/L	0.177	0.070	1.06	0.074	0.282
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	0.008	0.010	0.003	0.006	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	0.003	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.771	0.530	0.253	0.925	0.115
Nickel	7440-02-0	0.001	mg/L	0.003	0.013	0.002	0.002	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW17-26-15D	GW17-26-15S	GW17-26-14S	GW17-26-14D	GW17-26-10S
				Client sampling date / time	22-Nov-2017 10:55	22-Nov-2017 11:15	22-Nov-2017 12:10	22-Nov-2017 12:40	22-Nov-2017 15:25
Compound	CAS Number	LOR	Unit		EM1716035-001	EM1716035-002	EM1716035-003	EM1716035-004	EM1716035-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.005**	**0.006**	**0.010**	<0.005	**0.005**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.4**	**0.2**	**0.5**	**0.4**	**0.3**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.30**	**0.14**	**0.24**	**0.39**	**0.67**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**0.02**	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.02**	<0.01	<0.01	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	**0.01**	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**46.3**	**76.1**	**52.1**	**42.5**	**26.6**
Total Cations	----	0.01	meq/L		**40.0**	**64.2**	**45.0**	**38.0**	**22.9**
Ionic Balance	----	0.01	%		**7.30**	**8.54**	**7.36**	**5.66**	**7.44**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW17-26-15D	GW17-26-15S	GW17-26-14S	GW17-26-14D	GW17-26-10S
				Client sampling date / time	22-Nov-2017 10:55	22-Nov-2017 11:15	22-Nov-2017 12:10	22-Nov-2017 12:40	22-Nov-2017 15:25
Compound	CAS Number	LOR	Unit		EM1716035-001	EM1716035-002	EM1716035-003	EM1716035-004	EM1716035-005
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ **Total Xylenes**	1330-20-7	2	µg/L		<2	<2	<2	<2	<2
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**88.0**	**97.2**	**92.2**	**91.5**	**92.7**
Toluene-D8	2037-26-5	2	%		**82.0**	**90.9**	**87.0**	**88.0**	**90.7**
4-Bromofluorobenzene	460-00-4	2	%		**95.0**	**106**	**102**	**100**	**104**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW17-26-10D	SW17-26-10	----	----	----
			Client sampling date / time	22-Nov-2017 15:50	22-Nov-2017 16:00	----	----	----
Compound	CAS Number	LOR	Unit	EM1716035-006	EM1716035-007	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.76**	**7.89**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**7690**	**499**	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	**5000**	**324**	----	----	----
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	**4.82**	**0.200**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**482**	**61**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**482**	**61**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**301**	**18**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**2500**	**113**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**158**	**15**	----	----	----
Magnesium	7439-95-4	1	mg/L	**181**	**9**	----	----	----
Sodium	7440-23-5	1	mg/L	**1090**	**61**	----	----	----
Potassium	7440-09-7	1	mg/L	**6**	**3**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.028**	**0.002**	----	----	----
Boron	7440-42-8	0.05	mg/L	**0.18**	<0.05	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.068**	**0.027**	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.064**	**0.005**	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.001**	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW17-26-10D	SW17-26-10	----	----	----
			Client sampling date / time	22-Nov-2017 15:50	22-Nov-2017 16:00	----	----	----
Compound	CAS Number	LOR	Unit	EM1716035-006	EM1716035-007	--------	--------	--------
				Result	Result	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Selenium	7782-49-2	0.01	mg/L	<0.01	<0.01	----	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L	<0.005	<0.005	----	----	----
EG035F: Dissolved Mercury by FIMS								
Mercury	7439-97-6	0.0001	mg/L	<0.0001	<0.0001	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.9**	**0.2**	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.59**	**0.03**	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	14797-65-0	0.01	mg/L	<0.01	**0.01**	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	**0.01**	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	**0.01**	----	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**86.4**	**4.78**	----	----	----
Total Cations	----	0.01	meq/L	**70.3**	**4.22**	----	----	----
Ionic Balance	----	0.01	%	**10.2**	**6.24**	----	----	----
EP020: Oil and Grease (O&G)								
Oil & Grease	----	5	mg/L	<5	<5	----	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
C6 - C10 Fraction	C6_C10	20	µg/L	<20	<20	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L	<20	<20	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW17-26-10D	SW17-26-10	----	----	----
				Client sampling date / time	22-Nov-2017 15:50	22-Nov-2017 16:00	----	----	----
Compound	CAS Number	LOR	Unit		EM1716035-006	EM1716035-007	--------	--------	--------
					Result	Result	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	----	----	----
Toluene	108-88-3	2	µg/L		<2	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	----	----	----
^ **Total Xylenes**	1330-20-7	2	µg/L		<2	<2	----	----	----
^ **Sum of BTEX**	----	1	µg/L		<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**89.3**	**91.9**	----	----	----
Toluene-D8	2037-26-5	2	%		**86.2**	**81.2**	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**97.4**	**96.6**	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM1716035**	Page	: 1 of 9
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 22-Nov-2017
Site	: ----	Issue Date	: 28-Nov-2017
Sampler	: KELLY-JANE WALLIS	No. of samples received	: 7
Order number	: 187	No. of samples analysed	: 7

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

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

Summary of Outliers

Outliers : Quality Control Samples

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

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

Outliers : Analysis Holding Time Compliance

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

Outliers : Frequency of Quality Control Samples

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

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED009: Anions	EM1716035--001	GW17-26-15D	**Bromide**	24959-67-9	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	EM1716013--009	Anonymous	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG020F: Dissolved Metals by ICP-MS	EM1715999--003	Anonymous	**Manganese**	7439-96-5	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK040P: Fluoride by PC Titrator	EM1716013--005	Anonymous	**Fluoride**	16984-48-8	2.60 %	70-130%	**Recovery less than lower data quality objective**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
TRH - Semivolatile Fraction	1	20	5.00	10.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

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

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

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

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

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**----**	----	----	**22-Nov-2017**	22-Nov-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**----**	----	----	**23-Nov-2017**	20-Dec-2017	✓
ED009: Anions							
Clear Plastic Bottle - Natural (ED009-X)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**----**	----	----	**27-Nov-2017**	20-Dec-2017	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**----**	----	----	**23-Nov-2017**	06-Dec-2017	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**----**	----	----	**23-Nov-2017**	20-Dec-2017	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**----**	----	----	**23-Nov-2017**	20-Dec-2017	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**----**	----	----	**23-Nov-2017**	20-Dec-2017	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**----**	----	----	**23-Nov-2017**	21-May-2018	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**----**	----	----	**23-Nov-2017**	20-Dec-2017	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**----**	----	----	**23-Nov-2017**	20-Dec-2017	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**----**	----	----	**23-Nov-2017**	20-Dec-2017	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**----**	----	----	**23-Nov-2017**	24-Nov-2017	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**----**	----	----	**23-Nov-2017**	20-Dec-2017	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**----**	----	----	**23-Nov-2017**	24-Nov-2017	✓
EP020: Oil and Grease (O&G)							
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**----**	----	----	**27-Nov-2017**	20-Dec-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**23-Nov-2017**	29-Nov-2017	✓	**24-Nov-2017**	02-Jan-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**23-Nov-2017**	06-Dec-2017	✓	**23-Nov-2017**	06-Dec-2017	✓
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Amber Glass Bottle - Unpreserved (EP071)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**23-Nov-2017**	29-Nov-2017	✓	**24-Nov-2017**	02-Jan-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**23-Nov-2017**	06-Dec-2017	✓	**23-Nov-2017**	06-Dec-2017	✓
EP080: BTEXN							
Amber VOC Vial - Sulfuric Acid (EP080)							
GW17-26-15D, GW17-26-15S, GW17-26-14S, GW17-26-14D, GW17-26-10S, GW17-26-10D, SW17-26-10	**22-Nov-2017**	**23-Nov-2017**	06-Dec-2017	✓	**23-Nov-2017**	06-Dec-2017	✓

Quality Control Parameter Frequency Compliance

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

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	4	33	**12.12**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	3	22	**13.64**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	2	7	**28.57**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	20	**5.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	16	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	2	33	**6.06**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	7	**14.29**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	16	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

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

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Calculated TDS (from Electrical Conductivity)	EA016	WATER	In house: Calculation from Electrical Conductivity (APHA 2510 B) using a conversion factor specified in the analytical report. This method is compliant with NEPM (2013) Schedule B(3)
Standard Anions -by IC (Extended Method)	ED009-X	WATER	In house: Referenced to APHA 4110B. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Oil and Grease	EP020	WATER	In house: Referenced to APHA 5520 B. Oil & grease is a gravimetric procedure to determine the amount of oil & grease residue in an aqueous sample. The sample is serially extracted three times n-hexane. The resultant extracts are combined, dehydrated and concentrated prior to gravimetric determination. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

CHAIN OF CUSTODY

ALS Laboratory: **please tick** →

☐ **Sydney:** 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ **Newcastle:** 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ **Brisbane:** 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ **Townsville:** 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne:** 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide:** 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth:** 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston:** 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	**TURNAROUND REQUIREMENTS :** Standard (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	**FOR LABORATORY USE ONLY (Circle)** Custody Seal Intact? Yes No N/A
OFFICE: Melbourne, Southbank		Free ice / frozen ice bricks present upon receipt? Yes No N/A
PROJECT: PS101340	**ALS QUOTE NO.:** EN/008/17	**COC SEQUENCE NUMBER (Circle)** COC: (1) 2 3 4 5 6 7
ORDER NUMBER: 187		OF: (1) 2 3 4 5 6 7
PROJECT MANAGER: Ray Hatley	**CONTACT PH:** 02 92725234	Random Sample Temperature on Receipt: °C
SAMPLER: Kelly-Jane Wallis	**SAMPLER MOBILE:** 0447026695	Other comment:
COC emailed to ALS? (YES / (NO))	**EDD FORMAT (or default):**	
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com, Alistair.Stewart@wsp.com		
Email Invoice to : au.accountspayable@wsp.com		

RELINQUISHED BY:	**RECEIVED BY:**	**RELINQUISHED BY:**	**RECEIVED BY:**
KJ Wallis			
DATE/TIME: 22/11/17 4:45pm	DATE/TIME:	DATE/TIME:	DATE/TIME: 22/11, 16:45

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).											Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	IN-1	EA005	NT-1	NT-2A	ED009X	NT-4	EK055	EK071	W-3F, Al(EG020F)	EP020	W-4	
1	GW17-26-15D	22/11/17 10:55	W		8	X	X	X	X	X	X	X	X	X	X	X	
2	GW17-26-15S	" 11:15	W		8												
3	GW17-26-14S	" 12:10	W		8												
4	GW17-26-14D	" 12:40	W		10												QA TPH
5	GW17-26-10S	" 3:25	W		8												
6	GW17-26-10D	" 3:50	W		8												
7	SW17-26-10	" 4:00	W		8												
				TOTAL													

Environmental Division
Melbourne
Work Order Reference
EM1716035

Telephone : + 61-3-8549 9600

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1716152**	Page	: 1 of 10
Amendment	: **2**		
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Contact	: Graeme Jablonskas
Address	: Level 15, 28 Freshwater Place SOUTHBANK VIC, AUSTRALIA 3006	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 03 9861 1111	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 24-Nov-2017 12:20
Order number	: 187	Date Analysis Commenced	: 24-Nov-2017
C-O-C number	: ----	Issue Date	: 12-Dec-2017 16:42
Sampler	: KELLY-JANE WALLIS		
Site	: ----		
Quote number	: EN/008/17		
No. of samples received	: 14		
No. of samples analysed	: 11		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ashesh Patel	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Chris Lemaitre	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Nancy Wang	2IC Organic Chemist	Melbourne Organics, Springvale, VIC
Nikki Stepniewski	Senior Inorganic Instrument Chemist	Melbourne Inorganics, Springvale, VIC

General Comments

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

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

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

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

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

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

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

- ED093F: EM1716152 #1-7, 10, 13, results for Cations have been confirmed by re-preparation and re-analysis.
- EK059G: It is recognised that Nitrite and Nitrate as N (NOx) is less than Nitrites as N for sample EM1716152#8. However, the difference is within experimental variation of the methods. Results have been confirmed by re-preparation and re-analysis.
- Amendment (12/12/2017): This report has been amended and re-released to allow the swapping of sample IDs for sample #5 and #8. All analysis results are as per the previous report.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- EG020F: EM1716152-009 required dilution prior to dissolved metals analysis due to sample matrix interference. LOR values have been adjusted accordingly.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW17-26-03	GW17-26-11S	GW17-26-11D	GW17-26-09	SW17-26-08
			Client sampling date / time	23-Nov-2017 09:35	23-Nov-2017 10:40	23-Nov-2017 11:00	23-Nov-2017 13:50	23-Nov-2017 15:00
Compound	CAS Number	LOR	Unit	EM1716152-001	EM1716152-002	EM1716152-003	EM1716152-004	EM1716152-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.40**	**7.30**	**7.36**	**6.55**	**8.14**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1300**	**2640**	**5910**	**7490**	**632**
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	**845**	**1720**	**3840**	**4870**	**411**
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	**0.625**	**1.53**	**3.64**	**3.17**	**0.265**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**204**	**407**	**468**	**123**	**89**
Total Alkalinity as CaCO3	----	1	mg/L	**204**	**407**	**468**	**123**	**89**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**64**	**44**	**226**	**690**	**26**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**308**	**743**	**1770**	**2680**	**151**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**20**	**78**	**150**	**297**	**18**
Magnesium	7439-95-4	1	mg/L	**13**	**66**	**122**	**275**	**13**
Sodium	7440-23-5	1	mg/L	**220**	**350**	**862**	**956**	**79**
Potassium	7440-09-7	1	mg/L	<1	**8**	**7**	**6**	**4**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	<0.001	**0.017**	**0.074**	**0.004**	**0.001**
Boron	7440-42-8	0.05	mg/L	**0.05**	**0.13**	**0.16**	**0.12**	**0.05**
Barium	7440-39-3	0.001	mg/L	**0.010**	**0.237**	**0.068**	**0.047**	**0.077**
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	**0.002**	**0.003**	**0.016**	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	**0.001**	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	**0.188**	**0.253**	**0.499**	**0.429**	<0.001
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.004**	**0.002**	**0.016**	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW17-26-03	GW17-26-11S	GW17-26-11D	GW17-26-09	SW17-26-08
				Client sampling date / time	23-Nov-2017 09:35	23-Nov-2017 10:40	23-Nov-2017 11:00	23-Nov-2017 13:50	23-Nov-2017 15:00
Compound	CAS Number	LOR	Unit		EM1716152-001	EM1716152-002	EM1716152-003	EM1716152-004	EM1716152-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.005**	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.4**	**0.6**	**0.6**	**0.2**	**0.4**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.04**	**0.63**	**0.59**	**0.16**	**0.01**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.01**	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.79**	<0.01	**0.03**	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.80**	<0.01	**0.03**	<0.01	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**14.1**	**30.0**	**64.0**	**92.4**	**6.58**
Total Cations	----	0.01	meq/L		**11.6**	**24.8**	**55.2**	**79.2**	**5.51**
Ionic Balance	----	0.01	%		**9.56**	**9.59**	**7.37**	**7.71**	**8.87**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW17-26-03	GW17-26-11S	GW17-26-11D	GW17-26-09	SW17-26-08
				Client sampling date / time	23-Nov-2017 09:35	23-Nov-2017 10:40	23-Nov-2017 11:00	23-Nov-2017 13:50	23-Nov-2017 15:00
Compound	CAS Number	LOR	Unit		EM1716152-001	EM1716152-002	EM1716152-003	EM1716152-004	EM1716152-005
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	1330-20-7	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		107	104	88.1	104	90.1
Toluene-D8	2037-26-5	2	%		98.0	96.3	75.9	96.8	75.8
4-Bromofluorobenzene	460-00-4	2	%		92.2	105	81.6	108	83.3

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW17-26-11	SW17-26-09	GW17-26-08	SW17-26-Beach1	QA12
			Client sampling date / time	23-Nov-2017 11:20	23-Nov-2017 14:10	23-Nov-2017 14:55	23-Nov-2017 15:50	23-Nov-2017 00:00
Compound	CAS Number	LOR	Unit	EM1716152-006	EM1716152-007	EM1716152-008	EM1716152-009	EM1716152-010
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.57	7.60	5.90	8.00	6.67
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	488	367	27200	55100	7820
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	317	238	17700	35800	5080
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	0.211	0.120	15.9	55.0	3.21
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	61	56	66	121	126
Total Alkalinity as CaCO3	----	1	mg/L	61	56	66	121	126
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	16	13	3820	2740	694
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	116	74	9900	21000	2640
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	15	12	933	352	271
Magnesium	7439-95-4	1	mg/L	8	6	1620	1240	252
Sodium	7440-23-5	1	mg/L	63	45	2780	10100	956
Potassium	7440-09-7	1	mg/L	3	2	26	385	5
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	0.01	1.72	<0.02	<0.01
Arsenic	7440-38-2	0.001	mg/L	0.001	0.001	0.139	0.003	0.004
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	0.18	4.16	0.12
Barium	7440-39-3	0.001	mg/L	0.027	0.044	0.032	0.010	0.048
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	0.009	<0.002	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	0.0008	<0.0002	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	0.859	<0.002	0.016
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	0.002	<0.002	<0.001
Copper	7440-50-8	0.001	mg/L	0.007	<0.001	<0.001	<0.002	<0.001
Manganese	7439-96-5	0.001	mg/L	0.025	0.013	8.37	0.008	0.429
Nickel	7440-02-0	0.001	mg/L	0.001	<0.001	1.54	<0.002	0.016
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	0.002	<0.002	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW17-26-11	SW17-26-09	GW17-26-08	SW17-26-Beach1	QA12
				Client sampling date / time	23-Nov-2017 11:20	23-Nov-2017 14:10	23-Nov-2017 14:55	23-Nov-2017 15:50	23-Nov-2017 00:00
Compound	CAS Number	LOR	Unit		EM1716152-006	EM1716152-007	EM1716152-008	EM1716152-009	EM1716152-010
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.02	<0.01
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.02	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	**0.167**	<0.010	**0.005**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.2**	**0.4**	**1.0**	**0.2**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.02**	**0.02**	**1.90**	**0.05**	**0.17**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	**0.03**	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	**0.01**	<0.01	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.01**	<0.01	<0.01	**0.08**	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**4.82**	**3.48**	**360**	**652**	**91.4**
Total Cations	----	0.01	meq/L		**4.22**	**3.10**	**301**	**569**	**76.0**
Ionic Balance	----	0.01	%		**6.63**	**5.71**	**8.86**	**6.80**	**9.24**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW17-26-11	SW17-26-09	GW17-26-08	SW17-26-Beach1	QA12
				Client sampling date / time	23-Nov-2017 11:20	23-Nov-2017 14:10	23-Nov-2017 14:55	23-Nov-2017 15:50	23-Nov-2017 00:00
Compound	CAS Number	LOR	Unit		EM1716152-006	EM1716152-007	EM1716152-008	EM1716152-009	EM1716152-010
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	1330-20-7	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**95.1**	**101**	**104**	**106**	**96.0**
Toluene-D8	2037-26-5	2	%		**84.5**	**92.2**	**94.1**	**91.1**	**86.5**
4-Bromofluorobenzene	460-00-4	2	%		**82.3**	**99.8**	**105**	**103**	**91.4**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	Trip Blank	----	----	----	----
				Client sampling date / time	[23-Nov-2017]	----	----	----	----
Compound	CAS Number	LOR	Unit		EM1716152-014	--------	--------	--------	--------
					Result	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	----	----	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		<20	----	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	----	----	----	----
Toluene	108-88-3	2	µg/L		<2	----	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	----	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	----	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	----	----	----	----
^ **Total Xylenes**	1330-20-7	2	µg/L		<2	----	----	----	----
^ **Sum of BTEX**	----	1	µg/L		<1	----	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**93.4**	----	----	----	----
Toluene-D8	2037-26-5	2	%		**91.4**	----	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**101**	----	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM1716152**	Page	: 1 of 10
Amendment	: **2**		
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 24-Nov-2017
Site	: ----	Issue Date	: 12-Dec-2017
Sampler	: KELLY-JANE WALLIS	No. of samples received	: 14
Order number	: 187	No. of samples analysed	: 11

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

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

Summary of Outliers

Outliers : Quality Control Samples

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

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

Outliers : Analysis Holding Time Compliance

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

Outliers : Frequency of Quality Control Samples

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

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	EM1716152--001	GW17-26-03	**Sulfate as SO4 - Turbidimetric**	14808-79-8	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Ar	EM1716141--002	Anonymous	**Nitrite + Nitrate as N**	----	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)		Extraction / Preparation: Date extracted	Due for extraction	Days overdue	Analysis: Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural							
GW17-26-03,	GW17-26-11S,	----	----	----	27-Nov-2017	23-Nov-2017	**4**
GW17-26-11D,	GW17-26-09,						
SW17-26-08,	SW17-26-11,						
SW17-26-09,	GW17-26-08,						
SW17-26-Beach1,	QA12						

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count: QC	Count: Regular	Rate (%): Actual	Rate (%): Expected	Quality Control Specification
Laboratory Duplicates (DUP)					
TRH - Semivolatile Fraction	1	12	8.33	10.00	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)					
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	1	17	5.88	10.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

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

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

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

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

Matrix: **WATER**

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

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

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator								
Clear Plastic Bottle - Natural (EA005-P)								
GW17-26-03,	GW17-26-11S,	**23-Nov-2017**	**----**	----	----	**27-Nov-2017**	23-Nov-2017	×
GW17-26-11D,	GW17-26-09,							
SW17-26-08,	SW17-26-11,							
SW17-26-09,	GW17-26-08,							
SW17-26-Beach1,	QA12							
EA010P: Conductivity by PC Titrator								
Clear Plastic Bottle - Natural (EA010-P)								
GW17-26-03,	GW17-26-11S,	**23-Nov-2017**	**----**	----	----	**27-Nov-2017**	21-Dec-2017	✓
GW17-26-11D,	GW17-26-09,							
SW17-26-08,	SW17-26-11,							
SW17-26-09,	GW17-26-08,							
SW17-26-Beach1,	QA12							
ED009: Anions								
Clear Plastic Bottle - Natural (ED009-X)								
GW17-26-03,	GW17-26-11S,	**23-Nov-2017**	**----**	----	----	**28-Nov-2017**	21-Dec-2017	✓
GW17-26-11D,	GW17-26-09,							
SW17-26-08,	SW17-26-11,							
SW17-26-09,	GW17-26-08,							
SW17-26-Beach1,	QA12							
ED037P: Alkalinity by PC Titrator								
Clear Plastic Bottle - Natural (ED037-P)								
GW17-26-03,	GW17-26-11S,	**23-Nov-2017**	**----**	----	----	**27-Nov-2017**	07-Dec-2017	✓
GW17-26-11D,	GW17-26-09,							
SW17-26-08,	SW17-26-11,							
SW17-26-09,	GW17-26-08,							
SW17-26-Beach1,	QA12							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Clear Plastic Bottle - Natural (ED041G)								
GW17-26-03,	GW17-26-11S,	**23-Nov-2017**	**----**	----	----	**27-Nov-2017**	21-Dec-2017	✓
GW17-26-11D,	GW17-26-09,							
SW17-26-08,	SW17-26-11,							
SW17-26-09,	GW17-26-08,							
SW17-26-Beach1,	QA12							
ED045G: Chloride by Discrete Analyser								
Clear Plastic Bottle - Natural (ED045G)								
GW17-26-03,	GW17-26-11S,	**23-Nov-2017**	**----**	----	----	**27-Nov-2017**	21-Dec-2017	✓
GW17-26-11D,	GW17-26-09,							
SW17-26-08,	SW17-26-11,							
SW17-26-09,	GW17-26-08,							
SW17-26-Beach1,	QA12							

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED093F: Dissolved Major Cations								
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)								
GW17-26-03,	GW17-26-11S,	**23-Nov-2017**	**----**	----	----	**27-Nov-2017**	21-Dec-2017	✓
GW17-26-11D,	GW17-26-09,							
SW17-26-08,	SW17-26-11,							
SW17-26-09,	GW17-26-08,							
SW17-26-Beach1,	QA12							
EG020F: Dissolved Metals by ICP-MS								
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)								
GW17-26-03,	GW17-26-11S,	**23-Nov-2017**	**----**	----	----	**27-Nov-2017**	22-May-2018	✓
GW17-26-11D,	GW17-26-09,							
SW17-26-08,	SW17-26-11,							
SW17-26-09,	GW17-26-08,							
SW17-26-Beach1,	QA12							
EG035F: Dissolved Mercury by FIMS								
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)								
GW17-26-03,	GW17-26-11S,	**23-Nov-2017**	**----**	----	----	**27-Nov-2017**	21-Dec-2017	✓
GW17-26-11D,	GW17-26-09,							
SW17-26-08,	SW17-26-11,							
SW17-26-09,	GW17-26-08,							
SW17-26-Beach1,	QA12							
EK040P: Fluoride by PC Titrator								
Clear Plastic Bottle - Natural (EK040P)								
GW17-26-03,	GW17-26-11S,	**23-Nov-2017**	**----**	----	----	**27-Nov-2017**	21-Dec-2017	✓
GW17-26-11D,	GW17-26-09,							
SW17-26-08,	SW17-26-11,							
SW17-26-09,	GW17-26-08,							
SW17-26-Beach1,	QA12							
EK055G: Ammonia as N by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK055G)								
GW17-26-03,	GW17-26-11S,	**23-Nov-2017**	**----**	----	----	**27-Nov-2017**	21-Dec-2017	✓
GW17-26-11D,	GW17-26-09,							
SW17-26-08,	SW17-26-11,							
SW17-26-09,	GW17-26-08,							
SW17-26-Beach1,	QA12							
EK057G: Nitrite as N by Discrete Analyser								
Clear Plastic Bottle - Natural (EK057G)								
GW17-26-03,	GW17-26-11S,	**23-Nov-2017**	**----**	----	----	**24-Nov-2017**	25-Nov-2017	✓
GW17-26-11D,	GW17-26-09,							
SW17-26-08,	SW17-26-11,							
SW17-26-09,	GW17-26-08,							
SW17-26-Beach1,	QA12							

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
GW17-26-03, GW17-26-11S, GW17-26-11D, GW17-26-09, SW17-26-08, SW17-26-11, SW17-26-09, GW17-26-08, SW17-26-Beach1, QA12	**23-Nov-2017**	**----**	----	----	**27-Nov-2017**	21-Dec-2017	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
GW17-26-03, GW17-26-11S, GW17-26-11D, GW17-26-09, SW17-26-08, SW17-26-11, SW17-26-09, GW17-26-08, SW17-26-Beach1, QA12	**23-Nov-2017**	**----**	----	----	**24-Nov-2017**	25-Nov-2017	✓
EP020: Oil and Grease (O&G)							
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020)							
GW17-26-03, GW17-26-11S, GW17-26-11D, GW17-26-09, SW17-26-08, SW17-26-11, SW17-26-09, GW17-26-08, SW17-26-Beach1, QA12	**23-Nov-2017**	**----**	----	----	**29-Nov-2017**	21-Dec-2017	✓
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071)							
GW17-26-03, GW17-26-11S, GW17-26-11D, GW17-26-09, SW17-26-08, SW17-26-11, SW17-26-09, GW17-26-08, SW17-26-Beach1, QA12	**23-Nov-2017**	**27-Nov-2017**	30-Nov-2017	✓	**28-Nov-2017**	06-Jan-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW17-26-03, GW17-26-11S, GW17-26-11D, GW17-26-09, SW17-26-08, SW17-26-11, SW17-26-09, GW17-26-08, SW17-26-Beach1, QA12	**23-Nov-2017**	**24-Nov-2017**	07-Dec-2017	✓	**24-Nov-2017**	07-Dec-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
Trip Blank	**23-Nov-2017**	**27-Nov-2017**	07-Dec-2017	✓	**27-Nov-2017**	07-Dec-2017	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Amber Glass Bottle - Unpreserved (EP071)							
GW17-26-03, GW17-26-11S, GW17-26-11D, GW17-26-09, SW17-26-08, SW17-26-11, SW17-26-09, GW17-26-08, SW17-26-Beach1, QA12	**23-Nov-2017**	**27-Nov-2017**	30-Nov-2017	✓	**28-Nov-2017**	06-Jan-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW17-26-03, GW17-26-11S, GW17-26-11D, GW17-26-09, SW17-26-08, SW17-26-11, SW17-26-09, GW17-26-08, SW17-26-Beach1, QA12	**23-Nov-2017**	**24-Nov-2017**	07-Dec-2017	✓	**24-Nov-2017**	07-Dec-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
Trip Blank	**23-Nov-2017**	**27-Nov-2017**	07-Dec-2017	✓	**27-Nov-2017**	07-Dec-2017	✓
EP080: BTEXN							
Amber VOC Vial - Sulfuric Acid (EP080)							
GW17-26-03, GW17-26-11S, GW17-26-11D, GW17-26-09, SW17-26-08, SW17-26-11, SW17-26-09, GW17-26-08, SW17-26-Beach1, QA12	**23-Nov-2017**	**24-Nov-2017**	07-Dec-2017	✓	**24-Nov-2017**	07-Dec-2017	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
Trip Blank	**23-Nov-2017**	**27-Nov-2017**	07-Dec-2017	✓	**27-Nov-2017**	07-Dec-2017	✓

Quality Control Parameter Frequency Compliance

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

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	4	37	**10.81**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	4	33	**12.12**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	4	30	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	4	25	**16.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	4	37	**10.81**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	12	**8.33**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	3	27	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	33	**6.06**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	30	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	25	**8.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	17	**5.88**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	27	**7.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	2	33	**6.06**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Conductivity by PC Titrator	EA010-P	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	30	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	25	**8.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	27	**7.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	2	33	**6.06**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	30	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	25	**8.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	27	**7.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

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

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Calculated TDS (from Electrical Conductivity)	EA016	WATER	In house: Calculation from Electrical Conductivity (APHA 2510 B) using a conversion factor specified in the analytical report. This method is compliant with NEPM (2013) Schedule B(3)
Standard Anions -by IC (Extended Method)	ED009-X	WATER	In house: Referenced to APHA 4110B. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Oil and Grease	EP020	WATER	In house: Referenced to APHA 5520 B. Oil & grease is a gravimetric procedure to determine the amount of oil & grease residue in an aqueous sample. The sample is serially extracted three times n-hexane. The resultant extracts are combined, dehydrated and concentrated prior to gravimetric determination. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

CHAIN OF CUSTODY

ALS Laboratory: ***please tick →***

☐ **Sydney:** 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ **Newcastle:** 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ **Brisbane:** 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ **Townsville:** 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne:** 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide:** 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth:** 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston:** 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	**TURNAROUND REQUIREMENTS :** Standard (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	**FOR LABORATORY USE ONLY (Circle)**	
OFFICE: Melbourne, Southbank		Custody Seal Intact?	Yes / No / N/A
PROJECT: PS101340	**ALS QUOTE NO.: EN/008/17**	Free ice / frozen ice bricks present upon receipt?	Yes / No / N/A
ORDER NUMBER: 187	**COC SEQUENCE NUMBER (Circle)** COC: (1) 2 3 4 5 6 7	Random Sample Temperature on Receipt:	°C
PROJECT MANAGER: Ray Hatley	**CONTACT PH: 02 92725234** OF: 1 (2) 3 4 5 6 7	Other comment:	
SAMPLER: Kelly-Jane Wallis	**SAMPLER MOBILE: 0447026695**	**RELINQUISHED BY:** KJ Wallis	**RECEIVED BY:**
COC emailed to ALS? (YES / (NO)	**EDD FORMAT (or default):**	DATE/TIME: 24/11/17 12:00	DATE/TIME:
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com, Alistair.Stewart@wsp.com		**RELINQUISHED BY:**	DATE/TIME:
Email Invoice to : au.accountspayable@wsp.com		DATE/TIME:	**RECEIVED BY:** (ALS) DATE/TIME: 24/11 02:20

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION	ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).											Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	IN-1	EA005	NT-1	NT-2A	ED009X	NT-4	EK055	EK071	W-3F, Al(EG020F)	EP020	W-4	
1	GW17-26-03	23/11/17 9:35	W		10	X	X	X	X	X	X	X	X	X	X	X	2 x QA TPH
2	GW17-26-11S	" 10:40	W		8	|	|	|	|	|	|	|	|	|	|	|	
3	GW17-26-11D	" 11:00	W														
4	GW17-26-09	" 1:50	W														
5	GW17-26-08	" 3:00	W														
6	SW17-26-11	" 11:20	W														
7	SW17-26-09	" 2:10	W														
8	SW17-26-08	" 2:55	W														
9	SW17-26-Beach1	" 3:50	W														EC = 55000 uS/cm
10	QA12	23/11/17	W														
11	ID18-GWBH02	24/11/17 11:30	W		8	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
12	ID18-GWBH05	24/11/17 9:50	W		8	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
				TOTAL													

NO2 NP 24/11

Environmental Division
Melbourne
Work Order Reference
EM1716152

Telephone : +61-3-8549 9600

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

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☐ **Launceston:** 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	**TURNAROUND REQUIREMENTS :** Standard (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: Melbourne, Southbank		Custody Seal Intact? Yes No N/A
PROJECT: PS101340	**ALS QUOTE NO.: EN/008/17**	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER: 187	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Ray Hatley	**CONTACT PH: 02 92725234** OF: 1 2 3 4 5 6 7	Other comment:

SAMPLER: Kelly-Jane Wallis	**SAMPLER MOBILE: 0447026695**	**RELINQUISHED BY:** KJ Wallis	**RECEIVED BY:**	**RELINQUISHED BY:**
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**	DATE/TIME: 24/11/17 12:20	DATE/TIME:	DATE/TIME:
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com, Alistair.Stewart@wsp.com				
Email Invoice to : au.accountspayable@wsp.com				

| | | | |

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1803640**	Page	: 1 of 14
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Contact	: Graeme Jablonskas
Address	: Level 15, 28 Freshwater Place SOUTHBANK VIC, AUSTRALIA 3006	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 03 9861 1111	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 26-Feb-2018 16:20
Order number	: 325	Date Analysis Commenced	: 26-Feb-2018
C-O-C number	: ----	Issue Date	: 05-Mar-2018 16:19
Sampler	: ALISTAIR STEWART		
Site	: ----		
Quote number	: EN/008/17		
No. of samples received	: 11		
No. of samples analysed	: 11		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Nancy Wang	2IC Organic Chemist	Melbourne Organics, Springvale, VIC
Nikki Stepniewski	Senior Inorganic Instrument Chemist	Melbourne Inorganics, Springvale, VIC
Xing Lin	Senior Organic Chemist	Melbourne Organics, Springvale, VIC

General Comments

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

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

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

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

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

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

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

- Ionic Balance out of acceptable limits for sample #6 and #8 due to analytes not quantified in this report.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- ED041G: EM1803272-002 Poor matrix spike recovery for sulfate due to sample matrix. Confirmed by re-extraction and re-analysis.
- EK071G: EM1803631-002 Poor matrix spike recovery for reactive phosphorus due to sample matrix. Confirmed by re-extraction and re-analysis.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.
- Benzo(a)pyrene Toxicity Equivalent Quotient (TEQ) is the sum total of the concentration of the eight carcinogenic PAHs multiplied by their Toxicity Equivalence Factor (TEF) relative to Benzo(a)pyrene. TEF values are provided in brackets as follows: Benz(a)anthracene (0.1), Chrysene (0.01), Benzo(b+j) & Benzo(k)fluoranthene (0.1), Benzo(a)pyrene (1.0), Indeno(1.2.3.cd)pyrene (0.1), Dibenz(a.h)anthracene (1.0), Benzo(g.h.i)perylene (0.01). Less than LOR results for 'TEQ Zero' are treated as zero.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW17-26-01E	SW17-26-11	SW17-26-6	SW17-26-7	SW17-26-8
			Client sampling date / time	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00
Compound	CAS Number	LOR	Unit	EM1803640-001	EM1803640-002	EM1803640-003	EM1803640-004	EM1803640-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.69	7.60	7.71	7.79	7.68
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	1030	365	503	507	490
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	670	237	327	330	318
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	1.41	0.169	0.257	0.250	0.249
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	210	66	82	84	80
Total Alkalinity as CaCO3	----	1	mg/L	210	66	82	84	80
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	19	17	16	10	17
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	239	63	105	104	101
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	34	12	14	14	13
Magnesium	7439-95-4	1	mg/L	23	6	10	10	10
Sodium	7440-23-5	1	mg/L	134	45	66	65	64
Potassium	7440-09-7	1	mg/L	26	6	4	4	5
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	0.002	0.001	0.002	0.004	0.002
Boron	7440-42-8	0.05	mg/L	0.20	<0.05	<0.05	<0.05	<0.05
Barium	7440-39-3	0.001	mg/L	0.065	0.026	0.082	0.073	0.080
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.004	0.004	<0.001	<0.001	0.004
Manganese	7439-96-5	0.001	mg/L	0.065	0.011	0.001	<0.001	0.002
Nickel	7440-02-0	0.001	mg/L	0.003	0.001	<0.001	<0.001	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW17-26-01E	SW17-26-11	SW17-26-6	SW17-26-7	SW17-26-8
				Client sampling date / time	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803640-001	EM1803640-002	EM1803640-003	EM1803640-004	EM1803640-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.009**	**0.008**	<0.005	<0.005	**0.008**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.15**	**0.08**	<0.01	<0.01	<0.01
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.17**	<0.01	**0.01**	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.17**	<0.01	**0.01**	<0.01	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.02**	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**11.3**	**3.45**	**4.93**	**4.82**	**4.80**
Total Cations	----	0.01	meq/L		**10.1**	**3.20**	**4.49**	**4.45**	**4.38**
Ionic Balance	----	0.01	%		**5.84**	**3.70**	**4.65**	**3.98**	**4.55**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		**7**	**7**	<5	<5	<5
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		**380**	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		**180**	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		**560**	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW17-26-01E	SW17-26-11	SW17-26-6	SW17-26-7	SW17-26-8
				Client sampling date / time	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803640-001	EM1803640-002	EM1803640-003	EM1803640-004	EM1803640-005
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		**500**	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		**500**	<100	<100	<100	<100
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**98.2**	**94.8**	**95.4**	**93.7**	**97.9**
Toluene-D8	2037-26-5	2	%		**87.7**	**84.8**	**83.4**	**80.5**	**86.1**
4-Bromofluorobenzene	460-00-4	2	%		**97.3**	**95.5**	**95.4**	**91.9**	**95.8**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW17-26-9	SW17-26-10	SW18-26-4	SW18-26-16	Trip blank
			Client sampling date / time	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00
Compound	CAS Number	LOR	Unit	EM1803640-006	EM1803640-007	EM1803640-008	EM1803640-009	EM1803640-010
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.40**	**7.86**	**7.52**	**7.46**	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**252**	**359**	**364**	**410**	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	**164**	**233**	**237**	**266**	----
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	**0.107**	**0.170**	**0.162**	**0.284**	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**58**	**62**	**94**	**112**	----
Total Alkalinity as CaCO3	----	1	mg/L	**58**	**62**	**94**	**112**	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**10**	**20**	**5**	<1	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**42**	**58**	**56**	**66**	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**8**	**11**	**18**	**14**	----
Magnesium	7439-95-4	1	mg/L	**4**	**6**	**6**	**6**	----
Sodium	7440-23-5	1	mg/L	**32**	**44**	**40**	**55**	----
Potassium	7440-09-7	1	mg/L	**5**	**6**	**2**	**14**	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.09**	**0.01**	<0.01	<0.01	----
Arsenic	7440-38-2	0.001	mg/L	**0.001**	**0.001**	**0.002**	**0.005**	----
Boron	7440-42-8	0.05	mg/L	<0.05	<0.05	<0.05	<0.05	----
Barium	7440-39-3	0.001	mg/L	**0.032**	**0.023**	**0.045**	**0.017**	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----
Copper	7440-50-8	0.001	mg/L	<0.001	**0.004**	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L	**0.011**	**0.003**	**0.020**	**0.191**	----
Nickel	7440-02-0	0.001	mg/L	<0.001	**0.001**	<0.001	**0.002**	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW17-26-9	SW17-26-10	SW18-26-4	SW18-26-16	Trip blank
				Client sampling date / time	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803640-006	EM1803640-007	EM1803640-008	EM1803640-009	EM1803640-010
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.006**	<0.005	<0.005	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EG050F: Dissolved Hexavalent Chromium									
Hexavalent Chromium	18540-29-9	0.01	mg/L		----	----	<0.01	<0.01	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.2**	**0.2**	**0.2**	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.04**	<0.01	**0.01**	**0.04**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.04**	<0.01	**0.01**	**0.04**	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.04**	<0.01	<0.01	**0.33**	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**2.55**	**3.29**	**3.56**	**4.10**	----
Total Cations	----	0.01	meq/L		**2.25**	**3.11**	**3.18**	**3.94**	----
Ionic Balance	----	0.01	%		**6.32**	**2.83**	**5.62**	**1.95**	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	**5**	<5	----
EP066: Polychlorinated Biphenyls (PCB)									
Total Polychlorinated biphenyls	----	1	µg/L		----	----	<1	<1	----
EP068B: Organophosphorus Pesticides (OP)									
Dichlorvos	62-73-7	0.5	µg/L		----	----	<0.5	<0.5	----
Demeton-S-methyl	919-86-8	0.5	µg/L		----	----	<0.5	<0.5	----
Monocrotophos	6923-22-4	2.0	µg/L		----	----	<2.0	<2.0	----
Dimethoate	60-51-5	0.5	µg/L		----	----	<0.5	<0.5	----
Diazinon	333-41-5	0.5	µg/L		----	----	<0.5	<0.5	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW17-26-9	SW17-26-10	SW18-26-4	SW18-26-16	Trip blank
				Client sampling date / time	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803640-006	EM1803640-007	EM1803640-008	EM1803640-009	EM1803640-010
					Result	Result	Result	Result	Result
EP068B: Organophosphorus Pesticides (OP) - Continued									
Chlorpyrifos-methyl	5598-13-0	0.5	µg/L		----	----	<0.5	<0.5	----
Parathion-methyl	298-00-0	2.0	µg/L		----	----	<2.0	<2.0	----
Malathion	121-75-5	0.5	µg/L		----	----	<0.5	<0.5	----
Fenthion	55-38-9	0.5	µg/L		----	----	<0.5	<0.5	----
Chlorpyrifos	2921-88-2	0.5	µg/L		----	----	<0.5	<0.5	----
Parathion	56-38-2	2.0	µg/L		----	----	<2.0	<2.0	----
Pirimphos-ethyl	23505-41-1	0.5	µg/L		----	----	<0.5	<0.5	----
Chlorfenvinphos	470-90-6	0.5	µg/L		----	----	<0.5	<0.5	----
Bromophos-ethyl	4824-78-6	0.5	µg/L		----	----	<0.5	<0.5	----
Fenamiphos	22224-92-6	0.5	µg/L		----	----	<0.5	<0.5	----
Prothiofos	34643-46-4	0.5	µg/L		----	----	<0.5	<0.5	----
Ethion	563-12-2	0.5	µg/L		----	----	<0.5	<0.5	----
Carbophenothion	786-19-6	0.5	µg/L		----	----	<0.5	<0.5	----
Azinphos Methyl	86-50-0	0.5	µg/L		----	----	<0.5	<0.5	----
EP068C: Triazines									
Atrazine	1912-24-9	0.5	µg/L		----	----	<0.5	<0.5	----
EP068D: Pyrethroids									
Bifenthrin	82657-04-3	0.5	µg/L		----	----	<0.5	<0.5	----
EP075(SIM)A: Phenolic Compounds									
Phenol	108-95-2	1.0	µg/L		----	----	<1.0	<1.0	----
2-Chlorophenol	95-57-8	1.0	µg/L		----	----	<1.0	<1.0	----
2-Methylphenol	95-48-7	1.0	µg/L		----	----	<1.0	<1.0	----
3- & 4-Methylphenol	1319-77-3	2.0	µg/L		----	----	<2.0	<2.0	----
2-Nitrophenol	88-75-5	1.0	µg/L		----	----	<1.0	<1.0	----
2.4-Dimethylphenol	105-67-9	1.0	µg/L		----	----	<1.0	<1.0	----
2.4-Dichlorophenol	120-83-2	1.0	µg/L		----	----	<1.0	<1.0	----
2.6-Dichlorophenol	87-65-0	1.0	µg/L		----	----	<1.0	<1.0	----
4-Chloro-3-methylphenol	59-50-7	1.0	µg/L		----	----	<1.0	<1.0	----
2.4.6-Trichlorophenol	88-06-2	1.0	µg/L		----	----	<1.0	<1.0	----
2.4.5-Trichlorophenol	95-95-4	1.0	µg/L		----	----	<1.0	<1.0	----
Pentachlorophenol	87-86-5	2.0	µg/L		----	----	<2.0	<2.0	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		----	----	<1.0	<1.0	----
Acenaphthylene	208-96-8	1.0	µg/L		----	----	<1.0	<1.0	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW17-26-9	SW17-26-10	SW18-26-4	SW18-26-16	Trip blank
				Client sampling date / time	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803640-006	EM1803640-007	EM1803640-008	EM1803640-009	EM1803640-010
					Result	Result	Result	Result	Result
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons - Continued									
Acenaphthene	83-32-9	1.0	µg/L		----	----	<1.0	<1.0	----
Fluorene	86-73-7	1.0	µg/L		----	----	<1.0	<1.0	----
Phenanthrene	85-01-8	1.0	µg/L		----	----	<1.0	<1.0	----
Anthracene	120-12-7	1.0	µg/L		----	----	<1.0	<1.0	----
Fluoranthene	206-44-0	1.0	µg/L		----	----	<1.0	<1.0	----
Pyrene	129-00-0	1.0	µg/L		----	----	<1.0	<1.0	----
Benz(a)anthracene	56-55-3	1.0	µg/L		----	----	<1.0	<1.0	----
Chrysene	218-01-9	1.0	µg/L		----	----	<1.0	<1.0	----
Benzo(b+j)fluoranthene	205-99-2 205-82-3	1.0	µg/L		----	----	<1.0	<1.0	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		----	----	<1.0	<1.0	----
Benzo(a)pyrene	50-32-8	0.5	µg/L		----	----	<0.5	<0.5	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		----	----	<1.0	<1.0	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		----	----	<1.0	<1.0	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		----	----	<1.0	<1.0	----
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L		----	----	<0.5	<0.5	----
^ Benzo(a)pyrene TEQ (zero)	----	0.5	µg/L		----	----	<0.5	<0.5	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	**310**	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	**230**	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	**540**	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	**490**	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	**490**	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW17-26-9	SW17-26-10	SW18-26-4	SW18-26-16	Trip blank
				Client sampling date / time	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00	26-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803640-006	EM1803640-007	EM1803640-008	EM1803640-009	EM1803640-010
					Result	Result	Result	Result	Result
EP080: BTEXN - Continued									
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP066S: PCB Surrogate									
Decachlorobiphenyl	2051-24-3	1	%		----	----	110	107	----
EP068S: Organochlorine Pesticide Surrogate									
Dibromo-DDE	21655-73-2	0.5	%		----	----	107	92.8	----
EP068T: Organophosphorus Pesticide Surrogate									
DEF	78-48-8	0.5	%		----	----	109	112	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	1.0	%		----	----	36.5	33.0	----
2-Chlorophenol-D4	93951-73-6	1.0	%		----	----	83.2	73.1	----
2.4.6-Tribromophenol	118-79-6	1.0	%		----	----	107	99.3	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	1.0	%		----	----	101	84.0	----
Anthracene-d10	1719-06-8	1.0	%		----	----	99.6	96.5	----
4-Terphenyl-d14	1718-51-0	1.0	%		----	----	109	104	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		99.0	97.5	92.9	98.7	97.4
Toluene-D8	2037-26-5	2	%		93.0	87.4	82.9	88.3	90.0
4-Bromofluorobenzene	460-00-4	2	%		98.6	93.4	92.1	95.4	97.3

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW18-26-18	----	----	----	----
			Client sampling date / time	26-Feb-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit	EM1803640-011	--------	--------	--------	--------
				Result	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.41**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**305**	----	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	**198**	----	----	----	----
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	**0.140**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**56**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**56**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**18**	----	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**50**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**10**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**5**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**39**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**5**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	<0.001	----	----	----	----
Boron	7440-42-8	0.05	mg/L	<0.05	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.032**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.001**	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.015**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.001**	----	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW18-26-18	----	----	----	----
				Client sampling date / time	26-Feb-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM1803640-011	--------	--------	--------	--------
					Result	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	----	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	----	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.15**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.06**	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.06**	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	----	----	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**2.90**	----	----	----	----
Total Cations	----	0.01	meq/L		**2.73**	----	----	----	----
Ionic Balance	----	0.01	%		**3.00**	----	----	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	----	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	----	----	----	----
C10 - C14 Fraction	----	50	µg/L		<50	----	----	----	----
C15 - C28 Fraction	----	100	µg/L		<100	----	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	----	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	----	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW18-26-18	----	----	----	----
				Client sampling date / time	26-Feb-2018 00:00	----	----	----	----
Compound	CAS Number	LOR	Unit		EM1803640-011	--------	--------	--------	--------
					Result	----	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	----	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	----	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	----	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	----	----	----	----
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	----	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	----	----	----	----
Toluene	108-88-3	2	µg/L		<2	----	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	----	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	----	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	----	----	----	----
^ **Total Xylenes**	----	2	µg/L		<2	----	----	----	----
^ **Sum of BTEX**	----	1	µg/L		<1	----	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	----	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**99.2**	----	----	----	----
Toluene-D8	2037-26-5	2	%		**96.1**	----	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**104**	----	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP066S: PCB Surrogate			
Decachlorobiphenyl	2051-24-3	41	125
EP068S: Organochlorine Pesticide Surrogate			
Dibromo-DDE	21655-73-2	49	117
EP068T: Organophosphorus Pesticide Surrogate			
DEF	78-48-8	51	127
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10	46
2-Chlorophenol-D4	93951-73-6	23	104
2.4.6-Tribromophenol	118-79-6	28	130
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	36	114
Anthracene-d10	1719-06-8	51	119
4-Terphenyl-d14	1718-51-0	49	127
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM1803640**	Page	: 1 of 13
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 26-Feb-2018
Site	: ----	Issue Date	: 05-Mar-2018
Sampler	: ALISTAIR STEWART	No. of samples received	: 11
Order number	: 325	No. of samples analysed	: 11

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

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

Summary of Outliers

Outliers : Quality Control Samples

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

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

Outliers : Analysis Holding Time Compliance

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

Outliers : Frequency of Quality Control Samples

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

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED009: Anions	EM1803640--001	SW17-26-01E	**Bromide**	24959-67-9	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	EM1803272--002	Anonymous	**Sulfate as SO4 - Turbidimetric**	14808-79-8	26.9 %	70-130%	**Recovery less than lower data quality objective**
ED045G: Chloride by Discrete Analyser	EM1803272--002	Anonymous	**Chloride**	16887-00-6	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK071G: Reactive Phosphorus as P by discrete analyse	EM1803631--002	Anonymous	**Reactive Phosphorus as P**	14265-44-2	34.7 %	79-123%	**Recovery less than lower data quality objective**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
TRH - Semivolatile Fraction	1	21	4.76	10.00	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)					
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	2	24	8.33	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
Dissolved Mercury by FIMS	1	21	4.76	5.00	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	0	5	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	0	2	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	0	2	0.00	5.00	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	0	21	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

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

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

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

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

Matrix: **WATER**

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

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

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator								
Clear Plastic Bottle - Natural (EA005-P)								
SW17-26-01E,	SW17-26-11,	**26-Feb-2018**	**----**	----	----	**26-Feb-2018**	26-Feb-2018	✓
SW17-26-6,	SW17-26-7,							
SW17-26-8,	SW17-26-9,							
SW17-26-10,	SW18-26-4,							
SW18-26-16,	SW18-26-18							
EA010P: Conductivity by PC Titrator								
Clear Plastic Bottle - Natural (EA010-P)								
SW17-26-01E,	SW17-26-11,	**26-Feb-2018**	**----**	----	----	**28-Feb-2018**	26-Mar-2018	✓
SW17-26-6,	SW17-26-7,							
SW17-26-8,	SW17-26-9,							
SW17-26-10,	SW18-26-4,							
SW18-26-16,	SW18-26-18							
ED009: Anions								
Clear Plastic Bottle - Natural (ED009-X)								
SW17-26-01E,	SW17-26-11,	**26-Feb-2018**	**----**	----	----	**01-Mar-2018**	26-Mar-2018	✓
SW17-26-6,	SW17-26-7,							
SW17-26-8,	SW17-26-9,							
SW17-26-10,	SW18-26-4,							
SW18-26-16,	SW18-26-18							
ED037P: Alkalinity by PC Titrator								
Clear Plastic Bottle - Natural (ED037-P)								
SW17-26-01E,	SW17-26-11,	**26-Feb-2018**	**----**	----	----	**28-Feb-2018**	12-Mar-2018	✓
SW17-26-6,	SW17-26-7,							
SW17-26-8,	SW17-26-9,							
SW17-26-10,	SW18-26-4,							
SW18-26-16,	SW18-26-18							
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Clear Plastic Bottle - Natural (ED041G)								
SW17-26-01E,	SW17-26-11,	**26-Feb-2018**	**----**	----	----	**27-Feb-2018**	26-Mar-2018	✓
SW17-26-6,	SW17-26-7,							
SW17-26-8,	SW17-26-9,							
SW17-26-10,	SW18-26-4,							
SW18-26-16,	SW18-26-18							
ED045G: Chloride by Discrete Analyser								
Clear Plastic Bottle - Natural (ED045G)								
SW17-26-01E,	SW17-26-11,	**26-Feb-2018**	**----**	----	----	**27-Feb-2018**	26-Mar-2018	✓
SW17-26-6,	SW17-26-7,							
SW17-26-8,	SW17-26-9,							
SW17-26-10,	SW18-26-4,							
SW18-26-16,	SW18-26-18							

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED093F: Dissolved Major Cations								
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)								
SW17-26-01E,	SW17-26-11,	**26-Feb-2018**	**----**	----	----	**27-Feb-2018**	26-Mar-2018	✓
SW17-26-6,	SW17-26-7,							
SW17-26-8,	SW17-26-9,							
SW17-26-10,	SW18-26-4,							
SW18-26-16,	SW18-26-18							
EG020F: Dissolved Metals by ICP-MS								
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)								
SW17-26-01E,	SW17-26-11,	**26-Feb-2018**	**----**	----	----	**27-Feb-2018**	25-Aug-2018	✓
SW17-26-6,	SW17-26-7,							
SW17-26-8,	SW17-26-9,							
SW17-26-10,	SW18-26-4,							
SW18-26-16,	SW18-26-18							
EG035F: Dissolved Mercury by FIMS								
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)								
SW17-26-01E,	SW17-26-11,	**26-Feb-2018**	**----**	----	----	**28-Feb-2018**	26-Mar-2018	✓
SW17-26-6,	SW17-26-7,							
SW17-26-8,	SW17-26-9,							
SW17-26-10,	SW18-26-4,							
SW18-26-16,	SW18-26-18							
EG050F: Dissolved Hexavalent Chromium								
Clear Plastic Bottle - NaOH Filtered (EG050F)								
SW18-26-4,	SW18-26-16	**26-Feb-2018**	**----**	----	----	**02-Mar-2018**	26-Mar-2018	✓
EK040P: Fluoride by PC Titrator								
Clear Plastic Bottle - Natural (EK040P)								
SW17-26-01E,	SW17-26-11,	**26-Feb-2018**	**----**	----	----	**28-Feb-2018**	26-Mar-2018	✓
SW17-26-6,	SW17-26-7,							
SW17-26-8,	SW17-26-9,							
SW17-26-10,	SW18-26-4,							
SW18-26-16,	SW18-26-18							
EK055G: Ammonia as N by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK055G)								
SW17-26-01E,	SW17-26-11,	**26-Feb-2018**	**----**	----	----	**28-Feb-2018**	26-Mar-2018	✓
SW17-26-6,	SW17-26-7,							
SW17-26-8,	SW17-26-9,							
SW17-26-10,	SW18-26-4,							
SW18-26-16,	SW18-26-18							

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK057G: Nitrite as N by Discrete Analyser								
Clear Plastic Bottle - Natural (EK057G)								
SW17-26-01E,	SW17-26-11,	**26-Feb-2018**	**----**	----	----	**27-Feb-2018**	28-Feb-2018	✓
SW17-26-6,	SW17-26-7,							
SW17-26-8,	SW17-26-9,							
SW17-26-10,	SW18-26-4,							
SW18-26-16,	SW18-26-18							
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK059G)								
SW17-26-01E,	SW17-26-11,	**26-Feb-2018**	**----**	----	----	**28-Feb-2018**	26-Mar-2018	✓
SW17-26-6,	SW17-26-7,							
SW17-26-8,	SW17-26-9,							
SW17-26-10,	SW18-26-4,							
SW18-26-16,	SW18-26-18							
EK071G: Reactive Phosphorus as P by discrete analyser								
Clear Plastic Bottle - Natural (EK071G)								
SW17-26-01E,	SW17-26-11,	**26-Feb-2018**	**----**	----	----	**27-Feb-2018**	28-Feb-2018	✓
SW17-26-6,	SW17-26-7,							
SW17-26-8,	SW17-26-9,							
SW17-26-10,	SW18-26-4,							
SW18-26-16,	SW18-26-18							
EP020: Oil and Grease (O&G)								
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020)								
SW17-26-01E,	SW17-26-11,	**26-Feb-2018**	**----**	----	----	**02-Mar-2018**	26-Mar-2018	✓
SW17-26-6,	SW17-26-7,							
SW17-26-8,	SW17-26-9,							
SW17-26-10,	SW18-26-4,							
SW18-26-16,	SW18-26-18							
EP066: Polychlorinated Biphenyls (PCB)								
Amber Glass Bottle - Unpreserved (EP066)								
SW18-26-4,	SW18-26-16	**26-Feb-2018**	**27-Feb-2018**	05-Mar-2018	✓	**05-Mar-2018**	08-Apr-2018	✓
EP068B: Organophosphorus Pesticides (OP)								
Amber Glass Bottle - Unpreserved (EP068)								
SW18-26-4,	SW18-26-16	**26-Feb-2018**	**27-Feb-2018**	05-Mar-2018	✓	**05-Mar-2018**	08-Apr-2018	✓
EP068C: Triazines								
Amber Glass Bottle - Unpreserved (EP068)								
SW18-26-4,	SW18-26-16	**26-Feb-2018**	**27-Feb-2018**	05-Mar-2018	✓	**05-Mar-2018**	08-Apr-2018	✓
EP068D: Pyrethroids								
Amber Glass Bottle - Unpreserved (EP068)								
SW18-26-4,	SW18-26-16	**26-Feb-2018**	**27-Feb-2018**	05-Mar-2018	✓	**05-Mar-2018**	08-Apr-2018	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP075(SIM)A: Phenolic Compounds							
Amber Glass Bottle - Unpreserved (EP075(SIM))							
SW18-26-4, SW18-26-16	**26-Feb-2018**	**27-Feb-2018**	05-Mar-2018	✓	**05-Mar-2018**	08-Apr-2018	✓
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP075(SIM))							
SW18-26-4, SW18-26-16	**26-Feb-2018**	**27-Feb-2018**	05-Mar-2018	✓	**05-Mar-2018**	08-Apr-2018	✓
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071)							
SW17-26-11, SW17-26-6, SW17-26-7, SW17-26-8, SW17-26-9, SW17-26-10, SW18-26-4, SW18-26-16, SW18-26-18	**26-Feb-2018**	**27-Feb-2018**	05-Mar-2018	✓	**28-Feb-2018**	08-Apr-2018	✓
Amber Glass Bottle - Unpreserved (EP071)							
SW17-26-01E	**26-Feb-2018**	**28-Feb-2018**	05-Mar-2018	✓	**01-Mar-2018**	09-Apr-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
SW17-26-01E, SW17-26-11, SW17-26-6, SW17-26-7, SW17-26-8, SW17-26-9, SW17-26-10, SW18-26-4, SW18-26-16, Trip blank, SW18-26-18	**26-Feb-2018**	**27-Feb-2018**	12-Mar-2018	✓	**27-Feb-2018**	12-Mar-2018	✓
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Amber Glass Bottle - Unpreserved (EP071)							
SW17-26-11, SW17-26-6, SW17-26-7, SW17-26-8, SW17-26-9, SW17-26-10, SW18-26-4, SW18-26-16, SW18-26-18	**26-Feb-2018**	**27-Feb-2018**	05-Mar-2018	✓	**28-Feb-2018**	08-Apr-2018	✓
Amber Glass Bottle - Unpreserved (EP071)							
SW17-26-01E	**26-Feb-2018**	**28-Feb-2018**	05-Mar-2018	✓	**01-Mar-2018**	09-Apr-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
SW17-26-01E, SW17-26-11, SW17-26-6, SW17-26-7, SW17-26-8, SW17-26-9, SW17-26-10, SW18-26-4, SW18-26-16, Trip blank, SW18-26-18	**26-Feb-2018**	**27-Feb-2018**	12-Mar-2018	✓	**27-Feb-2018**	12-Mar-2018	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080: BTEXN							
Amber VOC Vial - Sulfuric Acid (EP080)							
SW17-26-01E, SW17-26-11, SW17-26-6, SW17-26-7, SW17-26-8, SW17-26-9, SW17-26-10, SW18-26-4, SW18-26-16, Trip blank, SW18-26-18	**26-Feb-2018**	**27-Feb-2018**	12-Mar-2018	✓	**27-Feb-2018**	12-Mar-2018	✓

Quality Control Parameter Frequency Compliance

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

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	4	38	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	3	22	**13.64**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	3	21	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	3	23	**13.04**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium - Dissolved	EG050F	1	5	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	4	32	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	3	23	**13.04**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	5	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	EP066	1	2	**50.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	21	**4.76**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	38	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	4	22	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	23	**8.70**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium - Dissolved	EG050F	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	32	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	23	**8.70**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	EP066	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Control Samples (LCS) - Continued							
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	24	**8.33**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	2	38	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	23	**8.70**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium - Dissolved	EG050F	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	32	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	23	**8.70**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	EP066	1	2	**50.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	2	38	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	22	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	21	**4.76**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	23	**8.70**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Hexavalent Chromium - Dissolved	EG050F	1	5	**20.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	32	**6.25**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	23	**8.70**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	0	5	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Pesticides by GCMS	EP068	0	2	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Polychlorinated Biphenyls (PCB)	EP066	0	2	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Matrix Spikes (MS) - Continued							
TRH - Semivolatile Fraction	EP071	0	21	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

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

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Calculated TDS (from Electrical Conductivity)	EA016	WATER	In house: Calculation from Electrical Conductivity (APHA 2510 B) using a conversion factor specified in the analytical report. This method is compliant with NEPM (2013) Schedule B(3)
Standard Anions -by IC (Extended Method)	ED009-X	WATER	In house: Referenced to APHA 4110B. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Hexavalent Chromium - Dissolved	EG050F	WATER	In house: Referenced to APHA 3500 Cr-B. Samples are 0.45µm filtered prior to analysis. Hexavalent chromium is determined on filtered water sample as received by pH adjustment and colour development using dephenylcarbazide. Each run of samples is measured against a five-point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Oil and Grease	EP020	WATER	In house: Referenced to APHA 5520 B. Oil & grease is a gravimetric procedure to determine the amount of oil & grease residue in an aqueous sample. The sample is serially extracted three times n-hexane. The resultant extracts are combined, dehydrated and concentrated prior to gravimetric determination. This method is compliant with NEPM (2013) Schedule B(3)
Polychlorinated Biphenyls (PCB)	EP066	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Pesticides by GCMS	EP068	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
PAH/Phenols (GC/MS - SIM)	EP075(SIM)	WATER	In house: Referenced to USEPA SW 846 - 8270D Sample extracts are analysed by Capillary GC/MS in SIM Mode and quantification is by comparison against an established 5 point calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ Sydney: 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ Newcastle: 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ Brisbane: 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ Townsville: 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ Melbourne: 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ Adelaide: 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ Perth: 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ Launceston: 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	TURNAROUND REQUIREMENTS : Standard (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	FOR LABORATORY USE ONLY (Circle): Custody Seal Intact? Yes No N/A; Free Ice / Frozen Ice bricks present upon receipt? Yes No N/A; Random Sample Temperature on Receipt: °C; Other comment:
OFFICE: Melbourne, Southbank		
PROJECT: PS101340	ALS QUOTE NO.: EN/008/17	COC SEQUENCE NUMBER (Circle): COC: (1) 2 3 4 5 6 7; OF: (1) 2 3 4 5 6 7
ORDER NUMBER: 325		
PROJECT MANAGER: Ray Hatley	CONTACT PH: 02 92725234	
SAMPLER: Alistair Stewart	SAMPLER MOBILE: 030537888	RELINQUISHED BY: Alistair Stewart; DATE/TIME: 4:20
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	RECEIVED BY: [illegible]; DATE/TIME: 26/2/16 4:20
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com, Alistair.Stewart@wsp.com		RELINQUISHED BY: ; DATE/TIME:
Email Invoice to : au.accountspayable@wsp.com		RECEIVED BY: ; DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS (MATRIX: Solid(S) Water(W))			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price). Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).											Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	IN-1	EA005	NT-1	NT-2A	ED009X	NT-4	EK055	EK071	W-3F, Al(EG020F)	EP020	W-4	
1	SW17-26-01E	26/2/16	W	P, AG, VOA, N	9	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	NP 26/2
2	SW17-26-11			SP,	9												
3	SW17-26-6				9												
4	SW17-26-7				9												
5	SW17-26-8				9												
6	SW17-26-9				9												
7	SW17-26-10				9												
8	SW18-26-4			+SH	11												
9	SW18-26-16			+SH	11												
10	Trip Blank				2												
11	SW18-26-18				11	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
				TOTAL													

Environmental Division Melbourne
Work Order Reference
EM1803640

Telephone : +61-3-8549 9600

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1803701**	Page	: 1 of 12
Amendment	: **1**		
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Contact	: Graeme Jablonskas
Address	: Level 15, 28 Freshwater Place SOUTHBANK VIC, AUSTRALIA 3006	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 03 9861 1111	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 27-Feb-2018 16:30
Order number	: 325	Date Analysis Commenced	: 28-Feb-2018
C-O-C number	: ----	Issue Date	: 12-Apr-2018 08:58
Sampler	: ALISTAIR STEWART		
Site	: ----		
Quote number	: EN/008/17		
No. of samples received	: 15		
No. of samples analysed	: 14		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Herman Lin	Laboratory Manager	Melbourne Inorganics, Springvale, VIC
Nancy Wang	2IC Organic Chemist	Melbourne Organics, Springvale, VIC
Nikki Stepniewski	Senior Inorganic Instrument Chemist	Melbourne Inorganics, Springvale, VIC

General Comments

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

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

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

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

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

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

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

- EA010: EM1803701-004, 006, 012, 014 samples have been reanalysed to confirm high conductivity results.
- EG020F: EM1803701-006 required dilution prior to dissolved metals analysis due to sample matrix interference. LOR values have been adjusted accordingly
- EP071: EM1803701_3 extracted after remove floating plant.
- Amendment (11/4/2018): This report has been amended as a result of a request to remove samples (ID18-BH15). All other analysis results are as per the previous report.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- ED041G: EM1803701-002 Poor matrix spike recovery for sulfate due to sample matrix. Confirmed by re-extraction and re-analysis.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	SW17-26-03E	SW17-26-14E	SW17-26-12E	SW17-26-04E	SW17-26-13E
			Client sampling date / time	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00
Compound	CAS Number	LOR	Unit	EM1803701-001	EM1803701-002	EM1803701-003	EM1803701-004	EM1803701-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.96	7.72	7.22	8.49	7.91
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	3560	1310	1270	28400	4050
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	2310	852	826	18500	2630
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	2.14	0.664	1.63	20.3	2.36
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	16	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	119	112	213	83	121
Total Alkalinity as CaCO3	----	1	mg/L	119	112	213	99	121
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	660	194	19	6710	782
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	745	245	279	7780	834
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	148	63	37	1120	162
Magnesium	7439-95-4	1	mg/L	94	28	24	1180	107
Sodium	7440-23-5	1	mg/L	410	130	144	4750	465
Potassium	7440-09-7	1	mg/L	26	10	31	147	29
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.02	0.03	0.04	<0.01	0.02
Arsenic	7440-38-2	0.001	mg/L	0.003	0.001	0.003	0.004	0.004
Boron	7440-42-8	0.05	mg/L	0.32	0.17	0.11	2.12	0.30
Barium	7440-39-3	0.001	mg/L	0.082	0.048	0.101	0.104	0.084
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L	0.017	0.084	0.697	0.026	0.070
Nickel	7440-02-0	0.001	mg/L	<0.001	0.001	0.002	0.002	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW17-26-03E	SW17-26-14E	SW17-26-12E	SW17-26-04E	SW17-26-13E
				Client sampling date / time	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803701-001	EM1803701-002	EM1803701-003	EM1803701-004	EM1803701-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	<0.005	<0.005	<0.005	<0.005
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.4**	**0.2**	**0.2**	**0.5**	**0.4**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.03**	**0.02**	**0.06**	**0.05**	**0.05**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	**0.02**	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	**0.02**	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	**0.39**	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**37.1**	**13.2**	**12.5**	**361**	**42.2**
Total Cations	----	0.01	meq/L		**33.6**	**11.4**	**10.9**	**363**	**37.8**
Ionic Balance	----	0.01	%		**4.97**	**7.45**	**7.02**	**0.31**	**5.45**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	**9**	<5	<5
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		**550**	<100	**670**	<100	<100
C29 - C36 Fraction	----	50	µg/L		**250**	<50	**460**	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		**800**	<50	**1130**	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	SW17-26-03E	SW17-26-14E	SW17-26-12E	SW17-26-04E	SW17-26-13E
				Client sampling date / time	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803701-001	EM1803701-002	EM1803701-003	EM1803701-004	EM1803701-005
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		**780**	<100	**1000**	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	**170**	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		**780**	<100	**1170**	<100	<100
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ **Total Xylenes**	----	2	µg/L		<2	<2	<2	<2	<2
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**109**	**109**	**111**	**111**	**100**
Toluene-D8	2037-26-5	2	%		**106**	**107**	**104**	**113**	**99.1**
4-Bromofluorobenzene	460-00-4	2	%		**110**	**106**	**110**	**117**	**103**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	DOGPOND	DUP1	DUP2	GW17-26-14D	GW17-26-14S
			Client sampling date / time	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00
Compound	CAS Number	LOR	Unit	EM1803701-006	EM1803701-007	EM1803701-008	EM1803701-009	EM1803701-010
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.75	8.02	7.16	7.20	7.57
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	91700	4010	4160	4180	4540
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	59600	2610	2700	2720	2950
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	93.0	2.39	2.54	2.53	2.50
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	406	122	341	339	375
Total Alkalinity as CaCO3	----	1	mg/L	406	122	341	339	375
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	15700	709	125	115	149
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	33900	833	1070	1080	1200
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	1210	148	125	123	154
Magnesium	7439-95-4	1	mg/L	4840	101	76	75	119
Sodium	7440-23-5	1	mg/L	20600	523	539	534	529
Potassium	7440-09-7	1	mg/L	560	31	7	7	12
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	0.11	0.02	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	0.018	0.004	0.101	0.101	0.011
Boron	7440-42-8	0.05	mg/L	9.53	0.31	0.19	0.16	0.14
Barium	7440-39-3	0.001	mg/L	0.112	0.085	0.094	0.092	0.782
Beryllium	7440-41-7	0.001	mg/L	<0.005	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0005	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	<0.005	<0.001	0.008	0.007	0.002
Chromium	7440-47-3	0.001	mg/L	0.008	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.005	<0.001	<0.001	<0.001	0.004
Manganese	7439-96-5	0.001	mg/L	0.381	0.072	0.900	0.898	0.248
Nickel	7440-02-0	0.001	mg/L	0.017	<0.001	0.004	0.004	0.002
Lead	7439-92-1	0.001	mg/L	<0.005	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DOGPOND	DUP1	DUP2	GW17-26-14D	GW17-26-14S
				Client sampling date / time	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803701-006	EM1803701-007	EM1803701-008	EM1803701-009	EM1803701-010
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.05	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L		<0.05	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.025	<0.005	<0.005	<0.005	**0.012**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.8**	**0.5**	**0.5**	**0.5**	**0.6**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**1.55**	**0.05**	**0.26**	**0.27**	**0.13**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.01**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.01**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.03**	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**1290**	**40.7**	**39.6**	**39.6**	**44.4**
Total Cations	----	0.01	meq/L		**1370**	**39.2**	**36.1**	**35.7**	**40.8**
Ionic Balance	----	0.01	%		**2.92**	**1.82**	**4.60**	**5.20**	**4.28**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		**480**	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		**70**	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		**550**	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	DOGPOND	DUP1	DUP2	GW17-26-14D	GW17-26-14S
				Client sampling date / time	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803701-006	EM1803701-007	EM1803701-008	EM1803701-009	EM1803701-010
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		**490**	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		**490**	<100	<100	<100	<100
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ **Total Xylenes**	----	2	µg/L		<2	<2	<2	<2	<2
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**120**	**108**	**103**	**107**	**105**
Toluene-D8	2037-26-5	2	%		**111**	**107**	**101**	**104**	**103**
4-Bromofluorobenzene	460-00-4	2	%		**117**	**111**	**106**	**107**	**106**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW17-26-15D	GW18-26-23D	GW18-26-23S	TRIP BLANK	----
			Client sampling date / time	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	----
Compound	CAS Number	LOR	Unit	EM1803701-011	EM1803701-012	EM1803701-013	EM1803701-015	--------
				Result	Result	Result	Result	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**7.07**	**6.34**	**6.26**	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**4350**	**30200**	**1350**	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	**2830**	**19600**	**878**	----	----
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	**3.07**	**33.4**	**0.422**	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**279**	**74**	**47**	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**279**	**74**	**47**	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**109**	**1900**	**292**	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**1160**	**9870**	**218**	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**139**	**725**	**12**	----	----
Magnesium	7439-95-4	1	mg/L	**91**	**548**	**16**	----	----
Sodium	7440-23-5	1	mg/L	**512**	**4980**	**222**	----	----
Potassium	7440-09-7	1	mg/L	**8**	**85**	**15**	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	**0.01**	**1.30**	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.078**	**0.622**	**0.014**	----	----
Boron	7440-42-8	0.05	mg/L	**0.14**	**0.08**	**0.32**	----	----
Barium	7440-39-3	0.001	mg/L	**0.159**	**0.070**	**0.097**	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.008**	**0.002**	**0.003**	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	**0.002**	----	----
Copper	7440-50-8	0.001	mg/L	<0.001	<0.001	**0.003**	----	----
Manganese	7439-96-5	0.001	mg/L	**0.710**	**0.359**	**0.056**	----	----
Nickel	7440-02-0	0.001	mg/L	**0.003**	**0.001**	**0.005**	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	**0.002**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW17-26-15D	GW18-26-23D	GW18-26-23S	TRIP BLANK	----
				Client sampling date / time	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	----
Compound	CAS Number	LOR	Unit		EM1803701-011	EM1803701-012	EM1803701-013	EM1803701-015	--------
					Result	Result	Result	Result	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	**0.02**	----	----
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.010**	**0.014**	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.5**	**0.1**	**0.3**	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.24**	**2.53**	**0.64**	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**40.6**	**319**	**13.2**	----	----
Total Cations	----	0.01	meq/L		**36.9**	**300**	**12.0**	----	----
Ionic Balance	----	0.01	%		**4.73**	**3.13**	**4.82**	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	----	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW17-26-15D	GW18-26-23D	GW18-26-23S	TRIP BLANK	----
				Client sampling date / time	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	27-Feb-2018 00:00	----
Compound	CAS Number	LOR	Unit		EM1803701-011	EM1803701-012	EM1803701-013	EM1803701-015	--------
					Result	Result	Result	Result	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	----
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	----
^ Total Xylenes	----	2	µg/L		<2	<2	<2	<2	----
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	----
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**104**	**111**	**101**	**103**	----
Toluene-D8	2037-26-5	2	%		**98.4**	**106**	**100**	**103**	----
4-Bromofluorobenzene	460-00-4	2	%		**102**	**108**	**101**	**105**	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM1803701**	Page	: 1 of 11
Amendment	: **1**		
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 27-Feb-2018
Site	: ----	Issue Date	: 12-Apr-2018
Sampler	: ALISTAIR STEWART	No. of samples received	: 15
Order number	: 325	No. of samples analysed	: 14

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

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

Summary of Outliers

Outliers : Quality Control Samples

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

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

Outliers : Analysis Holding Time Compliance

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

Outliers : Frequency of Quality Control Samples

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

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED009: Anions	EM1803701--001	SW17-26-03E	**Bromide**	24959-67-9	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	EM1803701--002	SW17-26-14E	**Sulfate as SO4 - Turbidimetric**	14808-79-8	64.7 %	70-130%	**Recovery less than lower data quality objective**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)		Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural							
SW17-26-03E,	SW17-26-14E,	----	----	----	01-Mar-2018	27-Feb-2018	**2**
SW17-26-12E,	SW17-26-04E,						
SW17-26-13E,	DOGPOND,						
DUP1,	DUP2,						
GW17-26-14D,	GW17-26-14S,						
GW17-26-15D,	GW18-26-23D,						
GW18-26-23S							

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
TRH - Semivolatile Fraction	1	14	7.14	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
TRH - Semivolatile Fraction	0	14	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

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

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

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

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

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

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**----**	----	----	**01-Mar-2018**	27-Feb-2018	×
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**----**	----	----	**01-Mar-2018**	27-Mar-2018	✓
ED009: Anions							
Clear Plastic Bottle - Natural (ED009-X)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**----**	----	----	**02-Mar-2018**	27-Mar-2018	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**----**	----	----	**01-Mar-2018**	13-Mar-2018	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**----**	----	----	**28-Feb-2018**	27-Mar-2018	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**----**	----	----	**28-Feb-2018**	27-Mar-2018	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**----**	----	----	**01-Mar-2018**	27-Mar-2018	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**----**	----	----	**28-Feb-2018**	26-Aug-2018	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**----**	----	----	**01-Mar-2018**	27-Mar-2018	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**----**	----	----	**01-Mar-2018**	27-Mar-2018	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**----**	----	----	**02-Mar-2018**	27-Mar-2018	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**----**	----	----	**28-Feb-2018**	01-Mar-2018	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**----**	----	----	**02-Mar-2018**	27-Mar-2018	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**----**	----	----	**28-Feb-2018**	01-Mar-2018	✓
EP020: Oil and Grease (O&G)							
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**----**	----	----	**05-Mar-2018**	27-Mar-2018	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**28-Feb-2018**	06-Mar-2018	✓	**01-Mar-2018**	09-Apr-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S, TRIP BLANK	**27-Feb-2018**	**28-Feb-2018**	13-Mar-2018	✓	**28-Feb-2018**	13-Mar-2018	✓
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Amber Glass Bottle - Unpreserved (EP071)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S	**27-Feb-2018**	**28-Feb-2018**	06-Mar-2018	✓	**01-Mar-2018**	09-Apr-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S, TRIP BLANK	**27-Feb-2018**	**28-Feb-2018**	13-Mar-2018	✓	**28-Feb-2018**	13-Mar-2018	✓
EP080: BTEXN							
Amber VOC Vial - Sulfuric Acid (EP080)							
SW17-26-03E, SW17-26-14E, SW17-26-12E, SW17-26-04E, SW17-26-13E, DOGPOND, DUP1, DUP2, GW17-26-14D, GW17-26-14S, GW17-26-15D, GW18-26-23D, GW18-26-23S, TRIP BLANK	**27-Feb-2018**	**28-Feb-2018**	13-Mar-2018	✓	**28-Feb-2018**	13-Mar-2018	✓

Quality Control Parameter Frequency Compliance

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

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	4	37	**10.81**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	4	37	**10.81**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	4	31	**12.90**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	14	**7.14**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	14	**14.29**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	4	31	**12.90**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Conductivity by PC Titrator	EA010-P	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	31	**6.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	31	**6.45**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	14	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	14	**7.14**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

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

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Calculated TDS (from Electrical Conductivity)	EA016	WATER	In house: Calculation from Electrical Conductivity (APHA 2510 B) using a conversion factor specified in the analytical report. This method is compliant with NEPM (2013) Schedule B(3)
Standard Anions -by IC (Extended Method)	ED009-X	WATER	In house: Referenced to APHA 4110B. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Oil and Grease	EP020	WATER	In house: Referenced to APHA 5520 B. Oil & grease is a gravimetric procedure to determine the amount of oil & grease residue in an aqueous sample. The sample is serially extracted three times n-hexane. The resultant extracts are combined, dehydrated and concentrated prior to gravimetric determination. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ **Sydney:** 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ **Newcastle:** 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ **Brisbane:** 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ **Townsville:** 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne:** 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide:** 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth:** 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston:** 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	TURNAROUND REQUIREMENTS : Standard (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	FOR LABORATORY USE ONLY (Circle): Custody Seal Intact? Yes No N/A; Free ice/ frozen ice bricks present upon receipt? Yes No N/A; Random Sample Temperature on Receipt: °C; Other comment:
OFFICE: Melbourne, Southbank		
PROJECT: PS101340	ALS QUOTE NO.: EN/008/17	COC SEQUENCE NUMBER (Circle): COC: (1) 2 3 4 5 6 7; OF: 1 (2) 3 4 5 6 7
ORDER NUMBER: 325		
PROJECT MANAGER: Ray Hatley	CONTACT PH: 02 92725234	
SAMPLER: Alistair Stewart	SAMPLER MOBILE: ~~0405337888~~ 0430537888	RELINQUISHED BY: 27/2/18 16:30
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	RECEIVED BY:
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com, Alistair.Stewart@wsp.com		DATE/TIME:
Email Invoice to : au.accountspayable@wsp.com		RELINQUISHED BY: DATE/TIME:
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:		RECEIVED BY: Rowena Fung DATE/TIME: 27/2 16:30

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).											Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	IN-1	EA005	NT-1	NT-2A	ED009X	NT- 4	EK055	EK071	W-3F, Al(EG020F)	EP020	W-4	
1	SW17-26-03E	27/2/18	W		8	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
2	SW17-26-14E																
3	SW17-26-12E																
4	SW17-26-04E																
5	SW17-26-13E				9												
6	DOGPOND				8												
7	DUP 1																
8	DUP 2																
9	GW17-26-14D																
10	GW17-26-14S																
11	GW17-26-15D																
12	GW18-26-23D	↓	↓	NP 2ml	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	
				TOTAL													

Environmental Division
Melbourne
Work Order Reference
EM1803701

Telephone : +61-3-8549 9600

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehy
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ **Sydney:** 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
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☐ **Brisbane:** 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ **Townsville:** 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne:** 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide:** 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth:** 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston:** 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	**TURNAROUND REQUIREMENTS :** Standard (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	**FOR LABORATORY USE ONLY (Circle)**
OFFICE: Melbourne, Southbank		Custody Seal Intact? Yes No N/A
PROJECT: PS101340	**ALS QUOTE NO.:** EN/008/17	Free ice / frozen ice bricks present upon receipt? Yes No N/A
ORDER NUMBER: 325	**COC SEQUENCE NUMBER (Circle)** COC: 1 2 3 4 5 6 7	Random Sample Temperature on Receipt: °C
PROJECT MANAGER: Ray Hatley	**CONTACT PH:** 02 92725234 OF: 1 2 3 4 5 6 7	Other comment:
SAMPLER: Alistair Stewart	**SAMPLER MOBILE:** 030537888	**RELINQUISHED BY:** 27/2/18 16:30
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**	**DATE/TIME:**
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com, Alistair.Stewart@wsp.com		**RECEIVED BY:**
Email Invoice to : au.accountspayable@wsp.com		**DATE/TIME:**
		RELINQUISHED BY:
		DATE/TIME:
		RECEIVED BY: [signature]
		DATE/TIME: 28/2 1630

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).											Additional Information		
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	IN-1	EA005	NT-1	NT-2A	ED009X	NT-4	EK055	EK071	W-3F, Al(EG020F)	EP020	W-4			
13	GW18-26-235	27/2/18	W		8	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
14	ID18-BH15	↓	↓		8	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓			
15	TRIP BLANK				2	✓													
				TOTAL															

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1803825**	Page	: 1 of 9
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Contact	: Graeme Jablonskas
Address	: Level 15, 28 Freshwater Place SOUTHBANK VIC, AUSTRALIA 3006	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 03 9861 1111	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 01-Mar-2018 08:15
Order number	: 325	Date Analysis Commenced	: 02-Mar-2018
C-O-C number	: ----	Issue Date	: 08-Mar-2018 11:37
Sampler	: SA		
Site	: ----		
Quote number	: EN/008/17		
No. of samples received	: 10		
No. of samples analysed	: 10		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Xing Lin	Senior Organic Chemist	Melbourne Organics, Springvale, VIC

General Comments

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

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

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

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

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

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

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

- EP080: Particular sample EM1803825_04 shows positive hit for Toluene. Confirmed by re-analysis.
- EG020F: Sample EM1803825-003 has been diluted prior to analysis due to sample matrix and LORs have been raised accordingly.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- ED041G: EM1803825-010 Poor matrix spike recovery for sulfate due to matrix effects. Results have been confirmed by re-preparation and re-analysis.
- ED045G: EM1803825-010 Poor matrix spike recovery for chloride due to sample matrix. Confirmed by re-extraction and re-analysis.
- ED009x: samples required dilution due to sample matrix . LOR values have been adjusted accordingly.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW 17-26-12D	GW 17-26-12S	SW 17-26-15B	GW 18-26-22D	GW 18-26-22S
			Client sampling date / time	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00
Compound	CAS Number	LOR	Unit	EM1803825-001	EM1803825-002	EM1803825-003	EM1803825-004	EM1803825-005
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	7.01	6.29	7.96	7.22	6.41
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	6540	12400	59900	6770	3670
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	4250	8060	38900	4400	2380
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	2.74	2.88	62.8	4.30	2.77
Iodide	20461-54-5	0.010	mg/L	<0.500	<0.500	<2.00	<0.500	<0.200
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	324	152	126	216	81
Total Alkalinity as CaCO3	----	1	mg/L	324	152	126	216	81
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	184	1370	2790	230	365
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	1600	3590	18400	1780	904
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	118	298	455	184	60
Magnesium	7439-95-4	1	mg/L	121	409	1340	109	65
Sodium	7440-23-5	1	mg/L	832	1570	11300	862	503
Potassium	7440-09-7	1	mg/L	9	7	490	11	11
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	0.02	<0.02	<0.01	0.06
Arsenic	7440-38-2	0.001	mg/L	0.163	0.005	0.003	0.022	0.011
Boron	7440-42-8	0.05	mg/L	0.12	0.10	4.45	0.17	0.22
Barium	7440-39-3	0.001	mg/L	0.120	0.136	0.009	0.207	0.072
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.002	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0002	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	0.001	0.004	<0.002	0.001	0.006
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.002	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	0.001	<0.002	<0.001	0.005
Manganese	7439-96-5	0.001	mg/L	0.095	0.166	0.007	0.086	0.195
Nickel	7440-02-0	0.001	mg/L	0.001	0.009	<0.002	0.002	0.008

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW 17-26-12D	GW 17-26-12S	SW 17-26-15B	GW 18-26-22D	GW 18-26-22S
				Client sampling date / time	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803825-001	EM1803825-002	EM1803825-003	EM1803825-004	EM1803825-005
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.002	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.02	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.02	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.005**	**0.006**	<0.010	<0.005	**0.018**
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.1**	**0.8**	**0.3**	**0.3**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.62**	**0.27**	**0.09**	**1.88**	**1.01**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.01**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.01**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	**0.08**	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**55.4**	**133**	**580**	**59.3**	**34.7**
Total Cations	----	0.01	meq/L		**52.3**	**117**	**637**	**55.9**	**30.5**
Ionic Balance	----	0.01	%		**2.94**	**6.34**	**4.72**	**2.94**	**6.46**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW 17-26-12D	GW 17-26-12S	SW 17-26-15B	GW 18-26-22D	GW 18-26-22S
				Client sampling date / time	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803825-001	EM1803825-002	EM1803825-003	EM1803825-004	EM1803825-005
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	**3**	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ **Total Xylenes**	----	2	µg/L		<2	<2	<2	<2	<2
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	**3**	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**104**	**98.3**	**99.7**	**102**	**102**
Toluene-D8	2037-26-5	2	%		**83.6**	**83.4**	**106**	**99.3**	**92.4**
4-Bromofluorobenzene	460-00-4	2	%		**104**	**105**	**112**	**118**	**102**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW 17-26-13D	GW 17-26-13S	GW 17-26-11D	GW 17-26-11S	DUP3
			Client sampling date / time	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00
Compound	CAS Number	LOR	Unit	EM1803825-006	EM1803825-007	EM1803825-008	EM1803825-009	EM1803825-010
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	6.88	6.82	7.26	7.22	7.32
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	4330	4520	5950	2750	6030
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	2810	2940	3870	1790	3920
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	2.94	2.96	3.93	1.61	3.85
Iodide	20461-54-5	0.010	mg/L	<0.200	<0.200	<0.200	<0.100	<0.200
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	296	252	490	405	489
Total Alkalinity as CaCO3	----	1	mg/L	296	252	490	405	489
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	126	128	227	40	203
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	1110	1140	1490	658	1500
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	107	51	156	71	161
Magnesium	7439-95-4	1	mg/L	81	72	122	66	126
Sodium	7440-23-5	1	mg/L	558	640	815	322	831
Potassium	7440-09-7	1	mg/L	6	10	8	8	9
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L	0.264	0.107	0.080	0.009	0.078
Boron	7440-42-8	0.05	mg/L	0.15	0.10	0.16	0.14	0.18
Barium	7440-39-3	0.001	mg/L	0.072	0.404	0.057	0.240	0.057
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	0.005	0.002	0.003	<0.001	0.003
Chromium	7440-47-3	0.001	mg/L	0.001	<0.001	0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	<0.001	0.002	<0.001	0.003	<0.001
Manganese	7439-96-5	0.001	mg/L	0.378	0.040	0.496	0.202	0.497
Nickel	7440-02-0	0.001	mg/L	0.002	0.001	0.002	<0.001	0.002

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW 17-26-13D	GW 17-26-13S	GW 17-26-11D	GW 17-26-11S	DUP3
				Client sampling date / time	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803825-006	EM1803825-007	EM1803825-008	EM1803825-009	EM1803825-010
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		<0.005	**0.008**	<0.005	**0.009**	<0.005
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.3**	**0.5**	**0.5**	**0.5**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.33**	**0.11**	**0.65**	**0.50**	**0.66**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**39.8**	**39.8**	**56.5**	**27.5**	**56.3**
Total Cations	----	0.01	meq/L		**36.4**	**36.6**	**53.5**	**23.2**	**54.8**
Ionic Balance	----	0.01	%		**4.48**	**4.31**	**2.79**	**8.49**	**1.38**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW 17-26-13D	GW 17-26-13S	GW 17-26-11D	GW 17-26-11S	DUP3
				Client sampling date / time	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00	28-Feb-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803825-006	EM1803825-007	EM1803825-008	EM1803825-009	EM1803825-010
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
^ **C6 - C10 Fraction minus BTEX (F1)**	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	<100	<100	<100	<100
^ **>C10 - C16 Fraction minus Naphthalene (F2)**	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ **Total Xylenes**	----	2	µg/L		<2	<2	<2	<2	<2
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**96.6**	**95.4**	**103**	**109**	**104**
Toluene-D8	2037-26-5	2	%		**80.9**	**79.8**	**93.7**	**99.8**	**96.3**
4-Bromofluorobenzene	460-00-4	2	%		**106**	**98.2**	**106**	**118**	**118**

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM1803825**	Page	: 1 of 10
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 01-Mar-2018
Site	: ----	Issue Date	: 08-Mar-2018
Sampler	: SA	No. of samples received	: 10
Order number	: 325	No. of samples analysed	: 10

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

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

Summary of Outliers

Outliers : Quality Control Samples

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

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

Outliers : Analysis Holding Time Compliance

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

Outliers : Frequency of Quality Control Samples

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

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED009: Anions	EM1803825--001	GW 17-26-12D	**Bromide**	24959-67-9	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	EM1803825--010	DUP3	**Sulfate as SO4 - Turbidimetric**	14808-79-8	62.8 %	70-130%	**Recovery less than lower data quality objective**
ED045G: Chloride by Discrete Analyser	EM1803825--010	DUP3	**Chloride**	16887-00-6	36.8 %	70-130%	**Recovery less than lower data quality objective**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)		Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural							
GW 17-26-12D,	GW 17-26-12S,	----	----	----	05-Mar-2018	28-Feb-2018	**5**
SW 17-26-15B,	GW 18-26-22D,						
GW 18-26-22S,	GW 17-26-13D,						
GW 17-26-13S,	GW 17-26-11D,						
GW 17-26-11S,	DUP3						

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
TRH - Semivolatile Fraction	1	15	6.67	10.00	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)					
Chloride by Discrete Analyser	3	34	8.82	10.00	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	2	37	5.41	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
TRH - Semivolatile Fraction	0	15	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

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

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

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

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

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

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator								
Clear Plastic Bottle - Natural (EA005-P)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**----**	----	----	**05-Mar-2018**	28-Feb-2018	×
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
EA010P: Conductivity by PC Titrator								
Clear Plastic Bottle - Natural (EA010-P)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**----**	----	----	**05-Mar-2018**	28-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
ED009: Anions								
Clear Plastic Bottle - Natural (ED009-X)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**----**	----	----	**07-Mar-2018**	28-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
ED037P: Alkalinity by PC Titrator								
Clear Plastic Bottle - Natural (ED037-P)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**----**	----	----	**05-Mar-2018**	14-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Clear Plastic Bottle - Natural (ED041G)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**----**	----	----	**02-Mar-2018**	28-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
ED045G: Chloride by Discrete Analyser								
Clear Plastic Bottle - Natural (ED045G)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**----**	----	----	**02-Mar-2018**	28-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
ED093F: Dissolved Major Cations								
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**----**	----	----	**02-Mar-2018**	28-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
EG020F: Dissolved Metals by ICP-MS								
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**----**	----	----	**02-Mar-2018**	27-Aug-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
EG035F: Dissolved Mercury by FIMS								
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**----**	----	----	**02-Mar-2018**	28-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
EK040P: Fluoride by PC Titrator								
Clear Plastic Bottle - Natural (EK040P)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**----**	----	----	**05-Mar-2018**	28-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK055G: Ammonia as N by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK055G)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**----**	----	----	**06-Mar-2018**	28-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
EK057G: Nitrite as N by Discrete Analyser								
Clear Plastic Bottle - Natural (EK057G)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**----**	----	----	**02-Mar-2018**	02-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Clear Plastic Bottle - Sulfuric Acid (EK059G)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**----**	----	----	**06-Mar-2018**	28-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
EK071G: Reactive Phosphorus as P by discrete analyser								
Clear Plastic Bottle - Natural (EK071G)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**----**	----	----	**02-Mar-2018**	02-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
EP020: Oil and Grease (O&G)								
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**----**	----	----	**07-Mar-2018**	28-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080/071: Total Petroleum Hydrocarbons								
Amber Glass Bottle - Unpreserved (EP071)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**02-Mar-2018**	07-Mar-2018	✓	**05-Mar-2018**	11-Apr-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
Amber VOC Vial - Sulfuric Acid (EP080)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**02-Mar-2018**	14-Mar-2018	✓	**02-Mar-2018**	14-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions								
Amber Glass Bottle - Unpreserved (EP071)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**02-Mar-2018**	07-Mar-2018	✓	**05-Mar-2018**	11-Apr-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
Amber VOC Vial - Sulfuric Acid (EP080)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**02-Mar-2018**	14-Mar-2018	✓	**02-Mar-2018**	14-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							
EP080: BTEXN								
Amber VOC Vial - Sulfuric Acid (EP080)								
GW 17-26-12D,	GW 17-26-12S,	**28-Feb-2018**	**02-Mar-2018**	14-Mar-2018	✓	**02-Mar-2018**	14-Mar-2018	✓
SW 17-26-15B,	GW 18-26-22D,							
GW 18-26-22S,	GW 17-26-13D,							
GW 17-26-13S,	GW 17-26-11D,							
GW 17-26-11S,	DUP3							

Quality Control Parameter Frequency Compliance

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

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	4	34	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	12	**16.67**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	4	40	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	4	37	**10.81**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	15	**6.67**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	2	40	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	3	34	**8.82**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	37	**5.41**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	34	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Method Blanks (MB) - Continued							
Conductivity by PC Titrator	EA010-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	34	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	12	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	37	**5.41**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	15	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

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

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Calculated TDS (from Electrical Conductivity)	EA016	WATER	In house: Calculation from Electrical Conductivity (APHA 2510 B) using a conversion factor specified in the analytical report. This method is compliant with NEPM (2013) Schedule B(3)
Standard Anions -by IC (Extended Method)	ED009-X	WATER	In house: Referenced to APHA 4110B. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)

Analytical Methods	Method	Matrix	Method Descriptions
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Oil and Grease	EP020	WATER	In house: Referenced to APHA 5520 B. Oil & grease is a gravimetric procedure to determine the amount of oil & grease residue in an aqueous sample. The sample is serially extracted three times n-hexane. The resultant extracts are combined, dehydrated and concentrated prior to gravimetric determination. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ **Sydney:** 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ **Newcastle:** 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ **Brisbane:** 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ **Townsville:** 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne:** 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide:** 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth:** 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston:** 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	TURNAROUND REQUIREMENTS : Standard (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	FOR LABORATORY USE ONLY (Circle): Custody Seal Intact? Yes No N/A; Free ice / frozen ice bricks present upon receipt? Yes No N/A; Random Sample Temperature on Receipt: °C; Other comment:
OFFICE: Melbourne, Southbank		
PROJECT: PS101340	ALS QUOTE NO.: EN/008/17	COC SEQUENCE NUMBER (Circle): COC: (1) 2 3 4 5 6 7; OF: (6) 2 3 4 5 6 7
ORDER NUMBER: 325		
PROJECT MANAGER: Ray Hatley	CONTACT PH: 02 92725234	
SAMPLER: ~~Alistair Stewart~~ Sam Alders	SAMPLER MOBILE: ~~0405537688~~ 0417628501	RELINQUISHED BY: S. Alders; DATE/TIME: 1/3/18 8:00
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	RECEIVED BY: ; DATE/TIME:
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com, Alistair.Stewart@wsp.com		RELINQUISHED BY: ; DATE/TIME:
Email Invoice to : au.accountspayable@wsp.com		RECEIVED BY: Anitha; DATE/TIME: 1/3 8:15

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price). Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).											Additional Information
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	IN-1	EA005	NT-1	NT-2A	ED009X	NT-4	EK055	EK071	W-3F, Al(EG020F)	EP020	W-4	
1	GW17-26-12D	28/2/18	WATER	P, AG, VOA, V SP	~~8~~ 9	X	X	X	X	X	X	X	X	X	X	X	
2	GW17-26-12S				~~8~~ 9												
3	SW17-26-15B				8												
4	GW18-26-22D				8												
5	GW18-26-22S				8												
6	GW17-26-13D				9												
7	GW17-26-13S				8												
8	GW17-26-11D				8												
9	GW17-26-11S				8												
10	DUP3				8												
				TOTAL													

Environmental Division Melbourne
Work Order Reference
EM1803825

Telephone : +61 3-8549 9600

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP = Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1803918**	Page	: 1 of 13
Amendment	: **1**		
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Contact	: Graeme Jablonskas
Address	: Level 15, 28 Freshwater Place SOUTHBANK VIC, AUSTRALIA 3006	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: +61 03 9861 1111	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 02-Mar-2018 16:45
Order number	: 325	Date Analysis Commenced	: 02-Mar-2018
C-O-C number	: ----	Issue Date	: 20-Apr-2018 15:39
Sampler	: SAM ALDOUS		
Site	: ----		
Quote number	: EN/008/17		
No. of samples received	: 14		
No. of samples analysed	: 12		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Chris Lemaitre	Non-Metals Team Leader	Melbourne Inorganics, Springvale, VIC
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Nancy Wang	2IC Organic Chemist	Melbourne Organics, Springvale, VIC
Xing Lin	Senior Organic Chemist	Melbourne Organics, Springvale, VIC

General Comments

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

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

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

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

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

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

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

- Amendment (12/4/2018): This report has been amended as a result of a request to remove samples (ID18-BH11, ID18-BH10). All other analysis results are as per the previous report.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- ED041G: EM1803902-003 Poor matrix spike recovery for sulfate due to sample matrix. Confirmed by re-extraction and re-analysis.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW18-26-18D	GW18-26-18S	GW17-26-10D	GW17-26-10S	DUP4
				Client sampling date / time	01-Mar-2018 00:00	01-Mar-2018 00:00	01-Mar-2018 00:00	01-Mar-2018 00:00	01-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803918-001	EM1803918-002	EM1803918-005	EM1803918-006	EM1803918-007
					Result	Result	Result	Result	Result
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		6.97	7.27	7.54	6.99	7.41
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		12600	4420	7710	2440	4440
EA016: Calculated TDS (from Electrical Conductivity)									
Total Dissolved Solids (Calc.)	----	10	mg/L		8190	2870	5010	1590	2890
ED009: Anions									
Bromide	24959-67-9	0.010	mg/L		10.0	2.38	4.69	1.62	2.23
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		224	419	492	258	437
Total Alkalinity as CaCO3	----	1	mg/L		224	419	492	258	437
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		791	190	305	50	219
ED045G: Chloride by Discrete Analyser									
Chloride	16887-00-6	1	mg/L		3950	1040	1930	632	1050
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		450	130	171	50	126
Magnesium	7439-95-4	1	mg/L		288	81	166	50	78
Sodium	7440-23-5	1	mg/L		1680	544	1020	324	521
Potassium	7440-09-7	1	mg/L		15	17	7	8	17
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Arsenic	7440-38-2	0.001	mg/L		0.300	0.014	0.027	0.006	0.012
Boron	7440-42-8	0.05	mg/L		0.17	0.33	0.17	0.09	0.32
Barium	7440-39-3	0.001	mg/L		0.115	0.177	0.053	0.208	0.172
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L		0.001	<0.001	<0.001	<0.001	<0.001
Chromium	7440-47-3	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L		0.002	0.003	<0.001	0.002	<0.001
Manganese	7439-96-5	0.001	mg/L		0.214	0.068	0.060	0.096	0.066
Nickel	7440-02-0	0.001	mg/L		0.002	0.002	<0.001	<0.001	0.002
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW18-26-18D	GW18-26-18S	GW17-26-10D	GW17-26-10S	DUP4
				Client sampling date / time	01-Mar-2018 00:00	01-Mar-2018 00:00	01-Mar-2018 00:00	01-Mar-2018 00:00	01-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803918-001	EM1803918-002	EM1803918-005	EM1803918-006	EM1803918-007
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.006**	**0.007**	<0.005	**0.006**	<0.005
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.5**	**0.6**	**0.9**	**0.3**	**0.6**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**1.00**	**0.59**	**0.61**	**0.38**	**0.51**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	**0.01**	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**0.02**	<0.01	<0.01	**0.01**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.02**	**0.01**	<0.01	**0.01**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**132**	**41.7**	**70.6**	**24.0**	**42.9**
Total Cations	----	0.01	meq/L		**120**	**37.2**	**66.7**	**20.9**	**35.8**
Ionic Balance	----	0.01	%		**5.06**	**5.59**	**2.82**	**6.93**	**9.03**
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	<5
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L		<100	**140**	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	**140**	<50	<50	<50
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW18-26-18D	GW18-26-18S	GW17-26-10D	GW17-26-10S	DUP4
				Client sampling date / time	01-Mar-2018 00:00	01-Mar-2018 00:00	01-Mar-2018 00:00	01-Mar-2018 00:00	01-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803918-001	EM1803918-002	EM1803918-005	EM1803918-006	EM1803918-007
					Result	Result	Result	Result	Result
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
>C16 - C34 Fraction	----	100	µg/L		<100	**180**	<100	<100	**100**
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	<100
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	**180**	<100	<100	**100**
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	<100
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**86.5**	**88.6**	**96.5**	**93.5**	**95.0**
Toluene-D8	2037-26-5	2	%		**71.4**	**82.0**	**102**	**92.2**	**92.4**
4-Bromofluorobenzene	460-00-4	2	%		**89.2**	**93.6**	**109**	**102**	**101**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW18-26-16S	GW18-26-16D	DUP5	GW17-26-5	GW5
			Client sampling date / time	02-Mar-2018 00:00	02-Mar-2018 00:00	02-Mar-2018 00:00	02-Mar-2018 00:00	02-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EM1803918-008	EM1803918-009	EM1803918-010	EM1803918-011	EM1803918-012
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	6.85	6.99	7.00	7.30	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	6590	4790	4650	32100	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	4280	3110	3020	20900	----
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	4.01	2.98	2.92	24.0	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	290	198	197	330	----
Total Alkalinity as CaCO3	----	1	mg/L	290	198	197	330	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	205	118	114	2210	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	1880	1290	1300	10500	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	119	83	87	1380	----
Magnesium	7439-95-4	1	mg/L	111	72	73	839	----
Sodium	7440-23-5	1	mg/L	986	667	684	4370	----
Potassium	7440-09-7	1	mg/L	1	1	1	6	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	<0.01	0.02	----
Arsenic	7440-38-2	0.001	mg/L	0.006	0.002	0.003	0.118	<0.001
Boron	7440-42-8	0.05	mg/L	0.09	<0.05	<0.05	0.18	<0.05
Barium	7440-39-3	0.001	mg/L	0.078	0.050	0.048	0.043	<0.001
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L	0.008	0.006	0.006	0.010	<0.001
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001
Copper	7440-50-8	0.001	mg/L	0.001	0.002	<0.001	0.002	<0.001
Manganese	7439-96-5	0.001	mg/L	1.31	0.822	0.800	0.612	<0.001
Nickel	7440-02-0	0.001	mg/L	0.026	0.025	0.022	0.006	<0.001
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW18-26-16S	GW18-26-16D	DUP5	GW17-26-5	GW5
				Client sampling date / time	02-Mar-2018 00:00	02-Mar-2018 00:00	02-Mar-2018 00:00	02-Mar-2018 00:00	02-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803918-008	EM1803918-009	EM1803918-010	EM1803918-011	EM1803918-012
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.005**	**0.011**	**0.005**	**0.011**	<0.005
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		----	----	----	----	<0.01
Arsenic	7440-38-2	0.001	mg/L		----	----	----	----	<0.001
Boron	7440-42-8	0.05	mg/L		----	----	----	----	<0.05
Barium	7440-39-3	0.001	mg/L		----	----	----	----	<0.001
Beryllium	7440-41-7	0.001	mg/L		----	----	----	----	<0.001
Cadmium	7440-43-9	0.0001	mg/L		----	----	----	----	<0.0001
Cobalt	7440-48-4	0.001	mg/L		----	----	----	----	<0.001
Chromium	7440-47-3	0.001	mg/L		----	----	----	----	<0.001
Copper	7440-50-8	0.001	mg/L		----	----	----	----	<0.001
Manganese	7439-96-5	0.001	mg/L		----	----	----	----	<0.001
Nickel	7440-02-0	0.001	mg/L		----	----	----	----	<0.001
Lead	7439-92-1	0.001	mg/L		----	----	----	----	<0.001
Selenium	7782-49-2	0.01	mg/L		----	----	----	----	<0.01
Vanadium	7440-62-2	0.01	mg/L		----	----	----	----	<0.01
Zinc	7440-66-6	0.005	mg/L		----	----	----	----	<0.005
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		----	----	----	----	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.4**	**0.3**	**0.3**	**0.7**	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.15**	**0.11**	**0.15**	**0.20**	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	**0.02**	**0.03**	<0.01	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		**0.02**	**0.73**	**0.71**	**0.01**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		**0.02**	**0.75**	**0.74**	**0.01**	----
EK071G: Reactive Phosphorus as P by discrete analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW18-26-16S	GW18-26-16D	DUP5	GW17-26-5	GW5
				Client sampling date / time	02-Mar-2018 00:00	02-Mar-2018 00:00	02-Mar-2018 00:00	02-Mar-2018 00:00	02-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803918-008	EM1803918-009	EM1803918-010	EM1803918-011	EM1803918-012
					Result	Result	Result	Result	Result
EK071G: Reactive Phosphorus as P by discrete analyser - Continued									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**63.1**	**42.8**	**43.0**	**349**	----
Total Cations	----	0.01	meq/L		**58.0**	**39.1**	**40.1**	**328**	----
Ionic Balance	----	0.01	%		**4.22**	**4.51**	**3.43**	**3.05**	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	<100	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**86.7**	**90.7**	**87.7**	**96.4**	**85.1**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW18-26-16S	GW18-26-16D	DUP5	GW17-26-5	GW5
				Client sampling date / time	02-Mar-2018 00:00	02-Mar-2018 00:00	02-Mar-2018 00:00	02-Mar-2018 00:00	02-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EM1803918-008	EM1803918-009	EM1803918-010	EM1803918-011	EM1803918-012
					Result	Result	Result	Result	Result
EP080S: TPH(V)/BTEX Surrogates - Continued									
Toluene-D8	2037-26-5	2	%		**75.4**	**86.4**	**83.9**	**82.9**	**72.6**
4-Bromofluorobenzene	460-00-4	2	%		**92.1**	**100**	**97.8**	**94.9**	**88.5**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW18-26-6	GW18-26-7	----	----	----
			Client sampling date / time	02-Mar-2018 00:00	02-Mar-2018 00:00	----	----	----
Compound	CAS Number	LOR	Unit	EM1803918-013	EM1803918-014	--------	--------	--------
				Result	Result	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**6.90**	**7.02**	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**23900**	**19400**	----	----	----
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	**15500**	**12600**	----	----	----
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	**9.89**	**8.61**	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**184**	**281**	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**184**	**281**	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**1850**	**1060**	----	----	----
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**7870**	**6160**	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**837**	**632**	----	----	----
Magnesium	7439-95-4	1	mg/L	**774**	**542**	----	----	----
Sodium	7440-23-5	1	mg/L	**3130**	**2290**	----	----	----
Potassium	7440-09-7	1	mg/L	**8**	**22**	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	<0.01	<0.01	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.004**	**0.031**	----	----	----
Boron	7440-42-8	0.05	mg/L	**0.12**	**0.13**	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.041**	**0.047**	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	<0.001	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	<0.0001	----	----	----
Cobalt	7440-48-4	0.001	mg/L	**0.030**	**0.010**	----	----	----
Chromium	7440-47-3	0.001	mg/L	<0.001	<0.001	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.004**	**0.002**	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.449**	**0.350**	----	----	----
Nickel	7440-02-0	0.001	mg/L	**0.015**	**0.003**	----	----	----
Lead	7439-92-1	0.001	mg/L	<0.001	<0.001	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW18-26-6	GW18-26-7	----	----	----
				Client sampling date / time	02-Mar-2018 00:00	02-Mar-2018 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EM1803918-013	EM1803918-014	--------	--------	--------
					Result	Result	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	----	----	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	----	----	----
Zinc	7440-66-6	0.005	mg/L		**0.010**	**0.010**	----	----	----
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	----	----	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.6**	----	----	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.30**	**0.29**	----	----	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		<0.01	<0.01	----	----	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	----	----	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**264**	**201**	----	----	----
Total Cations	----	0.01	meq/L		**242**	**176**	----	----	----
Ionic Balance	----	0.01	%		**4.42**	**6.65**	----	----	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	----	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L		<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	----	----	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	----	----	----
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW18-26-6	GW18-26-7	-----	-----	-----
				Client sampling date / time	02-Mar-2018 00:00	02-Mar-2018 00:00	----	----	----
Compound	CAS Number	LOR	Unit		EM1803918-013	EM1803918-014	--------	--------	--------
					Result	Result	----	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions - Continued									
>C10 - C16 Fraction	----	100	µg/L		<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	----	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	----	----	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	----	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	----	----	----
Toluene	108-88-3	2	µg/L		<2	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	----	----	----
^ Total Xylenes	----	2	µg/L		<2	<2	----	----	----
^ Sum of BTEX	----	1	µg/L		<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	----	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**93.7**	**90.8**	----	----	----
Toluene-D8	2037-26-5	2	%		**88.6**	**79.2**	----	----	----
4-Bromofluorobenzene	460-00-4	2	%		**102**	**90.1**	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM1803918**	Page	: 1 of 13
Amendment	: **1**		
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: RAY HATLEY	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 02-Mar-2018
Site	: ----	Issue Date	: 20-Apr-2018
Sampler	: SAM ALDOUS	No. of samples received	: 14
Order number	: 325	No. of samples analysed	: 12

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

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

Summary of Outliers

Outliers : Quality Control Samples

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

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

Outliers : Analysis Holding Time Compliance

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

Outliers : Frequency of Quality Control Samples

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

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED009: Anions	EM1803825--001	Anonymous	**Bromide**	24959-67-9	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
ED009: Anions	EM1803918--011	GW17-26-5	**Bromide**	24959-67-9	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA	EM1803902--003	Anonymous	**Sulfate as SO4 - Turbidimetric**	14808-79-8	64.5 %	70-130%	**Recovery less than lower data quality objective**

Outliers : Analysis Holding Time Compliance

Matrix: **WATER**

Method / Container / Client Sample ID(s)	Extraction / Preparation			Analysis		
	Date extracted	Due for extraction	Days overdue	Date analysed	Due for analysis	Days overdue
EA005P: pH by PC Titrator						
Clear Plastic Bottle - Natural						
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	----	----	----	06-Mar-2018	01-Mar-2018	**5**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type / Method	Count		Rate (%)		Quality Control Specification
	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
TRH - Semivolatile Fraction	1	11	9.09	10.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

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

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

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

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

Matrix: **WATER**

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

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

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator							
Clear Plastic Bottle - Natural (EA005-P)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**----**	----	----	**06-Mar-2018**	01-Mar-2018	×
Clear Plastic Bottle - Natural (EA005-P)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**----**	----	----	**02-Mar-2018**	02-Mar-2018	✓
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**----**	----	----	**06-Mar-2018**	29-Mar-2018	✓
Clear Plastic Bottle - Natural (EA010-P)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**----**	----	----	**06-Mar-2018**	30-Mar-2018	✓
ED009: Anions							
Clear Plastic Bottle - Natural (ED009-X)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**----**	----	----	**07-Mar-2018**	29-Mar-2018	✓
Clear Plastic Bottle - Natural (ED009-X)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**----**	----	----	**07-Mar-2018**	30-Mar-2018	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**----**	----	----	**06-Mar-2018**	15-Mar-2018	✓
Clear Plastic Bottle - Natural (ED037-P)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**----**	----	----	**06-Mar-2018**	16-Mar-2018	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**----**	----	----	**04-Mar-2018**	29-Mar-2018	✓
Clear Plastic Bottle - Natural (ED041G)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**----**	----	----	**04-Mar-2018**	30-Mar-2018	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**----**	----	----	**04-Mar-2018**	29-Mar-2018	✓
Clear Plastic Bottle - Natural (ED045G)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**----**	----	----	**04-Mar-2018**	30-Mar-2018	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**----**	----	----	**05-Mar-2018**	29-Mar-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**----**	----	----	**05-Mar-2018**	30-Mar-2018	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**----**	----	----	**05-Mar-2018**	28-Aug-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**----**	----	----	**05-Mar-2018**	29-Aug-2018	✓
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-F)							
GW5	**02-Mar-2018**	**----**	----	----	**06-Mar-2018**	29-Aug-2018	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T)							
GW5	**02-Mar-2018**	**06-Mar-2018**	29-Aug-2018	✓	**06-Mar-2018**	29-Aug-2018	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**----**	----	----	**05-Mar-2018**	29-Mar-2018	✓
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**----**	----	----	**05-Mar-2018**	30-Mar-2018	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035T)							
GW5	**02-Mar-2018**	**----**	----	----	**06-Mar-2018**	30-Mar-2018	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**----**	----	----	**06-Mar-2018**	29-Mar-2018	✓
Clear Plastic Bottle - Natural (EK040P)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**----**	----	----	**06-Mar-2018**	30-Mar-2018	✓
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**----**	----	----	**08-Mar-2018**	29-Mar-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**----**	----	----	**08-Mar-2018**	30-Mar-2018	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**----**	----	----	**03-Mar-2018**	03-Mar-2018	✓
Clear Plastic Bottle - Natural (EK057G)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**----**	----	----	**03-Mar-2018**	04-Mar-2018	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**----**	----	----	**08-Mar-2018**	29-Mar-2018	✓
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**----**	----	----	**08-Mar-2018**	30-Mar-2018	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**----**	----	----	**03-Mar-2018**	03-Mar-2018	✓
Clear Plastic Bottle - Natural (EK071G)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**----**	----	----	**03-Mar-2018**	04-Mar-2018	✓
EP020: Oil and Grease (O&G)							
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**----**	----	----	**09-Mar-2018**	29-Mar-2018	✓
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**----**	----	----	**09-Mar-2018**	30-Mar-2018	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**05-Mar-2018**	08-Mar-2018	✓	**08-Mar-2018**	14-Apr-2018	✓
Amber Glass Bottle - Unpreserved (EP071)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**05-Mar-2018**	09-Mar-2018	✓	**08-Mar-2018**	14-Apr-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**06-Mar-2018**	15-Mar-2018	✓	**07-Mar-2018**	15-Mar-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**06-Mar-2018**	16-Mar-2018	✓	**07-Mar-2018**	16-Mar-2018	✓
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Amber Glass Bottle - Unpreserved (EP071)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**05-Mar-2018**	08-Mar-2018	✓	**08-Mar-2018**	14-Apr-2018	✓
Amber Glass Bottle - Unpreserved (EP071)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**05-Mar-2018**	09-Mar-2018	✓	**08-Mar-2018**	14-Apr-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**06-Mar-2018**	15-Mar-2018	✓	**07-Mar-2018**	15-Mar-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**06-Mar-2018**	16-Mar-2018	✓	**07-Mar-2018**	16-Mar-2018	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EP080: BTEXN							
Amber VOC Vial - Sulfuric Acid (EP080)							
GW18-26-18D, GW18-26-18S, GW17-26-10D, GW17-26-10S, DUP4	**01-Mar-2018**	**06-Mar-2018**	15-Mar-2018	✓	**07-Mar-2018**	15-Mar-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW18-26-16S, GW18-26-16D, DUP5, GW17-26-5, GW5, GW18-26-6, GW18-26-7	**02-Mar-2018**	**06-Mar-2018**	16-Mar-2018	✓	**07-Mar-2018**	16-Mar-2018	✓

Quality Control Parameter Frequency Compliance

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

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	4	29	**13.79**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	4	38	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	3	24	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	4	38	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	2	11	**18.18**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	4	21	**19.05**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	10	**20.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	11	**9.09**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	17	**11.76**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	38	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Control Samples (LCS) - Continued							
TRH Volatiles/BTEX	EP080	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	29	**6.90**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	38	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	38	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	24	**8.33**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	2	21	**9.52**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	10	**10.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	11	**9.09**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	17	**5.88**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

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

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Calculated TDS (from Electrical Conductivity)	EA016	WATER	In house: Calculation from Electrical Conductivity (APHA 2510 B) using a conversion factor specified in the analytical report. This method is compliant with NEPM (2013) Schedule B(3)
Standard Anions -by IC (Extended Method)	ED009-X	WATER	In house: Referenced to APHA 4110B. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Oil and Grease	EP020	WATER	In house: Referenced to APHA 5520 B. Oil & grease is a gravimetric procedure to determine the amount of oil & grease residue in an aqueous sample. The sample is serially extracted three times n-hexane. The resultant extracts are combined, dehydrated and concentrated prior to gravimetric determination. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ **Sydney:** 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ **Newcastle:** 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ **Brisbane:** 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ **Townsville:** 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ **Melbourne:** 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ **Adelaide:** 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ **Perth:** 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston:** 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	**TURNAROUND REQUIREMENTS :** Standard (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	**FOR LABORATORY USE ONLY (Circle)** Custody Seal Intact? Yes No N/A
OFFICE: Melbourne, Southbank		Free ice / frozen ice bricks present upon receipt? Yes No N/A
PROJECT: PS101340	**ALS QUOTE NO.:** EN/008/17	Random Sample Temperature on Receipt: °C
ORDER NUMBER: 325	**COC SEQUENCE NUMBER (Circle)** COC: 1 2 3 4 5 6 7	Other comment:
PROJECT MANAGER: Ray Hatley	**CONTACT PH:** 02 92725234	OF: 1 2 3 4 5 6 7
SAMPLER: ~~Alistair Stewart~~ Sam Aldous	**SAMPLER MOBILE:** ~~0405578683~~ 0476280	**RELINQUISHED BY:** S. Aldous
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**	**DATE/TIME:** 2/03/2018
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com, Alistair.Stewart@wsp.com		**RECEIVED BY:** [illegible]
Email Invoice to : au.accountspayable@wsp.com		**DATE/TIME:** 2/3/18 4.45 pm
COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:		**RELINQUISHED BY:** / **DATE/TIME:** / **RECEIVED BY:** / **DATE/TIME:**

Environmental Division Melbourne
Work Order Reference
EM1803918

Telephone : +61-3-8549 9600

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price). Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).										
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	IN-1	EA005	NT-1	NT-2A	ED009X	NT-4	EK055	EK071	W-3F, Al(EG020F)	EP020	W-4
1	GW18-26-18D	1/3/18	W		10	X	X	X	X	X	X	X	X	X	X	X
2	GW18-26-18S				9											
3	TD18-BH11				8											
4	TD18-BH10				8											
5	GW17-26-10D				8											
6	GW17-26-10S				8											
7	DUP4				9											
8	GW18-26-16S	2/3/18			9											
9	GW18-26-16D	2/3/18			9											
10	DUP5	"			9											
11	GW17-26-5	"			8											
12	GW5	"			3									Analyse for →		TPH, BTEX, METALS
			TOTAL													

Suite Codes must be listed to attract suite price
Matrix: Soil Water BOD pH
Container / Preservative RF
Other NO2
Date NP 2/3

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ Sydney: 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ Newcastle: 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ Brisbane: 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
☐ Townsville: 14-15 Desma Ct, Bohle QLD 4818 Ph:07 4796 0600 E: townsville.environmental@alsenviro.com
☐ Melbourne: 2-4 Westall Rd, Springvale VIC 3171 Ph:03 8549 9600 E: samples.melbourne@alsenviro.com
☐ Adelaide: 2-1 Burma Rd, Pooraka SA 5095 Ph: 08 8359 0890 E:adelaide@alsenviro.com
☐ Perth: 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ Launceston: 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	TURNAROUND REQUIREMENTS : Standard (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)		FOR LABORATORY USE ONLY (Circle): Custody Seal Intact? Yes No N/A; Free ice / frozen ice bricks present upon receipt? Yes No N/A; Random Sample Temperature on Receipt: °C
OFFICE: Melbourne, Southbank			
PROJECT: PS101340	ALS QUOTE NO.: EN/008/17	COC SEQUENCE NUMBER (Circle) COC: 1 2 3 4 5 6 7	
ORDER NUMBER: 325		OF: 1 2 3 4 5 6 7	
PROJECT MANAGER: Ray Hatley	CONTACT PH: 02 92725234		Other comment:
SAMPLER: ~~Alistair Stewart~~ S. Aldous	SAMPLER MOBILE: ~~0305378888~~ 0417628801	RELINQUISHED BY: S. Aldous	RECEIVED BY: Ray LMD
COC emailed to ALS? (YES / NO)	EDD FORMAT (or default):	DATE/TIME: 2/3/18	DATE/TIME: 2/3/18 4:45
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com, Alistair.Stewart@wsp.com		RELINQUISHED BY:	RECEIVED BY:
Email Invoice to : au.accountspayable@wsp.com		DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION		ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where Metals are required, specify Total (unfiltered bottle required) or Dissolved (field filtered bottle required).											Additional Information		
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE (refer to codes below)	TOTAL BOTTLES	IN-1	EA005	NT-1	NT-2A	ED009X	NT-4	EK055	EK071	W-3F, Al(EG020F)	EP020	W-4			
13	GW18-26-6	2/3/18	W		8	X	X	X	X	X	X	X	X	X	X	X			
14	GW18-26-7	"	"		8	X	X	X	X	X	X	X	X	X	X	X			
				TOTAL															

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag.

ALS Environmental

CERTIFICATE OF ANALYSIS

Work Order	: **EM1804056**	Page	: 1 of 7
Amendment	: **1**		
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: ALISTAIR STEWART	Contact	: Graeme Jablonskas
Address	: Level 15, 28 Freshwater Place SOUTHBANK VIC, AUSTRALIA 3006	Address	: 4 Westall Rd Springvale VIC Australia 3171
Telephone	: ----	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 06-Mar-2018 14:00
Order number	: 325	Date Analysis Commenced	: 06-Mar-2018
C-O-C number	: ----	Issue Date	: 12-Apr-2018 09:07
Sampler	: SAM ALDOUS		
Site	: ----		
Quote number	: EN/008/17		
No. of samples received	: 6		
No. of samples analysed	: 5		

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

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

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

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

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics, Smithfield, NSW
Dilani Fernando	Senior Inorganic Chemist	Melbourne Inorganics, Springvale, VIC
Herman Lin	Laboratory Manager	Melbourne Inorganics, Springvale, VIC
Nancy Wang	2IC Organic Chemist	Melbourne Organics, Springvale, VIC
Xing Lin	Senior Organic Chemist	Melbourne Organics, Springvale, VIC

General Comments

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

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

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

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

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

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

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

- EK057G: Results for EM1804056-002 have been confirmed by re-preparation and re-analysis.
- Ionic Balance out of acceptable limits for sample #4 due to analytes not quantified in this report. Major anions and major cations have been confirmed by re-preparation and re-analysis.
- Amendment (12/04/2018): This report has been amended as a result of a request to remove a sample (ID18-BH10). All other analysis results are as per the previous report.
- Ionic balances were calculated using: major anions - chloride, alkalinity and sulfate; and major cations - calcium, magnesium, potassium and sodium.
- ED045G: The presence of thiocyanate can positively contribute to the chloride result, thereby may bias results higher than expected. Results should be scrutinised accordingly.
- It is recognised that Nitrite +Nitrate as N is less than Nitrite as N for sample #2. However, the difference is within experimental variation of the methods. confirmed by re-analysis.
- EA016: Calculated TDS is determined from Electrical conductivity using a conversion factor of 0.65.

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	GW17-26-8	GW17-26-9	GW17-26-3	GW17-26-4	GW3
			Client sampling date / time	06-Mar-2018 09:15	06-Mar-2018 09:45	06-Mar-2018 11:00	06-Mar-2018 12:00	06-Mar-2018 00:00
Compound	CAS Number	LOR	Unit	EM1804056-002	EM1804056-003	EM1804056-004	EM1804056-005	EM1804056-006
				Result	Result	Result	Result	Result
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**5.33**	**6.51**	**7.30**	**7.14**	**----**
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**27700**	**7500**	**972**	**17500**	**----**
EA016: Calculated TDS (from Electrical Conductivity)								
Total Dissolved Solids (Calc.)	----	10	mg/L	**18000**	**4880**	**632**	**11400**	**----**
ED009: Anions								
Bromide	24959-67-9	0.010	mg/L	**14.9**	**3.24**	**0.437**	**11.7**	**----**
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	<1	<1	<1	**----**
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	<1	<1	<1	<1	**----**
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**26**	**131**	**211**	**198**	**----**
Total Alkalinity as CaCO3	----	1	mg/L	**26**	**131**	**211**	**198**	**----**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**4050**	**670**	**44**	**904**	**----**
ED045G: Chloride by Discrete Analyser								
Chloride	16887-00-6	1	mg/L	**8710**	**2150**	**172**	**6100**	**----**
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**990**	**284**	**13**	**854**	**----**
Magnesium	7439-95-4	1	mg/L	**1570**	**251**	**10**	**481**	**----**
Sodium	7440-23-5	1	mg/L	**2880**	**871**	**168**	**2120**	**----**
Potassium	7440-09-7	1	mg/L	**32**	**7**	<1	**9**	**----**
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**1.31**	<0.01	<0.01	<0.01	**----**
Arsenic	7440-38-2	0.001	mg/L	**0.138**	**0.004**	<0.001	**0.026**	**----**
Boron	7440-42-8	0.05	mg/L	**0.24**	**0.14**	**0.06**	**0.14**	**----**
Barium	7440-39-3	0.001	mg/L	**0.022**	**0.053**	**0.006**	**0.076**	**----**
Beryllium	7440-41-7	0.001	mg/L	**0.008**	<0.001	<0.001	<0.001	**----**
Cadmium	7440-43-9	0.0001	mg/L	**0.0009**	<0.0001	<0.0001	<0.0001	**----**
Cobalt	7440-48-4	0.001	mg/L	**0.834**	**0.015**	<0.001	**0.023**	**----**
Chromium	7440-47-3	0.001	mg/L	**0.002**	<0.001	<0.001	<0.001	**----**
Copper	7440-50-8	0.001	mg/L	**0.002**	**0.002**	**0.002**	**0.003**	**----**
Manganese	7439-96-5	0.001	mg/L	**8.07**	**0.424**	**0.125**	**0.875**	**----**
Nickel	7440-02-0	0.001	mg/L	**1.45**	**0.015**	<0.001	**0.006**	**----**
Lead	7439-92-1	0.001	mg/L	**0.002**	<0.001	<0.001	<0.001	**----**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW17-26-8	GW17-26-9	GW17-26-3	GW17-26-4	GW3
				Client sampling date / time	06-Mar-2018 09:15	06-Mar-2018 09:45	06-Mar-2018 11:00	06-Mar-2018 12:00	06-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EM1804056-002	EM1804056-003	EM1804056-004	EM1804056-005	EM1804056-006
					Result	Result	Result	Result	Result
EG020F: Dissolved Metals by ICP-MS - Continued									
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L		**0.164**	**0.018**	<0.005	**0.012**	----
EG020T: Total Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		----	----	----	----	<0.01
Arsenic	7440-38-2	0.001	mg/L		----	----	----	----	<0.001
Boron	7440-42-8	0.05	mg/L		----	----	----	----	<0.05
Barium	7440-39-3	0.001	mg/L		----	----	----	----	<0.001
Beryllium	7440-41-7	0.001	mg/L		----	----	----	----	<0.001
Cadmium	7440-43-9	0.0001	mg/L		----	----	----	----	<0.0001
Cobalt	7440-48-4	0.001	mg/L		----	----	----	----	<0.001
Chromium	7440-47-3	0.001	mg/L		----	----	----	----	<0.001
Copper	7440-50-8	0.001	mg/L		----	----	----	----	<0.001
Manganese	7439-96-5	0.001	mg/L		----	----	----	----	<0.001
Nickel	7440-02-0	0.001	mg/L		----	----	----	----	<0.001
Lead	7439-92-1	0.001	mg/L		----	----	----	----	<0.001
Selenium	7782-49-2	0.01	mg/L		----	----	----	----	<0.01
Vanadium	7440-62-2	0.01	mg/L		----	----	----	----	<0.01
Zinc	7440-66-6	0.005	mg/L		----	----	----	----	<0.005
EG035F: Dissolved Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	----
EG035T: Total Recoverable Mercury by FIMS									
Mercury	7439-97-6	0.0001	mg/L		----	----	----	----	<0.0001
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.3**	**0.2**	**0.4**	**0.3**	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**2.05**	**0.19**	**0.01**	**0.59**	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	14797-65-0	0.01	mg/L		**0.02**	<0.01	**0.01**	<0.01	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	**0.01**	**0.47**	**0.01**	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	**0.01**	**0.48**	**0.01**	----
EK071G: Reactive Phosphorus as P by discrete analyser									

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	GW17-26-8	GW17-26-9	GW17-26-3	GW17-26-4	GW3
				Client sampling date / time	06-Mar-2018 09:15	06-Mar-2018 09:45	06-Mar-2018 11:00	06-Mar-2018 12:00	06-Mar-2018 00:00
Compound	CAS Number	LOR	Unit		EM1804056-002	EM1804056-003	EM1804056-004	EM1804056-005	EM1804056-006
					Result	Result	Result	Result	Result
EK071G: Reactive Phosphorus as P by discrete analyser - Continued									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		**0.02**	**0.02**	<0.01	<0.01	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**330**	**77.2**	**9.98**	**195**	----
Total Cations	----	0.01	meq/L		**305**	**72.9**	**8.78**	**175**	----
Ionic Balance	----	0.01	%		**4.07**	**2.88**	**6.42**	**5.47**	----
EP020: Oil and Grease (O&G)									
Oil & Grease	----	5	mg/L		<5	<5	<5	<5	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L		<50	<50	<50	<50	----
C15 - C28 Fraction	----	100	µg/L		<100	<100	<100	<100	----
C29 - C36 Fraction	----	50	µg/L		<50	<50	<50	<50	----
^ C10 - C36 Fraction (sum)	----	50	µg/L		<50	<50	<50	<50	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions									
C6 - C10 Fraction	C6_C10	20	µg/L		<20	<20	<20	<20	<20
^ C6 - C10 Fraction minus BTEX (F1)	C6_C10-BTEX	20	µg/L		<20	<20	<20	<20	<20
>C10 - C16 Fraction	----	100	µg/L		<100	<100	<100	<100	----
>C16 - C34 Fraction	----	100	µg/L		<100	<100	<100	<100	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	<100	----
^ >C10 - C40 Fraction (sum)	----	100	µg/L		<100	<100	<100	<100	----
^ >C10 - C16 Fraction minus Naphthalene (F2)	----	100	µg/L		<100	<100	<100	<100	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	<1	<1
Toluene	108-88-3	2	µg/L		<2	<2	<2	<2	<2
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	<2	<2
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	<2	<2
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	<2	<2
^ Total Xylenes	----	2	µg/L		<2	<2	<2	<2	<2
^ Sum of BTEX	----	1	µg/L		<1	<1	<1	<1	<1
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	<5	<5
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	2	%		**94.7**	**98.1**	**92.0**	**89.3**	**94.2**

Analytical Results

Sub-Matrix: **WATER** (Matrix: **WATER**)				Client sample ID	GW17-26-8	GW17-26-9	GW17-26-3	GW17-26-4	GW3
				Client sampling date / time	06-Mar-2018 09:15	06-Mar-2018 09:45	06-Mar-2018 11:00	06-Mar-2018 12:00	06-Mar-2018 00:00
Compound	*CAS Number*	*LOR*	*Unit*		**EM1804056-002**	**EM1804056-003**	**EM1804056-004**	**EM1804056-005**	**EM1804056-006**
					Result	Result	Result	Result	Result
EP080S: TPH(V)/BTEX Surrogates - Continued									
Toluene-D8	2037-26-5	2	%		**87.4**	**88.3**	**91.0**	**90.7**	**89.9**
4-Bromofluorobenzene	460-00-4	2	%		**90.8**	**97.3**	**102**	**98.1**	**97.0**

Surrogate Control Limits

Sub-Matrix: **WATER**		Recovery Limits (%)	
Compound	*CAS Number*	*Low*	*High*
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	73	129
Toluene-D8	2037-26-5	70	125
4-Bromofluorobenzene	460-00-4	71	129

ALS Environmental

QA/QC Compliance Assessment to assist with Quality Review

Work Order	: **EM1804056**	Page	: 1 of 9
Amendment	: **1**		
Client	: **WSP Australia Pty Ltd**	Laboratory	: Environmental Division Melbourne
Contact	: ALISTAIR STEWART	Telephone	: +61-3-8549 9609
Project	: PS101340	Date Samples Received	: 06-Mar-2018
Site	: ----	Issue Date	: 12-Apr-2018
Sampler	: SAM ALDOUS	No. of samples received	: 6
Order number	: 325	No. of samples analysed	: 5

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

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

Summary of Outliers

Outliers : Quality Control Samples

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

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

Outliers : Analysis Holding Time Compliance

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

Outliers : Frequency of Quality Control Samples

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

Outliers : Quality Control Samples

Duplicates, Method Blanks, Laboratory Control Samples and Matrix Spikes

Matrix: **WATER**

Compound Group Name	Laboratory Sample ID	Client Sample ID	Analyte	CAS Number	Data	Limits	Comment
Matrix Spike (MS) Recoveries							
ED009: Anions	EM1804056--002	GW17-26-8	**Bromide**	24959-67-9	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EG020F: Dissolved Metals by ICP-MS	EM1803834--001	Anonymous	**Manganese**	7439-96-5	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK055G: Ammonia as N by Discrete Analyser	EM1804039--002	Anonymous	**Ammonia as N**	7664-41-7	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**
EK071G: Reactive Phosphorus as P by discrete analyse	EM1804039--002	Anonymous	**Reactive Phosphorus as P**	14265-44-2	Not Determined	----	**MS recovery not determined, background level greater than or equal to 4x spike level.**

Outliers : Frequency of Quality Control Samples

Matrix: **WATER**

Quality Control Sample Type	Count		Rate (%)		Quality Control Specification
Method	QC	Regular	Actual	Expected	
Laboratory Duplicates (DUP)					
TRH - Semivolatile Fraction	0	4	0.00	10.00	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)					
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	1	20	5.00	10.00	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)					
TRH - Semivolatile Fraction	0	4	0.00	5.00	NEPM 2013 B3 & ALS QC Standard

Analysis Holding Time Compliance

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

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

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

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

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)		Sample Date	Extraction / Preparation			Analysis		
			Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA005P: pH by PC Titrator								
Clear Plastic Bottle - Natural (EA005-P)								
GW17-26-8,	GW17-26-9,	**06-Mar-2018**	**----**	----	----	**06-Mar-2018**	06-Mar-2018	✓
GW17-26-3,	GW17-26-4							

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EA010P: Conductivity by PC Titrator							
Clear Plastic Bottle - Natural (EA010-P)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**----**	----	----	**07-Mar-2018**	03-Apr-2018	✓
ED009: Anions							
Clear Plastic Bottle - Natural (ED009-X)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**----**	----	----	**08-Mar-2018**	03-Apr-2018	✓
ED037P: Alkalinity by PC Titrator							
Clear Plastic Bottle - Natural (ED037-P)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**----**	----	----	**07-Mar-2018**	20-Mar-2018	✓
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA							
Clear Plastic Bottle - Natural (ED041G)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**----**	----	----	**07-Mar-2018**	03-Apr-2018	✓
ED045G: Chloride by Discrete Analyser							
Clear Plastic Bottle - Natural (ED045G)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**----**	----	----	**07-Mar-2018**	03-Apr-2018	✓
ED093F: Dissolved Major Cations							
Clear Plastic Bottle - Nitric Acid; Filtered (ED093F)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**----**	----	----	**08-Mar-2018**	03-Apr-2018	✓
EG020F: Dissolved Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG020A-F)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**----**	----	----	**08-Mar-2018**	02-Sep-2018	✓
EG020T: Total Metals by ICP-MS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG020A-T)							
GW3	**06-Mar-2018**	**08-Mar-2018**	02-Sep-2018	✓	**08-Mar-2018**	02-Sep-2018	✓
EG035F: Dissolved Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Filtered (EG035F)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**----**	----	----	**08-Mar-2018**	03-Apr-2018	✓
EG035T: Total Recoverable Mercury by FIMS							
Clear Plastic Bottle - Nitric Acid; Unfiltered (EG035T)							
GW3	**06-Mar-2018**	**----**	----	----	**07-Mar-2018**	03-Apr-2018	✓
EK040P: Fluoride by PC Titrator							
Clear Plastic Bottle - Natural (EK040P)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**----**	----	----	**07-Mar-2018**	03-Apr-2018	✓

Matrix: **WATER**

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

Method / Container / Client Sample ID(s)	Sample Date	Extraction / Preparation			Analysis		
		Date extracted	Due for extraction	Evaluation	Date analysed	Due for analysis	Evaluation
EK055G: Ammonia as N by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK055G)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**----**	----	----	**09-Mar-2018**	03-Apr-2018	✓
EK057G: Nitrite as N by Discrete Analyser							
Clear Plastic Bottle - Natural (EK057G)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**----**	----	----	**07-Mar-2018**	08-Mar-2018	✓
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser							
Clear Plastic Bottle - Sulfuric Acid (EK059G)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**----**	----	----	**09-Mar-2018**	03-Apr-2018	✓
EK071G: Reactive Phosphorus as P by discrete analyser							
Clear Plastic Bottle - Natural (EK071G)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**----**	----	----	**07-Mar-2018**	08-Mar-2018	✓
EP020: Oil and Grease (O&G)							
Amber Jar - Sulfuric Acid or Sodium Bisulfate (EP020)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**----**	----	----	**13-Mar-2018**	03-Apr-2018	✓
EP080/071: Total Petroleum Hydrocarbons							
Amber Glass Bottle - Unpreserved (EP071)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**08-Mar-2018**	13-Mar-2018	✓	**09-Mar-2018**	17-Apr-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4, GW3	**06-Mar-2018**	**07-Mar-2018**	20-Mar-2018	✓	**09-Mar-2018**	20-Mar-2018	✓
EP080/071: Total Recoverable Hydrocarbons - NEPM 2013 Fractions							
Amber Glass Bottle - Unpreserved (EP071)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4	**06-Mar-2018**	**08-Mar-2018**	13-Mar-2018	✓	**09-Mar-2018**	17-Apr-2018	✓
Amber VOC Vial - Sulfuric Acid (EP080)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4, GW3	**06-Mar-2018**	**07-Mar-2018**	20-Mar-2018	✓	**09-Mar-2018**	20-Mar-2018	✓
EP080: BTEXN							
Amber VOC Vial - Sulfuric Acid (EP080)							
GW17-26-8, GW17-26-9, GW17-26-3, GW17-26-4, GW3	**06-Mar-2018**	**07-Mar-2018**	20-Mar-2018	✓	**09-Mar-2018**	20-Mar-2018	✓

Quality Control Parameter Frequency Compliance

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

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Duplicates (DUP)							
Alkalinity by PC Titrator	ED037-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	2	19	**10.53**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	2	13	**15.38**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
pH by PC Titrator	EA005-P	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	8	**12.50**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	2	18	**11.11**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	4	**0.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	2	15	**13.33**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Laboratory Control Samples (LCS)							
Alkalinity by PC Titrator	ED037-P	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	2	20	**10.00**	**10.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**10.00**	×	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Matrix: **WATER**

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

Quality Control Sample Type		Count		Rate (%)			Quality Control Specification
Analytical Methods	*Method*	*QC*	*Regular*	***Actual***	***Expected***	*Evaluation*	
Laboratory Control Samples (LCS) - Continued							
TRH Volatiles/BTEX	EP080	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Method Blanks (MB)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Conductivity by PC Titrator	EA010-P	1	13	**7.69**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Major Cations - Dissolved	ED093F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Oil and Grease	EP020	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	1	4	**25.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Matrix Spikes (MS)							
Ammonia as N by Discrete analyser	EK055G	1	19	**5.26**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Chloride by Discrete Analyser	ED045G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Mercury by FIMS	EG035F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Dissolved Metals by ICP-MS - Suite A	EG020A-F	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Fluoride by PC Titrator	EK040P	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Nitrite as N by Discrete Analyser	EK057G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Reactive Phosphorus as P-By Discrete Analyser	EK071G	1	8	**12.50**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Standard Anions -by IC (Extended Method)	ED009-X	1	18	**5.56**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Mercury by FIMS	EG035T	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
Total Metals by ICP-MS - Suite A	EG020A-T	1	20	**5.00**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard
TRH - Semivolatile Fraction	EP071	0	4	**0.00**	**5.00**	×	NEPM 2013 B3 & ALS QC Standard
TRH Volatiles/BTEX	EP080	1	15	**6.67**	**5.00**	✓	NEPM 2013 B3 & ALS QC Standard

Brief Method Summaries

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

Analytical Methods	Method	Matrix	Method Descriptions
pH by PC Titrator	EA005-P	WATER	In house: Referenced to APHA 4500 H+ B. This procedure determines pH of water samples by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Conductivity by PC Titrator	EA010-P	WATER	In house: Referenced to APHA 2510 B. This procedure determines conductivity by automated ISE. This method is compliant with NEPM (2013) Schedule B(3)
Calculated TDS (from Electrical Conductivity)	EA016	WATER	In house: Calculation from Electrical Conductivity (APHA 2510 B) using a conversion factor specified in the analytical report. This method is compliant with NEPM (2013) Schedule B(3)
Standard Anions -by IC (Extended Method)	ED009-X	WATER	In house: Referenced to APHA 4110B. This method is compliant with NEPM (2013) Schedule B(3)
Alkalinity by PC Titrator	ED037-P	WATER	In house: Referenced to APHA 2320 B This procedure determines alkalinity by automated measurement (e.g. PC Titrate) using pH 4.5 for indicating the total alkalinity end-point. This method is compliant with NEPM (2013) Schedule B(3)
Sulfate (Turbidimetric) as SO4 2- by Discrete Analyser	ED041G	WATER	In house: Referenced to APHA 4500-SO4. Dissolved sulfate is determined in a 0.45um filtered sample. Sulfate ions are converted to a barium sulfate suspension in an acetic acid medium with barium chloride. Light absorbance of the BaSO4 suspension is measured by a photometer and the SO4-2 concentration is determined by comparison of the reading with a standard curve. This method is compliant with NEPM (2013) Schedule B(3)
Chloride by Discrete Analyser	ED045G	WATER	In house: Referenced to APHA 4500 Cl - G.The thiocyanate ion is liberated from mercuric thiocyanate through sequestration of mercury by the chloride ion to form non-ionised mercuric chloride.in the presence of ferric ions the librated thiocynate forms highly-coloured ferric thiocynate which is measured at 480 nm APHA 21st edition seal method 2 017-1-L april 2003
Major Cations - Dissolved	ED093F	WATER	In house: Referenced to APHA 3120 and 3125; USEPA SW 846 - 6010 and 6020; Cations are determined by either ICP-AES or ICP-MS techniques. This method is compliant with NEPM (2013) Schedule B(3) Sodium Adsorption Ratio is calculated from Ca, Mg and Na which determined by ALS in house method QWI-EN/ED093F. This method is compliant with NEPM (2013) Schedule B(3) Hardness parameters are calculated based on APHA 2340 B. This method is compliant with NEPM (2013) Schedule B(3)
Dissolved Metals by ICP-MS - Suite A	EG020A-F	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. Samples are 0.45µm filtered prior to analysis. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.
Total Metals by ICP-MS - Suite A	EG020A-T	WATER	In house: Referenced to APHA 3125; USEPA SW846 - 6020, ALS QWI-EN/EG020. The ICPMS technique utilizes a highly efficient argon plasma to ionize selected elements. Ions are then passed into a high vacuum mass spectrometer, which separates the analytes based on their distinct mass to charge ratios prior to their measurement by a discrete dynode ion detector.

Analytical Methods	Method	Matrix	Method Descriptions
Dissolved Mercury by FIMS	EG035F	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) Samples are 0.45µm filtered prior to analysis. FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the filtered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Total Mercury by FIMS	EG035T	WATER	In house: Referenced to AS 3550, APHA 3112 Hg - B (Flow-injection (SnCl2)(Cold Vapour generation) AAS) FIM-AAS is an automated flameless atomic absorption technique. A bromate/bromide reagent is used to oxidise any organic mercury compounds in the unfiltered sample. The ionic mercury is reduced online to atomic mercury vapour by SnCl2 which is then purged into a heated quartz cell. Quantification is by comparing absorbance against a calibration curve. This method is compliant with NEPM (2013) Schedule B(3)
Fluoride by PC Titrator	EK040P	WATER	In house: Referenced to APHA 4500-F C: CDTA is added to the sample to provide a uniform ionic strength background, adjust pH, and break up complexes. Fluoride concentration is determined by either manual or automatic ISE measurement. This method is compliant with NEPM (2013) Schedule B(3)
Ammonia as N by Discrete analyser	EK055G	WATER	In house: Referenced to APHA 4500-NH3 G Ammonia is determined by direct colorimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite as N by Discrete Analyser	EK057G	WATER	In house: Referenced to APHA 4500-NO2- B. Nitrite is determined by direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Nitrate as N by Discrete Analyser	EK058G	WATER	In house: Referenced to APHA 4500-NO3- F. Nitrate is reduced to nitrite by way of a chemical reduction followed by quantification by Discrete Analyser. Nitrite is determined seperately by direct colourimetry and result for Nitrate calculated as the difference between the two results. This method is compliant with NEPM (2013) Schedule B(3)
Nitrite and Nitrate as N (NOx) by Discrete Analyser	EK059G	WATER	In house: Referenced to APHA 4500-NO3- F. Combined oxidised Nitrogen (NO2+NO3) is determined by Chemical Reduction and direct colourimetry by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Reactive Phosphorus as P-By Discrete Analyser	EK071G	WATER	In house: Referenced to APHA 4500-P F Ammonium molybdate and potassium antimonyl tartrate reacts in acid medium with othophosphate to form a heteropoly acid -phosphomolybdic acid - which is reduced to intensely coloured molybdenum blue by ascorbic acid. Quantification is by Discrete Analyser. This method is compliant with NEPM (2013) Schedule B(3)
Ionic Balance by PCT DA and Turbi SO4 DA	EN055 - PG	WATER	In house: Referenced to APHA 1030F. This method is compliant with NEPM (2013) Schedule B(3)
Oil and Grease	EP020	WATER	In house: Referenced to APHA 5520 B. Oil & grease is a gravimetric procedure to determine the amount of oil & grease residue in an aqueous sample. The sample is serially extracted three times n-hexane. The resultant extracts are combined, dehydrated and concentrated prior to gravimetric determination. This method is compliant with NEPM (2013) Schedule B(3)
TRH - Semivolatile Fraction	EP071	WATER	In house: Referenced to USEPA SW 846 - 8015A The sample extract is analysed by Capillary GC/FID and quantification is by comparison against an established 5 point calibration curve of n-Alkane standards. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)
TRH Volatiles/BTEX	EP080	WATER	In house: Referenced to USEPA SW 846 - 8260B Water samples are directly purged prior to analysis by Capillary GC/MS and quantification is by comparison against an established 5 point calibration curve. Alternatively, a sample is equilibrated in a headspace vial and a portion of the headspace determined by GCMS analysis. This method is compliant with the QC requirements of NEPM (2013) Schedule B(3)

Preparation Methods	Method	Matrix	Method Descriptions
Digestion for Total Recoverable Metals	EN25	WATER	In house: Referenced to USEPA SW846-3005. Method 3005 is a Nitric/Hydrochloric acid digestion procedure used to prepare surface and ground water samples for analysis by ICPAES or ICPMS. This method is compliant with NEPM (2013) Schedule B(3)
Separatory Funnel Extraction of Liquids	ORG14	WATER	In house: Referenced to USEPA SW 846 - 3510B 100 mL to 1L of sample is transferred to a separatory funnel and serially extracted three times using 60mL DCM for each extract. The resultant extracts are combined, dehydrated and concentrated for analysis. This method is compliant with NEPM (2013) Schedule B(3) . ALS default excludes sediment which may be resident in the container.
Volatiles Water Preparation	ORG16-W	WATER	A 5 mL aliquot or 5 mL of a diluted sample is added to a 40 mL VOC vial for sparging.

CHAIN OF CUSTODY

ALS Laboratory: please tick →

☐ **Sydney:** 277 Woodpark Rd, Smithfield NSW 2176 Ph: 02 8784 8555 E:samples.sydney@alsenviro.com
☐ **Newcastle:** 5 Rosegum Rd, Warabrook NSW 2304 Ph:02 4968 9433 E:samples.newcastle@alsenviro.com
☐ **Brisbane:** 32 Shand St, Stafford QLD 4053 Ph:07 3243 7222 E:samples.brisbane@alsenviro.com
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☐ **Perth:** 10 Hod Way, Malaga WA 6090 Ph: 08 9209 7655 E: samples.perth@alsenviro.com
☐ **Launceston:** 27 Wellington St, Launceston TAS 7250 Ph: 03 6331 2158 E: launceston@alsenviro.com

CLIENT: WSP	**TURNAROUND REQUIREMENTS :** Standard (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	**FOR LABORATORY USE ONLY (Circle)** Custody Seal Intact? Yes / No / N/A; Free ice / frozen ice bricks present upon receipt? Yes / No / N/A; Random Sample Temperature on Receipt: °C; Other comment:
OFFICE: Melbourne, Southbank	**ALS QUOTE NO.:** EN/008/17	**COC SEQUENCE NUMBER (Circle)** COC: (1) 2 3 4 5 6 7; OF: (1) 2 3 4 5 6 7
PROJECT: PS101340		
ORDER NUMBER: 325		
PROJECT MANAGER: ~~Ray Hatley~~ Alistair Stewart	**CONTACT PH:** ~~02 92752345~~ 03 8663 7877	
SAMPLER: ~~Alistair Stewart~~ Sam Aldous	**SAMPLER MOBILE:** ~~0405278888~~ 0417625801	**RELINQUISHED BY:** S. Aldous; **RECEIVED BY:**; **RELINQUISHED BY:**; **RECEIVED BY:** Ray Hatley
COC emailed to ALS? (YES / NO)	**EDD FORMAT (or default):**	
Email Reports to : Kelly-Jane.Wallis@wsp.com, Ray.Hatley@wsp.com, Alistair.Stewart@wsp.com		**DATE/TIME:** 6/3/18; **DATE/TIME:**; **DATE/TIME:** 6/13/18; **DATE/TIME:** 2:00pm
Email Invoice to : au.accountspayable@wsp.com		

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

ALS USE ONLY	SAMPLE DETAILS MATRIX: Solid(S) Water(W)			CONTAINER INFORMATION	ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price) Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).											Additional Information		
LAB ID	SAMPLE ID	DATE / TIME	MATRIX	TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	IN-1	EA005	NT-1	NT-2A	ED009X	NT-4	EK055	EK071	W-3F, Al(EG020F)	EP020	W-4	Oil & Grease	W-18	W-3T, Al
1	ID18-BH10	6/3/18 830am	W		1												X		
2	GW17-26-8	6/3/18 9:15			8	X	X	X	X	X	X	X	X	X	X	X			
3	GW17-26-9	6/3/18 9:45			8														
4	GW17-26-3	6/3/18 11:00am			9														
5	GW17-26-4	6/3/18 12:00pm			8														
6	GW3	↓	W		3													X	X
	TE 6-3																		

Environmental Division
Melbourne
Work Order Reference
EM1804056

Telephone : + 61-3-8549 9600

Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nit…d; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Su…Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehy…
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Pl… Unpreserved Bag.

APPENDIX C

SUPPLEMENTARY TECHNICAL REPORTS

VICROADS

SEPTEMBER 2018

MORDIALLOC BYPASS

EDITHVALE WETLAND WATER BALANCE MODELLING

Report Number: 2135645A-SE-26-WAT-REP-0008 REV0

wsp

Question today
Imagine tomorrow
Create for the future

Mordialloc Bypass
Edithvale Wetland Water Balance Modelling

VicRoads

WSP
Level 15, 28 Freshwater Place
Southbank VIC 3006

Tel: +61 3 9861 1111
Fax: +61 3 9861 1144
wsp.com

REV	DATE	DETAILS
0	16/09/2018	Final

	NAME	DATE	SIGNATURE
Prepared by:	Amir Hedjripour	16/09/2018	
Reviewed by:	Eric Lam	16/09/2018	
Approved by:	Sean Myers	16/09/2018	

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1 INTRODUCTION

1.1 BACKGROUND

WSP Australia Pty Limited (WSP) was engaged by VicRoads as the Technical Advisor for the proposed Mordialloc Bypass (the 'project'), located in outer Melbourne, Victoria. As the project footprint introduces changes to the surface water flow regime discharging to the Edithvale Wetland, a water balance modelling was deemed necessary to inform the Environment Effects Statement (ESS) of the project. This technical report summarises the details of the Edithvale Wetland water balance modelling, including the input data, assumptions, methodology and results.

Edithvale Wetland is a significant water body receiving water mainly from regional drainage system, receiving, retaining and diverting stormwater and other surface run-off. It is listed as a Wetland of International Importance under the Ramsar Convention.

1.2 PURPOSE

This report summarises the details and results of water balance modelling performed on Edithvale Wetland, and serves the purpose of addressing the potential indirect impacts, which is required for Ramsar wetlands under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). The water balance modelling was undertaken to inform the groundwater impact assessment on the level and extent of the impacts of the project in Edithvale Wetland's current hydrologic regime. As such, this document remains an appendix to the Groundwater Impact Assessment report.

Approval from the Commonwealth Minister for the Environment is required for an action which is likely to have a significant impact on wetlands of international significance. As such, a decision has been made to undertake a detailed evaluation of the likelihood and extent of potential changes to hydrological and physiochemical characteristics of Edithvale Wetland, as a result of the construction and operation of the project.

As part of the Edithvale and Bonbeach Level Crossing Removal Projects, a water balance model was developed for Edithvale Wetland on SOURCE platform by GHD-AECOM Joint Venture in February 2018. Because the input data and configuration of this model represented the latest Wetland conditions, it was decided to utilise this model in current study and only make the necessary modifications to address the current project requirements.

The numerical groundwater model set up for the Edithvale Wetland as part of the Edithvale and Bonbeach Level Crossing Removal Projects, provided direct input to the water balance model in form of daily time series representing recharge and leakage between the wetland and the aquifer. These was already provided to us with the water balance model and were used in the current assessment.

1.3 LOCATION

The Edithvale-Seaford Wetlands is the largest natural and constructed wetlands system of its type in the Port Phillip and Westernport basins. It is all that remains of Carrum Carrum Swamp, which once covered more than 4,000 hectares from Mordialloc in the north to Frankston in the south. The project footprint is positioned on the east side of the wetland and as such, a water balance model was required to estimate the impact of the proposed road upgrade on the interactions between the wetland water body and the local groundwater and surface water flows.

The wetland is comprised of a number of interconnected smaller water bodies of varying sizes and depths, which have been referred to as 'cells' in this report.

Figure 1.1 and Figure 1.2 show the Edithvale Wetland cells and the catchments reporting to them.

1.4 WETLAND DESCRIPTION

The key functions of the wetlands are (Ecology 2016):

- Receiving, retaining and diverting stormwater and other surface run-off
- Have a critical flood storage capacity that protects surrounding and downstream properties from flooding; and
- Contribute to protecting the water quality of Port Phillip Bay by retaining and treating stormwater and other run-off.

Edithvale Wetland is divided into North and South Sections:

- Edithvale South Wetlands
  - Edithvale South Wetlands comprises a natural depression on the south side of Edithvale Road with the lowest point being 0.3 m below sea level (GHD 2006).
  - Edithvale South Wetlands are predominantly fed by three drains from catchments to the east which initially entered sediment ponds at the edge of the macrophyte zone. The winter and spring standing water level generally sits at around 0.00 m Australia Height Datum (AHD), but rises up to 0.78 mAHD during rain events and discharges to Edithvale North Wetlands and Centre Swamp Drain; the invert level of the weir is -0.02 mAHD, and therefore, any water above that level discharges to Edithvale North Wetlands. Reduced rainfall during summer and autumn will result in evaporation and water levels drop below 0.00 mAHD.
  - A manually operated pump on Centre Swamp Drain can pump water when the drain holds water into the northern pool during dry periods.
- Edithvale North Wetlands
  - Edithvale North Wetland predominantly comprises a series of constructed wetlands within the former floodplain on the north side of Edithvale Road.
  - Stormwater enters the wetland from stormwater drains from the east via two sediment ponds and from Edithvale South Wetland via a pipe under Edithvale Road.
  - A series of weirs control flow of water between different wetland cells and limit total drawdown during prolonged dry or drought conditions. Stormwater supplies these cells from a series of drains and overland flow.

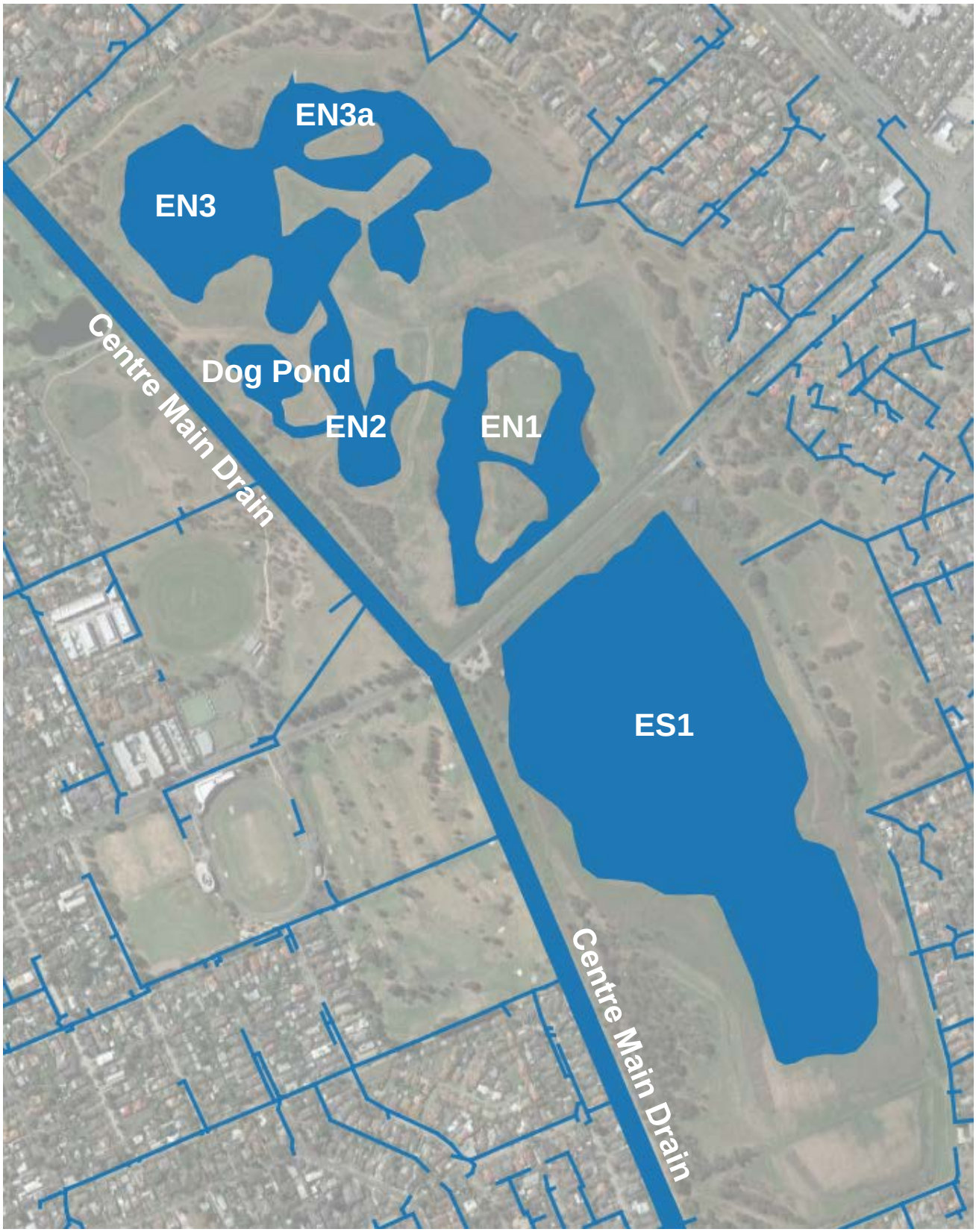


Figure 1.1 Edithvale Wetland cells

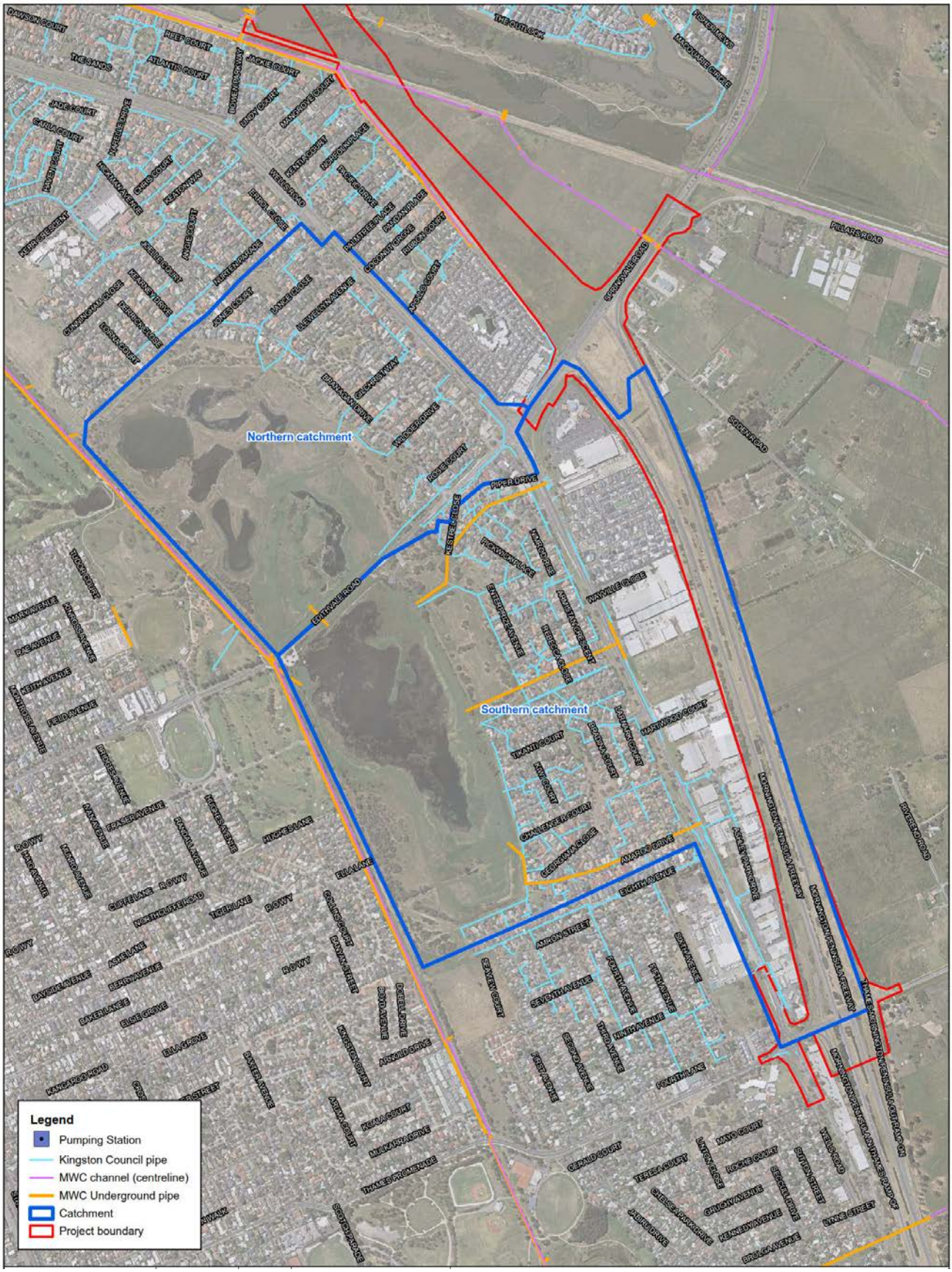


Figure 1.2 Edithvale Wetland cell catchments

2 INPUT DATA

2.1 WETLAND INFLOWS

The inflows into the wetland comprises direct rainfall over the water body and its beach area, surface runoff from the wetland's contributing catchments (refer Figure 1.1) and the groundwater discharge into the wetland water body.

2.1.1 DIRECT RAINFALL

The historical daily rainfall data at the Bonbeach (Carrum) weather station (Station no.086210) for the period 1990-2017 was used to model the direct rainfall falling on the wetland water body, as well as its beach area. In each time step, the open water surface area of each of the wetland cells was calculated using their storage curves, and that was used to calculate the volume of water adding to the system in form of direct rainfall over the cells' water bodies. Due to variation of wetland water level, its beach area increases in dry periods and decreases in wet periods. The rainfall upon the dried beach surface was also incorporated into the model, which produced runoff, based on the soil moisture and depression storage.

2.1.2 STORMWATER RUNOFF

The wetland cells also receive stormwater runoff from the adjacent contributing urban catchments via the council stormwater drainage network. In wet periods, the collected stormwater forms the largest inflow component into the wetland. However, in dry periods this component becomes insignificant or zero.

2.1.3 GROUNDWATER DISCHARGE

Groundwater inflows to the wetland varies between individual wetland cells as previously described by the Department of Sustainability and Environment (2012). Groundwater discharge to the wetland is an important process, particularly in dry periods when surface water contribution to the wetland is minimal. Except for very wet periods, the water level in the wetland is below sea level, making it a sink for local groundwater aquifer. The inflow from local groundwater system to the wetland was modelled in a standalone groundwater numerical model, and was imported into the water balance model in form of a flow time series.

2.2 WETLAND OUTFLOWS

The outflows from the wetland include evapotranspiration, outflow to Centre Main Drain and seepage to local groundwater system.

2.2.1 EVAPOTRANSPIRATION

During the dry periods, evapotranspiration is the main outflow component from the wetland. When the water level in wetland cell EN3 falls below -0.2 mAHD, evapotranspiration is the only means of water loss from the wetland complex. The historical climate data (1990-2017) at the Bonbeach (Carrum) weather station (Station no.086210) was used to model the evapotranspiration in the water balance model.

2.2.2 OUTFLOW TO CENTRE MAIN DRAIN

During the wet periods, the Centre Main Drain located on the west boundary of the wetland, is the main means of discharge from the wetland system. The Centre Main Drain consists of a 1,050 mm to 1,200 mm diameter reinforced concrete underground pipe located below a trapezoidal surface drain (swale). The connection between the wetland system and the Centre Main Drain can occur in cell EN3 via the 150 mm pipes in cell EN3, or overtopping from cell EN3 to the wetland swale in very wet periods.

2.3 GEOMETRIC CHARACTERISTICS

The storage curves (RL-volume-surface area relationship) for each wetland cell was derived using LiDAR data and a 2017 bathymetric survey of the wetland. The following curves were used by the model to calculate:

- The surface water area within each wetland cell, which were used to calculate direct rainfall volume and evapotranspiration.
- The water level corresponding to the water volume in each cell, to calculate the inter-cell flows as well as external discharge into the Centre Main Drain.

Maximum storage capacities of wetland cells are summarised in Table 2.1.

Table 2.1 Edithvale Wetland cells storage capacities and hydrologic regime

WETLAND CELL	STORAGE CAPACITY	OBSERVED HYDROLOGIC REGIME (GHD et al. 2006)
Cell EN1	385 ML	— Winter and spring inundation — Drying in summer and autumn — Desiccates every year — Moist areas in dry periods (groundwater)
Cell EN2	30 ML	— Draws down over summer — Maintains permanent water
Cell EN2b	8 ML	
Cell EN3	101 ML	— Responsive to groundwater — Deep pool that draws down in dry periods
Cell EN3a	108 ML	— Deep pool — Dries out depending on inflows vs. evaporation
Cell ES1	377 ML	— Normally about 0.15 m deep — Winter and spring inundation — Drying in summer and autumn — Desiccates every year in late December — Excavated pools have permanent water, except in drought.

Figure 2.1 to Figure 2.6 show the storage curves for each wetland cell.

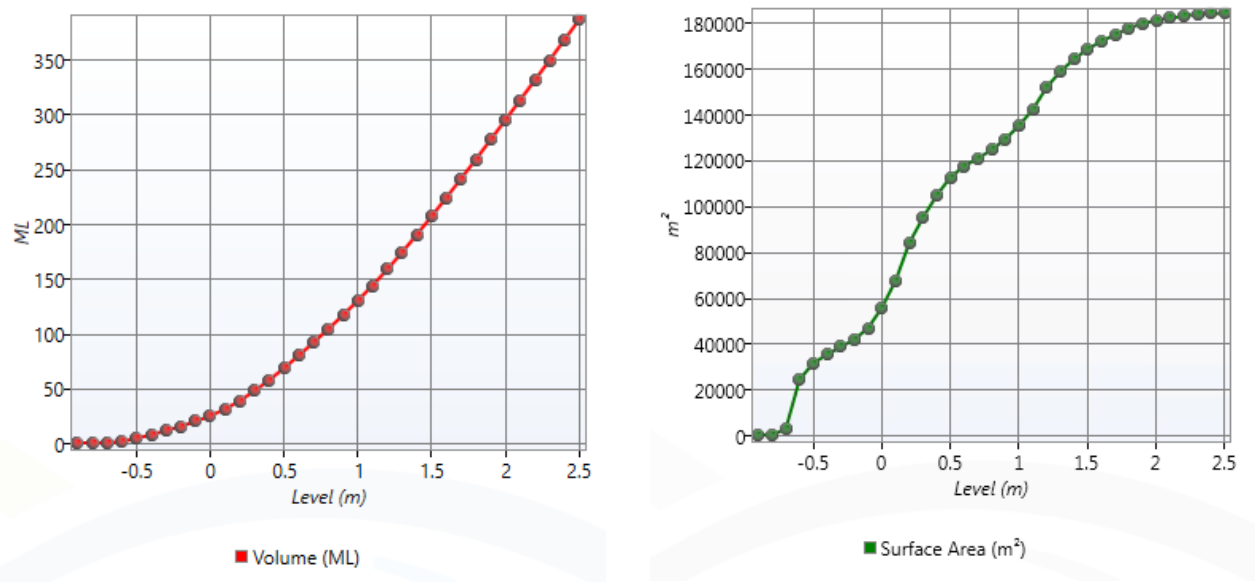


Figure 2.1 Storage curves for cell EN1

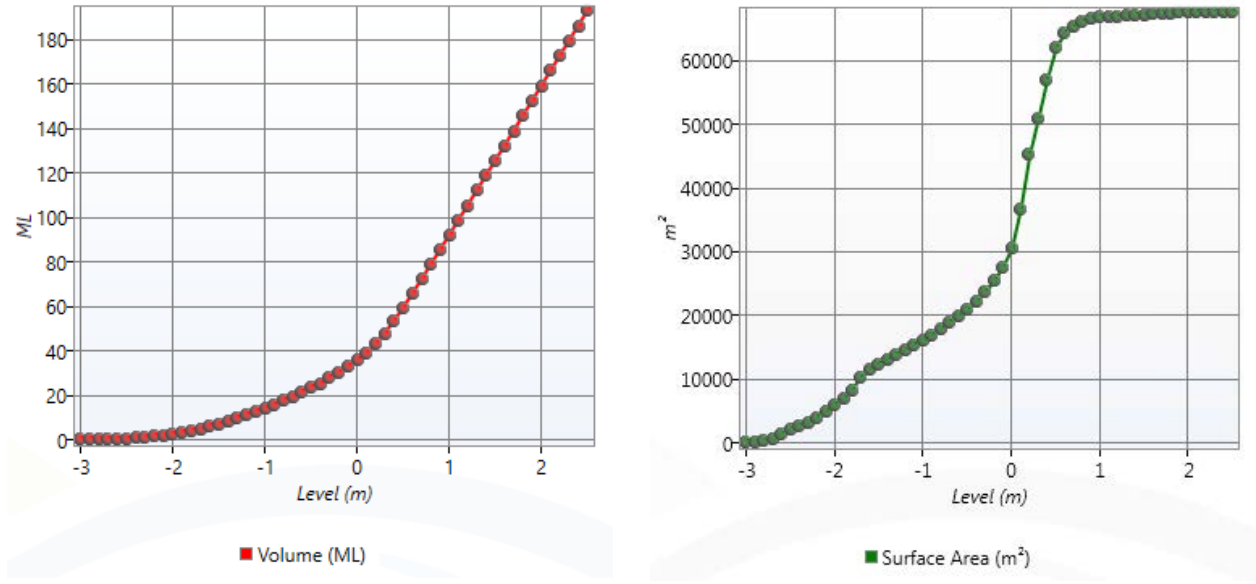


Figure 2.2 Storage curves for cell EN2

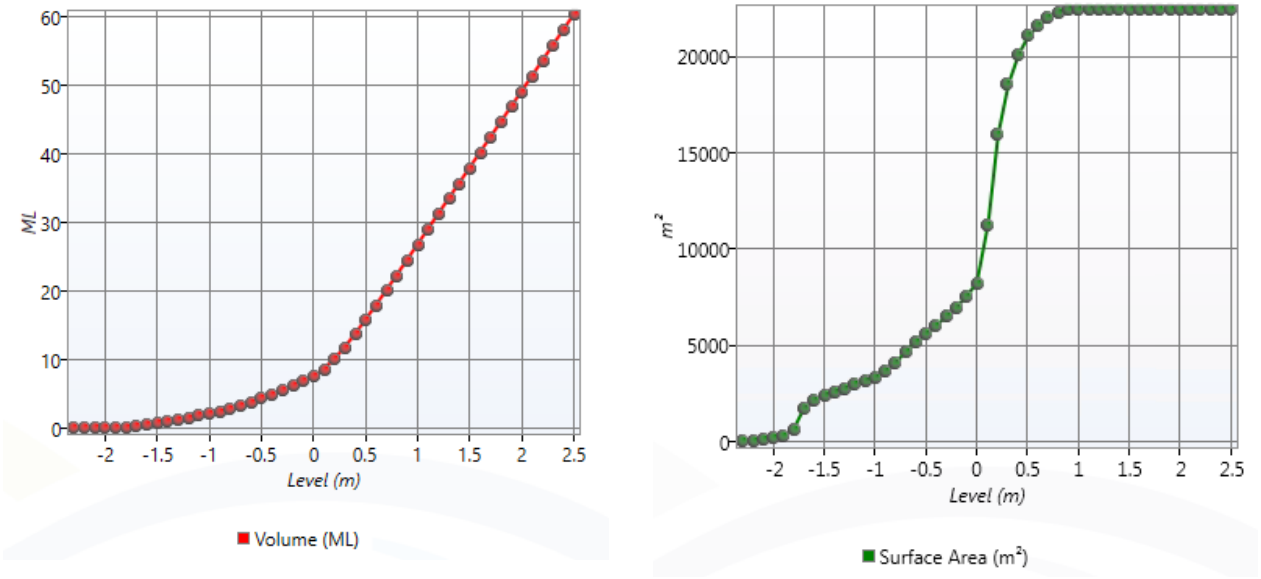


Figure 2.3 Storage curves for cell EN2b

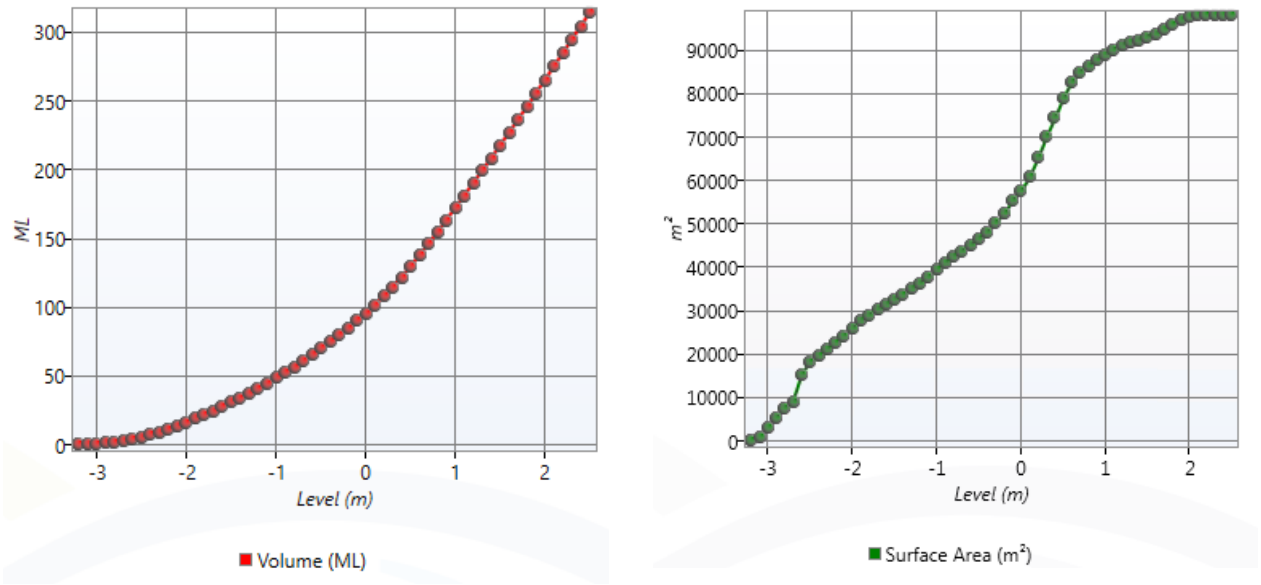


Figure 2.4 Storage curves for cell EN3

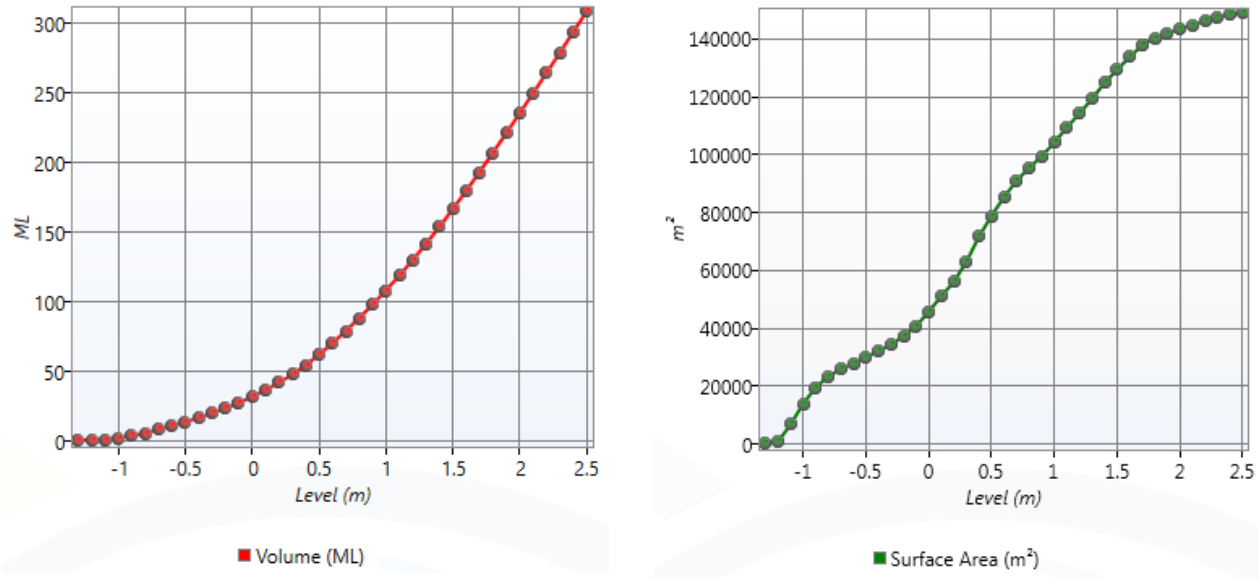


Figure 2.5 Storage curves for cell ES3a

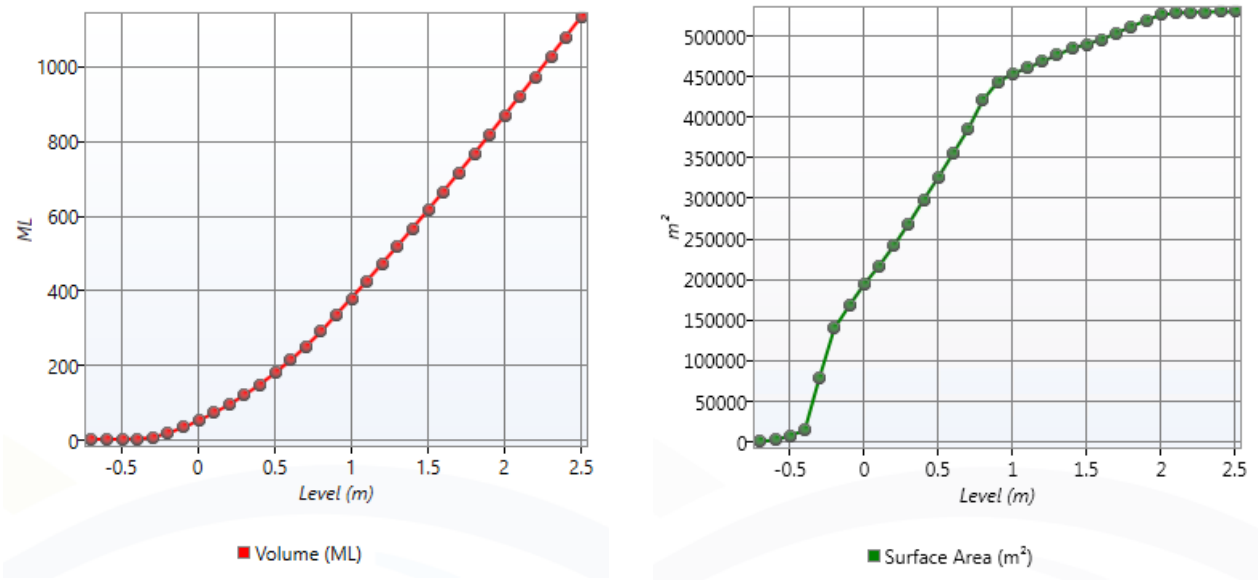


Figure 2.6 Storage curves for cell ES1

2.4 HYDRAULIC CONNECTIVITY

The cells within the wetland system are hydraulically connected to each other and can spill into the Centre Main Drain as well. Table 2.2 lists the type of connection and sill level (level at which the drains begin to flow).

Table 2.2 Edithvale Wetland hydraulic connectivity

	TYPE	SILL LEVEL (mAHD)
ES1 to EN1	Pipe (inverted siphon)	-0.02
EN1 to EN2	Natural channel	-0.15
EN2 to Dog Pond	Natural channel	-0.26
EN2 to EN3	Natural channel	-0.38
EN3a to EN3	Natural channel	-0.97
EN3 to Centre Main Drain	2×150 mm pipes	-0.2 and +0.3
EN3 to Centre Main Drain	Overflow	–
EN1 to Centre Main Drain	Overflow	–
ES1 to Centre Main Drain	Overflow	–

3 EXISTING CONDITIONS

3.1 SURFACE WATER RUNOFF

The surface water runoff resulting from rainfall was incorporated in the model in form of a daily flow time series. A standalone SIMHYD rainfall-runoff model was used to generate the flow time series. The SIMHYD model was calibrated against the observed water levels in the cells, which were translated into daily flow volumes. Although a SIMHYD model was calibrated in the AECOM/GHD 2018 report, the catchment reporting to the wetland was found to be slightly different from the catchment assumed in that report. In the earlier study, the Mornington Peninsula Freeway surface area between Thames Promenade and Springvale Road was not included in the catchment of the wetland. As such, the SIMHYD model was recalibrated with the new addition to the catchment, which based on our close investigation is a more accurate representation of the catchment.

The calibrated hydrologic parameters of the SIMHYD model are listed in Table 3.1. As all wetland cells are expected to yield similar model parameters (GHD/AECOM 2018), the calibration was only performed on cell ES1 and generalised to the other cells within the wetland.

Table 3.1 Calibrated SIMHYD model parameters

PARAMETER	CALIBRATED VALUE	PREVIOUS CALIBRATED VALUE (GHD/AECOM 2018)
Baseflow Coefficient	0.004	0.30
Impervious Threshold	4.94	0.887
Infiltration Coefficient	394	400
Infiltration Shape	4.94	2
Interflow Coefficient	0.004	0.035
Pervious Fraction	0.73	0.83
Rainfall Interception Store Capacity	2.78 mm	2.52 mm
Recharge Coefficient	0.10	1
Soil Moisture Store Capacity	498 mm	495 mm

A comparison between the statistical parameters of the observed and modelled runoff time series is presented in Table 3.2. The calibration was perfumed using the Genetic Algorithm method with Nash-Stutcliffe Criterion being used as the Primary Objective.

Table 3.2 Observed vs. modelled runoff time series

	START	END	LENGTH (DAYS)	TOTAL RUNOFF (mm)	MEAN (mm)	STANDARD DEVIATION (mm)	SKEWNESS (mm)
Observed	11/04/1997	14/06/2017	7370	1988	0.270	0.592	16.959
Modelled	11/04/1997	14/06/2017	7370	1856	0.252	1.163	14.545

It is important to note that due to the large intervals between the wetland water level records and the simplifications adopted to translate the observed water levels into runoff volumes, it is not expected that the calibrated SIMHYD model will be an accurate representative of the catchment. However, with the limited data that have been available, it provides the closest means to approximate the catchment hydrologic regime.

3.2 GROUNDWATER BASEFLOW AND LEAKAGE

The groundwater baseflow and leakage estimates were used to inform the water balance model in form of groundwater inflow and outflow time series to and from each wetland cell.

4 IMPACT ASSESSMENT

Changes in surface water runoff and groundwater regime in the operation phase of the project was previously identified as a potential impact to the Edithvale Wetlands. These impacts are in form of increased surface runoff, resulting from additional impervious road surfaces, and insignificant reduction of groundwater inflows to the wetland due to the compression of unconsolidated material under the embankment structures. Numerical groundwater modelling has since identified that impacts to groundwater associated with the project are negligible.

The scenarios used in the impact assessment are:

- **Base case**: refers to the setup of the model under the existing conditions of the study area, prior to construction of the project.
- **Proposed case**: refers to the setup of model which incorporates the design of the project into the base case scenario model.

In the SOURCE water balance model, the impervious fraction of the catchment was adjusted in the calibrated SIMHYD model to represent the changed catchment runoff characteristics in the Proposed case. Since the numerical groundwater model did not suggested significant changes in baseline groundwater conditions, no changes were made to the groundwater components of the water balance model. However, in order to perform a sensitivity analysis on water balance model results, another scenario was also investigated in which the groundwater inflows to wetland cells were scaled down by 10%. This was purely done for the purpose of sensitivity analysis and from groundwater model results it is not expected to experience this level of change in groundwater conditions. Therefore, the investigated scenarios in the water balance model are:

- Base case
- Proposed case – no change in groundwater (the more likely scenario)
- Proposed case – 10% reduction in groundwater inflows (an extreme scenario).

The above two Proposed cases were also investigated under climate change scenarios with projected evaporation and rainfall rates in years 2040 and 2065.

Because the project footprint falls within the catchment area of wetland cell ES1, this is the only cell which will be directly impacted from increased surface runoff. However, due to hydraulic connectivity of wetland cells, this impact will be transferred to other cells subsequently. The probability of surface inflow exceedance (without consideration of groundwater) to cell ES1 is shown in Table 4.1 and graphically in Figure 4.1.

Table 4.1 Surface runoff reporting to cell ES1 for Base case and Proposed case conditions

PERCENT OF TIME EXCEEDED	BASE CASE (ML/DAY)	PROPOSED CASE (ML/DAY)	DIFFERENCE (ML/DAY)
80th	0.019	0.020	+0.001
50th	0.002	0.002	0.000
20th	0.000	0.000	0.000

The southern wetland, namely the ES1 cell, is the only component of the wetland which will be impacted by changed surface runoff conditions. The surface runoff conditions in the northern wetland cells will remain unimpacted by the project footprint as their catchment conditions will not be affected by the project. The numerical groundwater modelling has indicated that impacts on groundwater regime to wetland cells resulting from the project will be negligible.

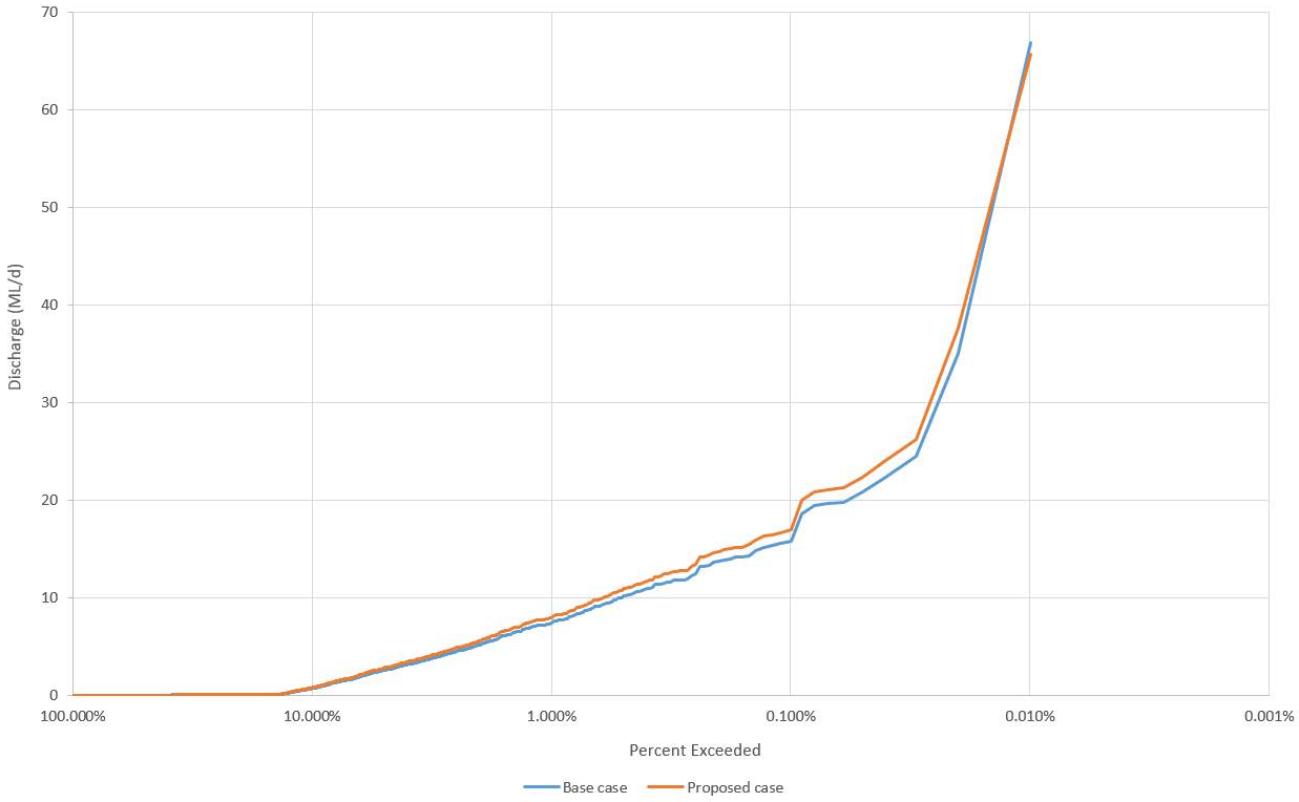


Figure 4.1 Probability of exceedance for the surface inflow reporting to wetland cell ES1 for the Base case and Proposed case scenarios

As Figure 4.1 suggests, in 99% of the simulated days there is insignificant difference between the Base case and Proposed cases. It is only in the extreme rainfall events that the difference between the Base case and Proposed case will be remarkable, which remains limited to about 2%.

4.1 IMPACT ON WATER LEVELS

The simulation was performed over a nine-year period between 2008-2017. The variations in wetland cells' water levels, and water level probability of exceedance for each of the wetland cells over the simulation period are provided in Appendix A-1. From the model results, it is evident that the additional hardstand area introduced by the Bypass to the catchment area of cell ES1 in the Proposed case predominantly leads to increased surface runoff reporting to the wetland.

As the values in Table 4.2 suggest, the proposed project will lead to insignificant change of water levels in wetland cells. Daily changes in water level are highest in cell EN2 due to being located at a lower elevation compared to the other cells, and its small storage capacity, which make its water level more sensitive to changes in the water volume.

Table 4.2 Percentile analysis of change in cell water levels

WETLAND CELL	PERCENTILE	CHANGE IN WATER LEVEL/DEPTH (NO CHANGE IN GROUNDWATER)	CHANGE IN WATER LEVEL/DEPTH (10% REDCUTION IN GROUNDWATER INFLOWS)	CHANGE IN WATER LEVEL/DEPTH (YEAR 2040-NO CHANGE IN GROUNDWATER)	CHANGE IN WATER LEVEL/DEPTH (YEAR 2040-10% REDUCTION IN GROUNDWATER)	CHANGE IN WATER LEVEL/DEPTH (YEAR 2065-NO CHANGE IN GROUNDWATER)	CHANGE IN WATER LEVEL/DEPTH (YEAR 2065-10% REDUCTION IN GROUNDWATER)
EN1	80th Percentile	+0.028m	+0.033m	+0.007m	+0.003m	0.0	0.0
	50th Percentile	0.0	0.0	-0.004m	-0.004m	-0.035m	-0.035m
	10th Percentile	-0.054m	-0.054m	-0.091m	-0.091m	-0.146m	-0.146m
EN2	80th Percentile	+0.424m	+0.407m	+0.034m	+0.003m	-0.002m	-0.003m
	50th Percentile	+0.011m	+0.011m	-0.070m	-0.070m	-0.117m	-0.117m
	10th Percentile	-0.043m	-0.043m	-0.270m	-0.270m	-0.419m	-0.419m
EN2b	80th Percentile	0.0	0.0	0.0	0.0	0.0	0.0
	50th Percentile	0.0	0.0	0.0	0.0	0.0	0.0
	10th Percentile	0.0	0.0	-0.048m	-0.048m	-0.094m	-0.094m
EN3	80th Percentile	+0.194m	+0.138m	-0.001m	-0.004m	-0.013m	-0.019m
	50th Percentile	+0.003m	+0.003m	-0.012m	-0.012m	-0.365m	-0.365m
	10th Percentile	-0.001m	-0.001m	-0.422m	-0.422m	-0.913m	-0.913m
EN3a	80th Percentile	+0.005m	+0.003m	-0.001m	-0.001m	-0.003m	-0.004m
	50th Percentile	+0.001m	+0.001m	-0.013m	-0.013m	-0.036m	-0.036m
	10th Percentile	0.0	0.0	-0.074m	-0.074m	-0.127m	-0.127m
ES1	80th Percentile	+0.015m	+0.015m	+0.005m	+0.004m	-0.001m	-0.002m
	50th Percentile	+0.007m	+0.007m	-0.001m	-0.001m	-0.009m	-0.009m
	10th Percentile	-0.003m	-0.003m	-0.021m	-0.021m	-0.038m	-0.038m

4.2 IMPACTS ON WETLAND SURFACE AREA

The variation of wetland cells' wet area was also investigated in the model to estimate the change in the extent of wet area. The detailed time series plots of surface areas for each wetland cell are presented in Appendix A-2 and a more concise plot representing the changes in surface area in northern wetland (cells EN1, EN2, EN2b, EN3 and EN3a) and southern wetland (cell ES1) is presented in Figure 4.2 and Figure 4.3.

As the values in the table suggest, the changes in wetland surface area is not very sensitive to the groundwater inflow rate, particularly in the southern wetland (cell ES1). Under existing climate conditions, in 80% of times the surface area of the northern wetland will increase by about 7% and in southern wetland by about 5%. Under the simulated climate change conditions there will be more significant changes to the wet surface areas, which largely due to changed climate conditions rather than the project.

Table 4.3 Percentile analysis of change in wetland surface areas in Proposed case scenarios

	CHANGE IN SURFACE AREA, NORTHERN WETLAND						CHANGE IN SURFACE AREA, SOUTHERN WETLAND					
	no change in groundwater	10% Reduction in groundwater	Year 2040- No Change in groundwater	Year 2040- 10% reduction in groundwater	Year 2065- No Change in groundwater	Year 2040- 10% reduction in groundwater	no change in groundwater	10% Reduction in groundwater	Year 2040- No Change in groundwater	Year 2040- 10% reduction in groundwater	Year 2065- No Change in groundwater	Year 2040- 10% reduction in groundwater
80th Percentile	+7.1%	+5.7%	0.0%	-0.5%	-1.8%	-2.0%	+5.3%	+5.3%	+0.9%	+0.9%	-0.1%	-0.4%
50th Percentile	+2.8%	+2.2%	-3.8%	-3.7%	-7.9%	-8.2%	+1.7%	+1.8%	-0.3%	-0.2%	-1.95	-2.0%
10th Percentile	-0.4%	-0.7%	-16.6%	-16.8%	-34.6%	-37.8%	-0.5%	-0.3%	-10.6%	-8.7%	-21.0%	-21.1%

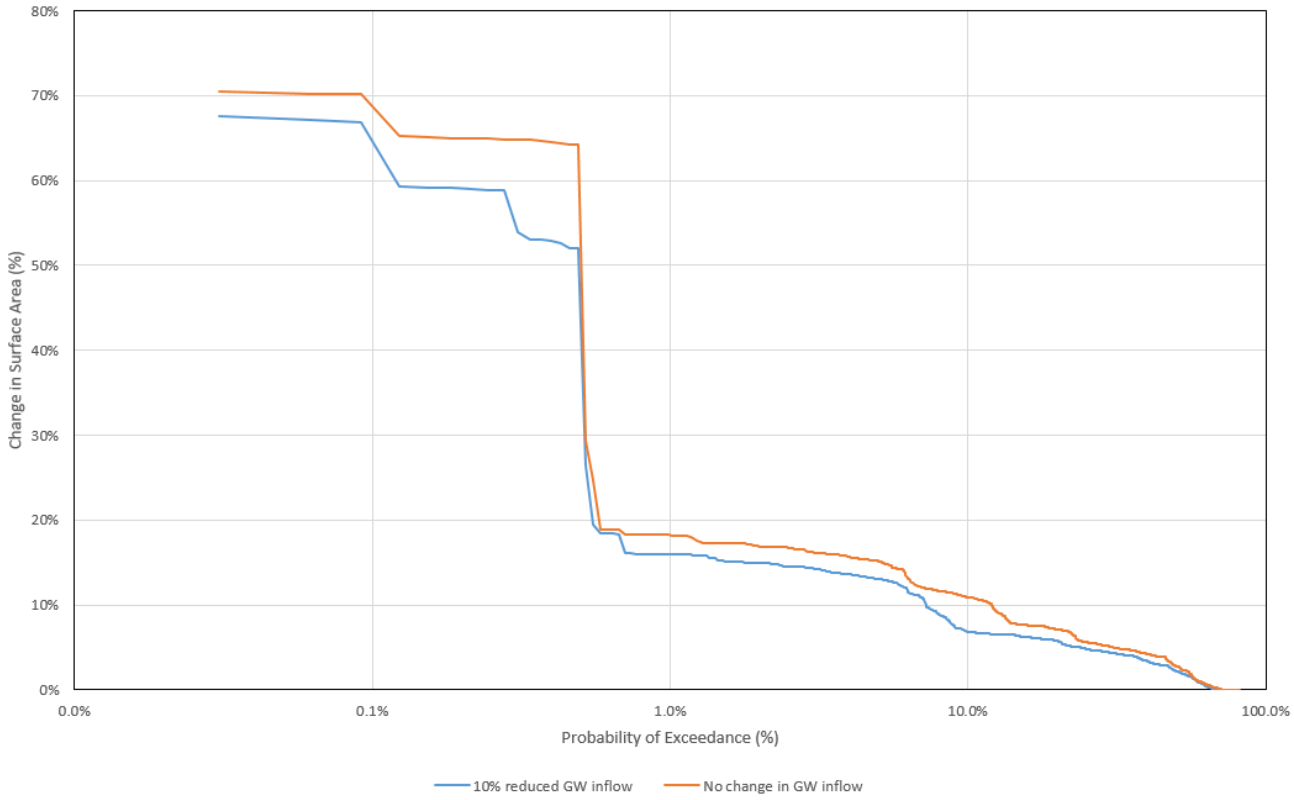


Figure 4.2 Probability of exceedance in northern wetland surface area

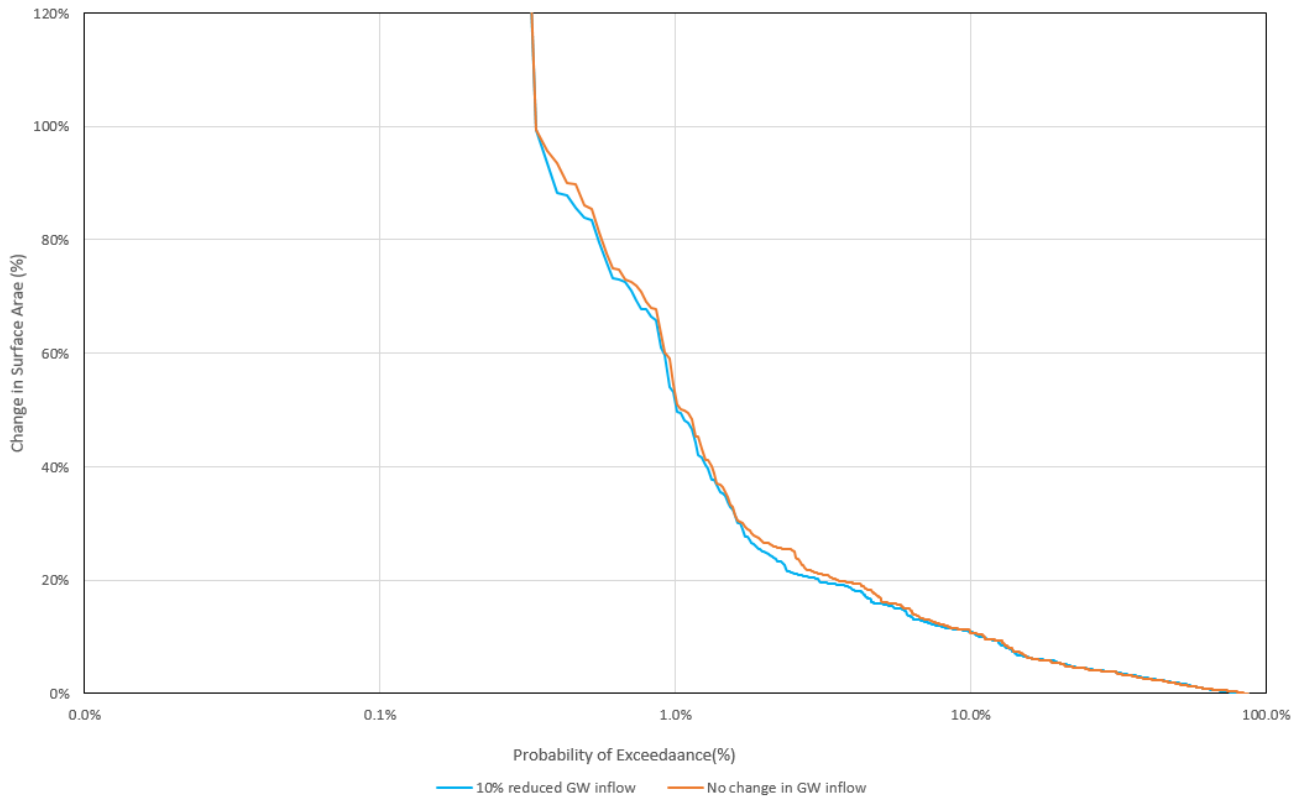


Figure 4.3 Probability of exceedance in southern wetland surface area

4.3 IMPACTS ON WETTING-DRYING PROCESS

The water balance model was used to estimate the number of dry days under Base case and Proposed case conditions. It should be noted that due to limited historical data available for the wetland cells, it has not been possible to identify the wet/dry status of each cell on a daily basis for the duration of simulation. Instead, the modelled values from the water balance under existing conditions were used to approximate the wet/dry status of each cell on a daily basis. The modelled results are shown in Table 4.4.

Under current climate conditions, there is insignificant change to the duration of wet/dry period for each wetland cell.

In general, there is no meaningful difference in the number of dry days in each wetland cell.

Table 4.4 Modelled number of dry days in each wetland cell under Base case and Proposed case scenarios

		CELL EN1	CELL EN2	CELL EN2b	CELL EN3	CELL EN3a	CELL ES1
Year 2009	Base case	241	0	23	0	0	0
	Proposed case (10% change in GW)	235	0	23	0	0	0
	Proposed case (No change in GW)	234	0	23	0	0	0
Year 2010	Base case	0	0	365	0	0	0
	Proposed case (10% change in GW)	0	0	365	0	0	0
	Proposed case (No change in GW)	0	0	365	0	0	0
Year 2011	Base case	0	0	365	0	0	0
	Proposed case (10% change in GW)	0	0	365	0	0	0
	Proposed case (No change in GW)	0	0	365	0	0	0
Year 2012	Base case	0	0	366	0	0	0
	Proposed case (10% change in GW)	0	0	366	0	0	0
	Proposed case (No change in GW)	0	0	366	0	0	0

		CELL EN1	CELL EN2	CELL EN2b	CELL EN3	CELL EN3a	CELL ES1
Year 2013	Base case	0	0	365	0	0	0
	Proposed case (10% change in GW)	0	0	365	0	0	0
	Proposed case (No change in GW)	0	0	365	0	0	0
Year 2014	Base case	0	0	365	0	0	0
	Proposed case (10% change in GW)	0	0	365	0	0	0
	Proposed case (No change in GW)	0	0	365	0	0	0
Year 2015	Base case	36	0	365	0	0	0
	Proposed case (10% change in GW)	43	0	365	0	0	0
	Proposed case (No change in GW)	43	0	365	0	0	0
Year 2016	Base case	172	1	366	1	1	0
	Proposed case (10% change in GW)	156	0	366	0	0	0
	Proposed case (No change in GW)	156	0	366	0	0	0

4.4 IMPACTS ON WATER QUALITY

Due to insignificance of changes in water levels within the wetland cells, it is expected that the predicted water quality change due to the proposed development will be very small compared to the large variation of water quality which already exists within the cells.

From the model result it is evident that the impact of changed groundwater regime on hydrologic regime of the wetland is less significant than changes in surface runoff. Also, as shown in Table 4.1, the impact on surface water flow regime reporting to cell ES1 is limited to less than 0.001 ML/d in 80% of times, so it is expected that there will be minimal impact to wetland water quality resulting from the proposed project. Any change to water quality indicators, including Total Dissolved Solids (TDS), will be in form of dilution.

5 CONCLUSION

The SOURCE water balance model which was made available for Edithvale Wetland was used to estimate the changes to the wetland's hydrologic regime due to the proposed project. A SIMHYD rainfall-runoff model was established for the wetland and calibrated against the observed data at cell ES1 to represent its existing surface runoff regime. The impervious fraction of the catchment in the SIMHYD model was increased to represent the increased surface runoff reporting to cell ES1 of the wetland by the Bypass under the Proposed case conditions.

For the Proposed case, the water balance of the wetland was investigated under two scenarios:

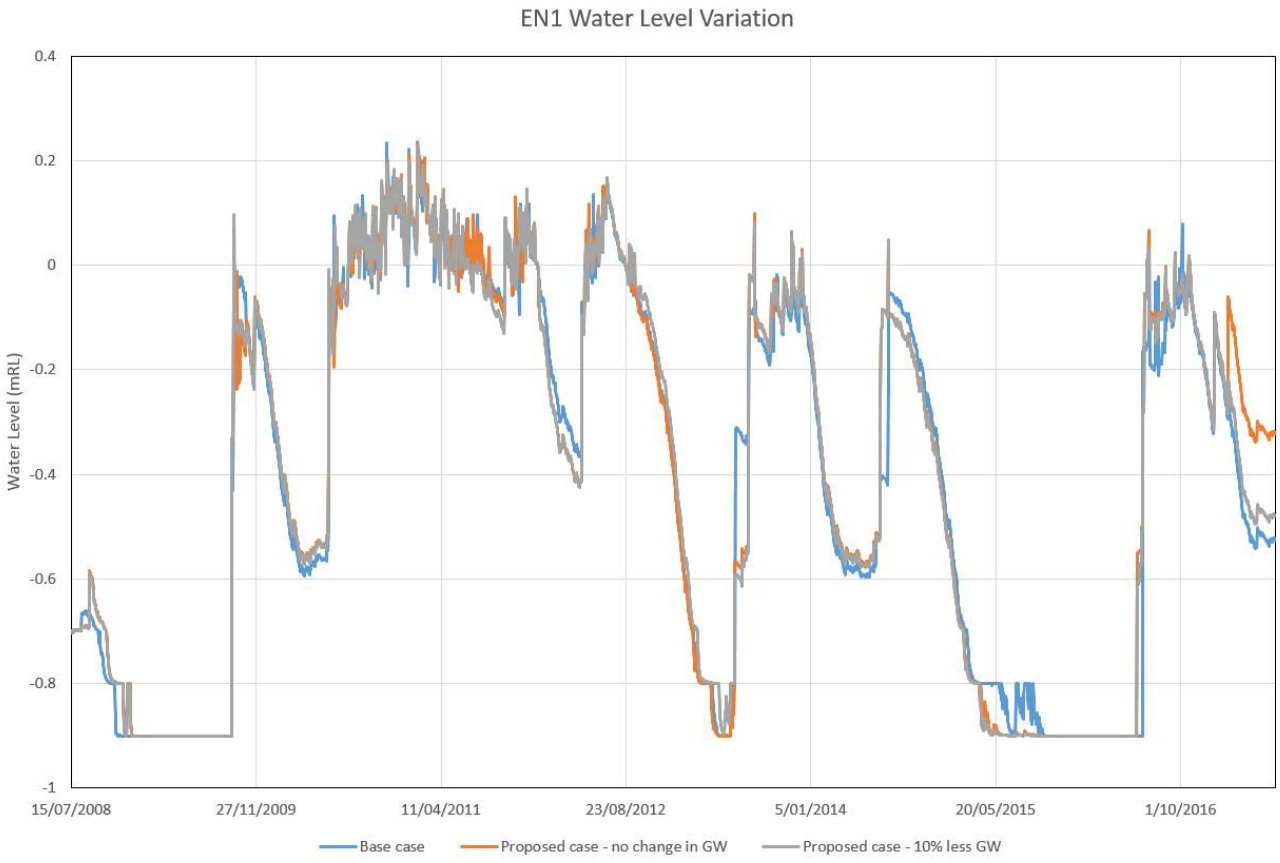
- No change in groundwater conditions; which, based on the groundwater modelling, is the more likely scenario
- 10% reduction in groundwater inflows into the wetland; which is an extreme case investigated for the purpose of a sensitivity analysis.

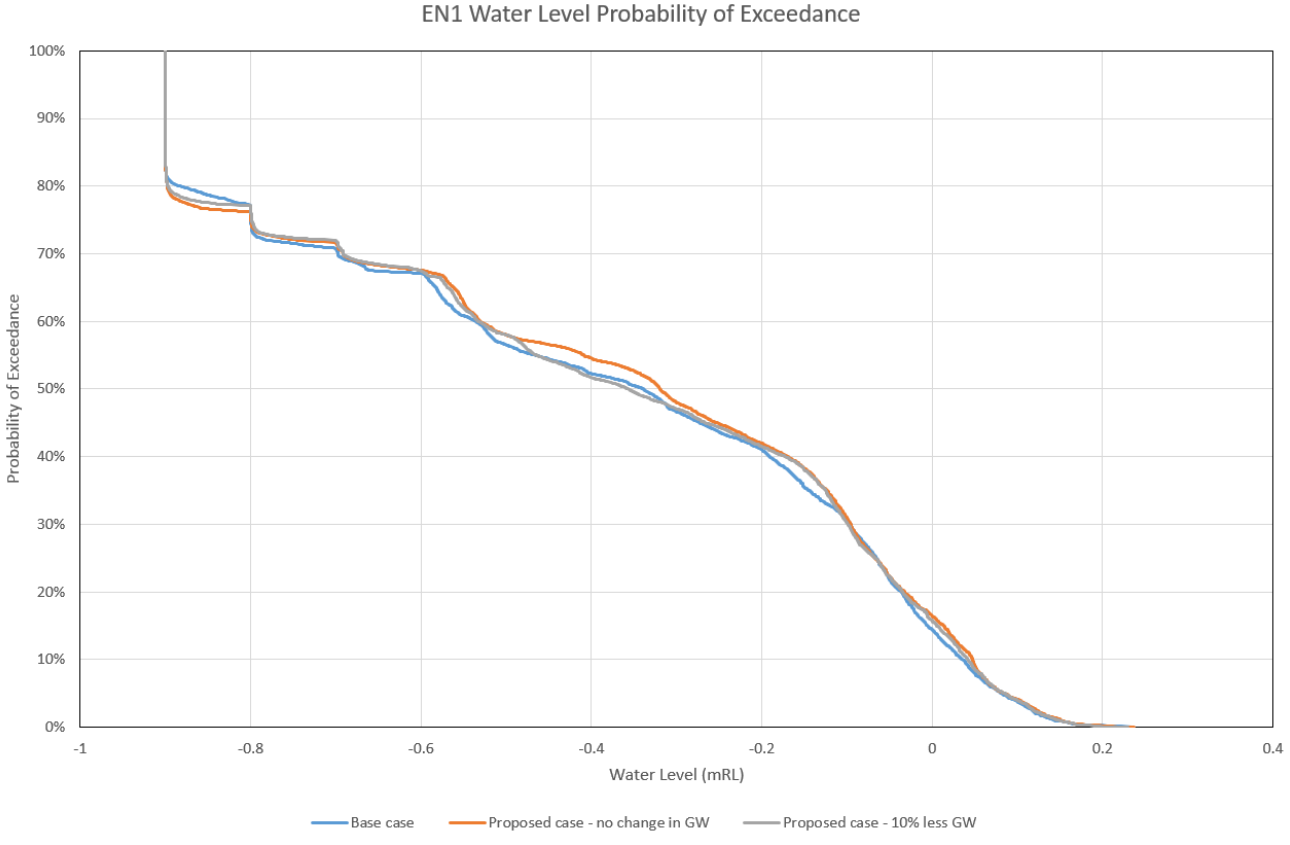
The sensitivity analysis suggests there is little sensitivity to changes in groundwater inflows between 0% to 10%. Also, it was evident from the results that the effect of increased surface runoff dominates the effect of reduced groundwater inflows, resulting in net increased inflow into the wetland.

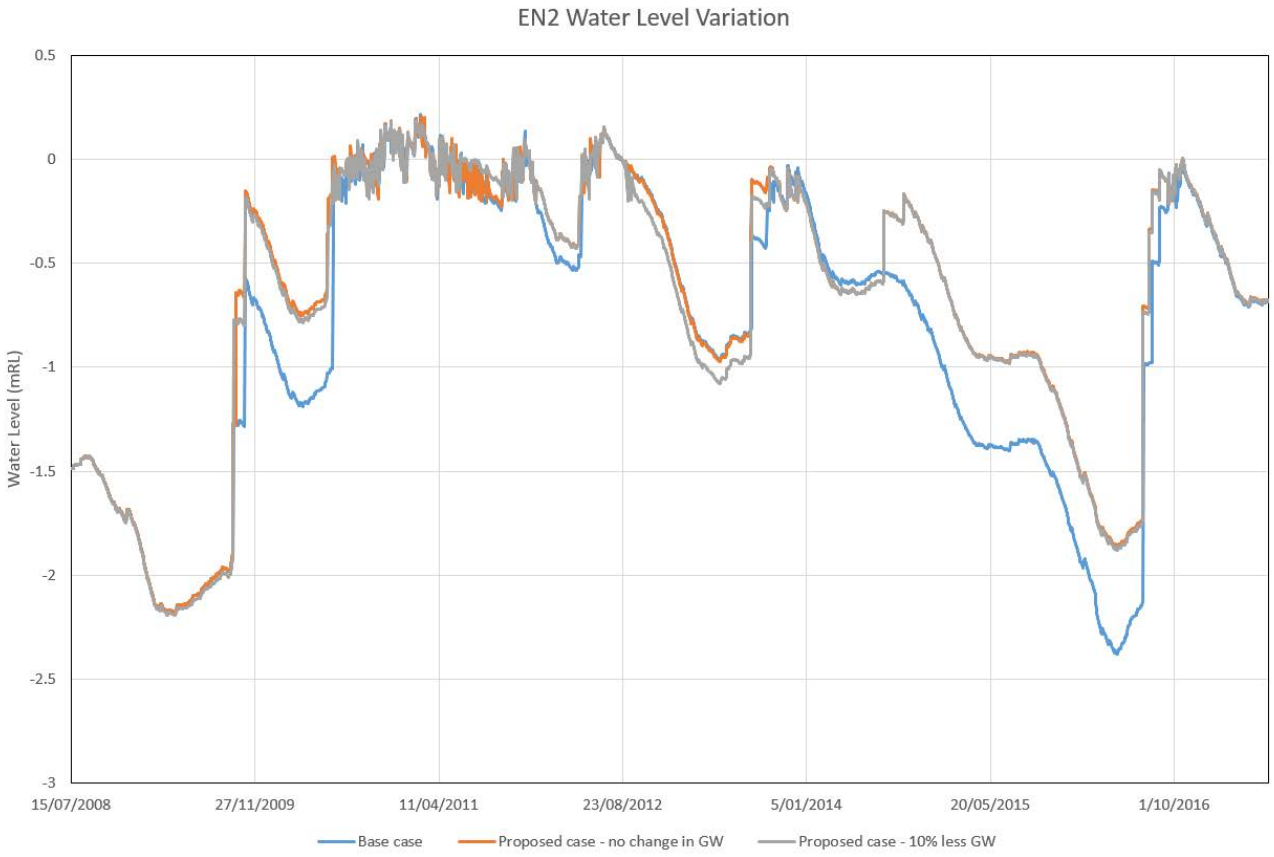
The model suggests that as a result of the project, the net flow reporting to cell ES1 will increase. However, in 80% of times the order of this change will be limited to 1m³ per day or less. Based on the percentile analysis undertaken, in 80% of times insignificant impact is expected to occur in wetland cells' water levels. Cell ES1 water levels are expected to remain unaffected in 80% of times and there will be minor change in water levels of the other wetland cells. The model also suggests that the changes to wetland open surface area will be less than 6% in 80% of times. The number of dry days in wetland cells under the Base case and Proposed case were investigated, suggesting that there will not be a meaningful impact on the duration of wet and dry periods within the wetland cells.

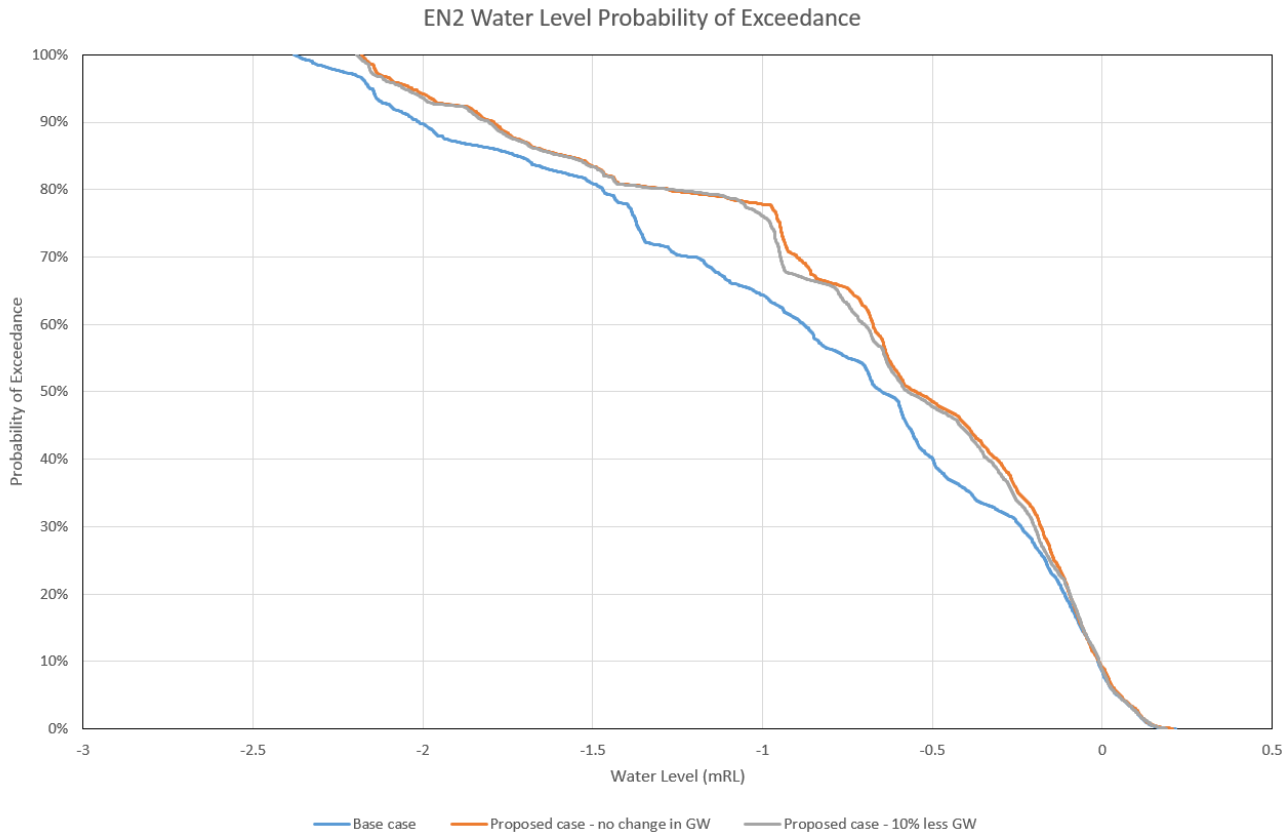
Due to insignificance of changes in water levels within the wetland cells, it is expected that the predicted water quality change due to the proposed development will be very small compared to the large variation of water quality which already exists within the cells, due to its highly variable flow regime. As such, no water quality modelling was deemed necessary for the purpose of the surface water impact assessment.

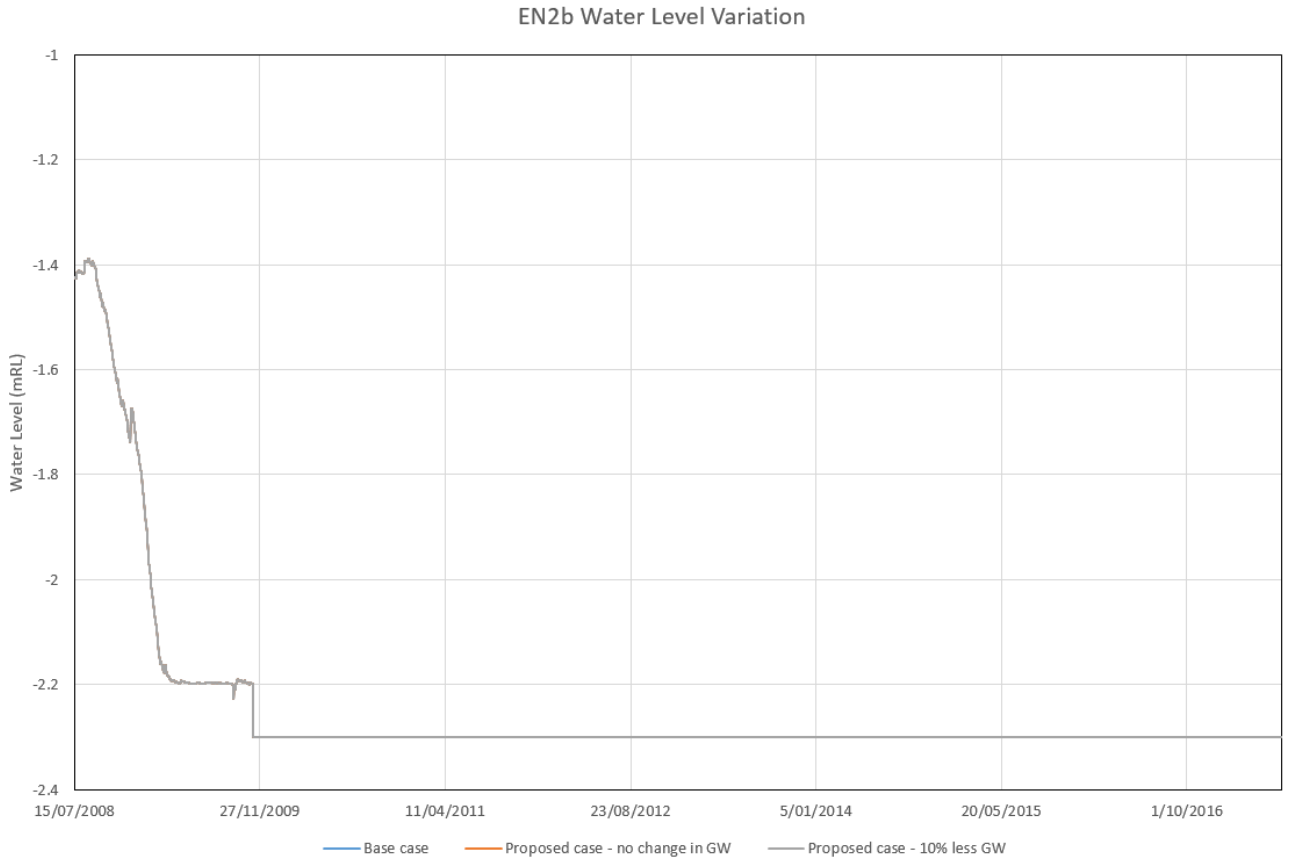
APPENDIX A-1
MODELLED WATER LEVEL VARIATION AND PROBABILITY OF EXCEEDANCE IN WETLAND CELLS

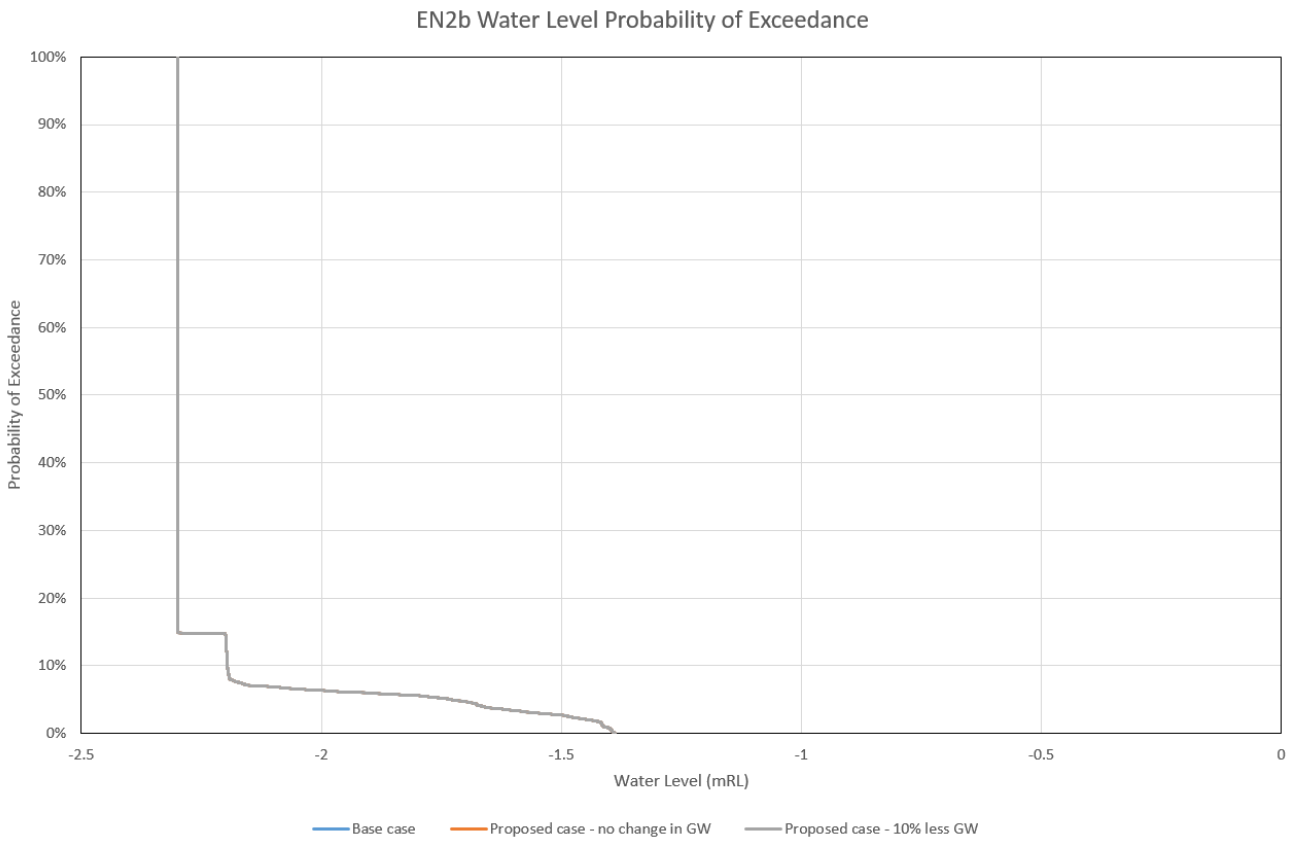

EN1 Water Level Variation
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
Water Level (mRL)
15/07/2008
27/11/2009
11/04/2011
23/08/2012
5/01/2014
20/05/2015
1/10/2016
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

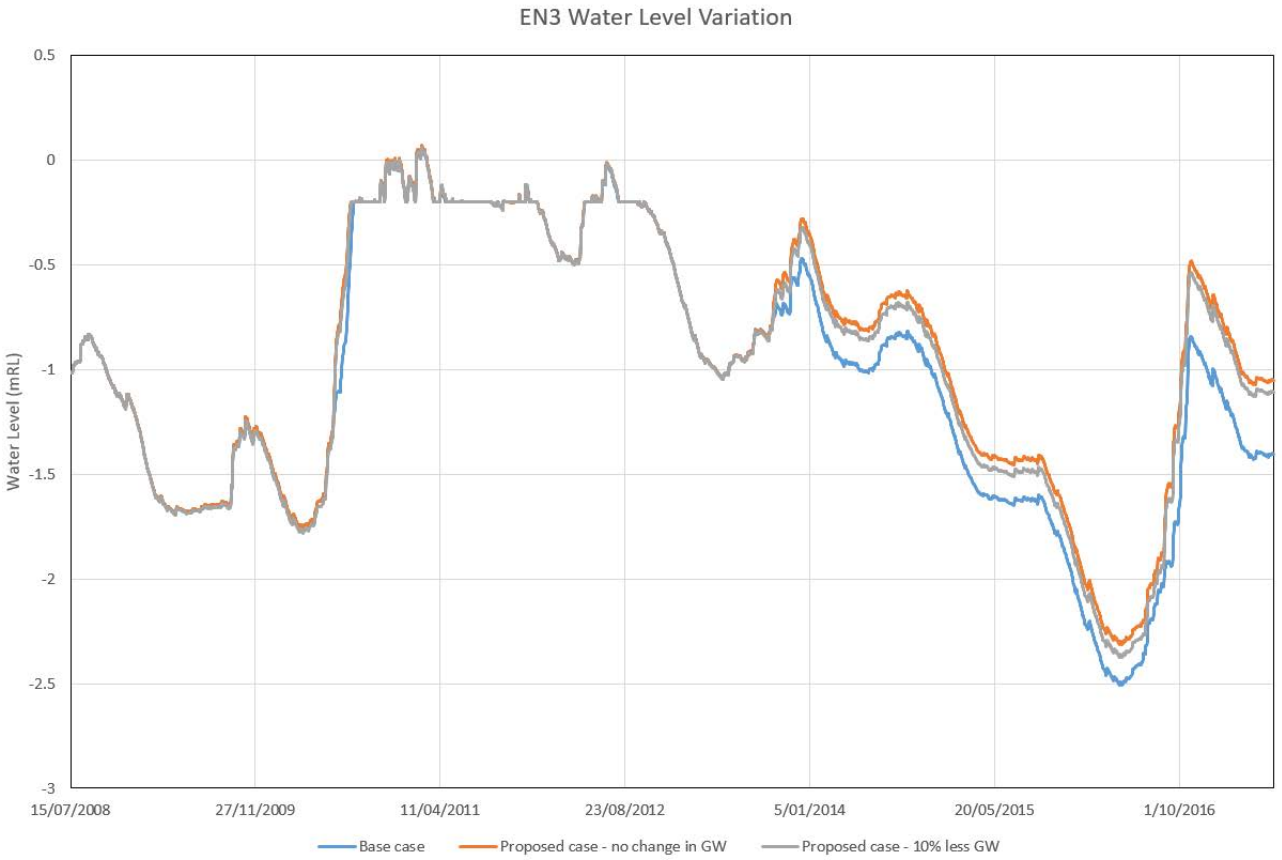

EN1 Water Level Probability of Exceedance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Probability of Exceedance
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
0.4
Water Level (mRL)
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

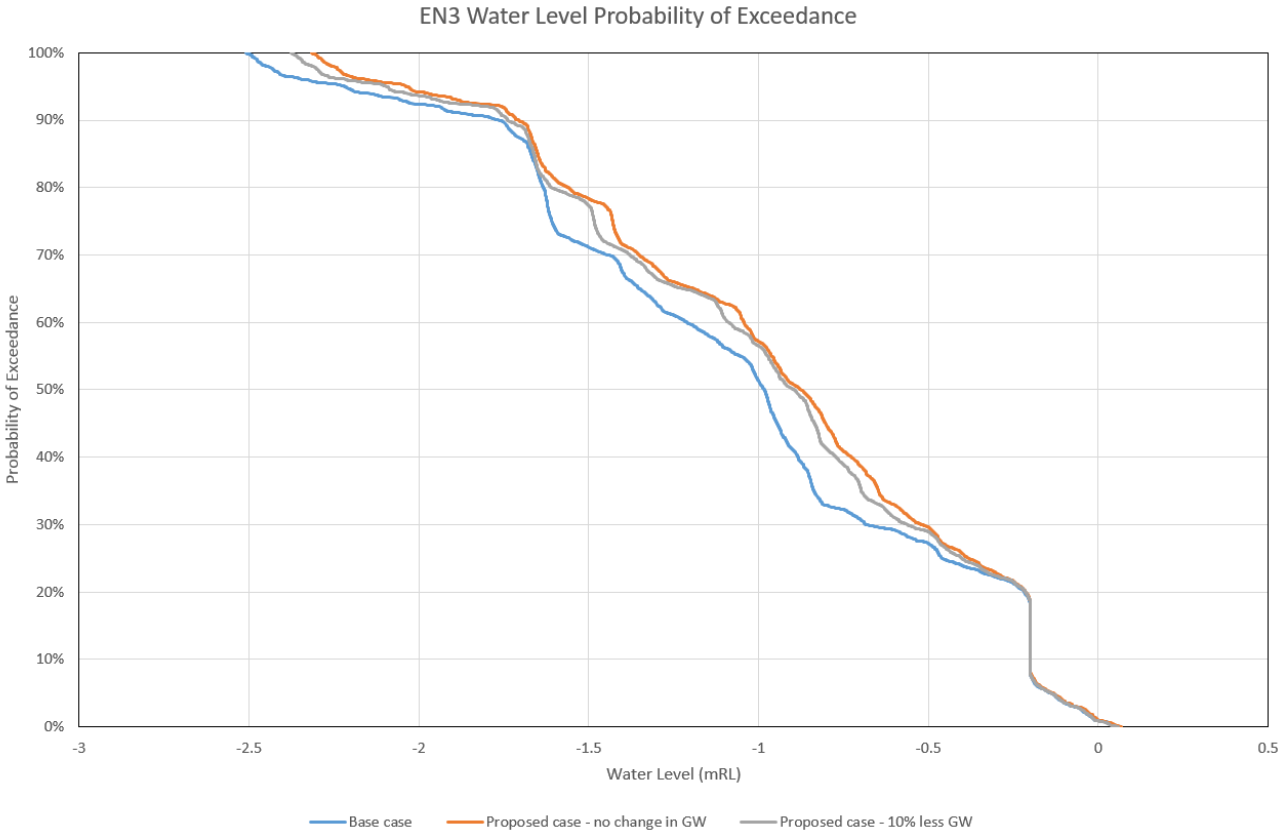

EN2 Water Level Variation
Water Level (mRL)
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
15/07/2008
27/11/2009
11/04/2011
23/08/2012
5/01/2014
20/05/2015
1/10/2016
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

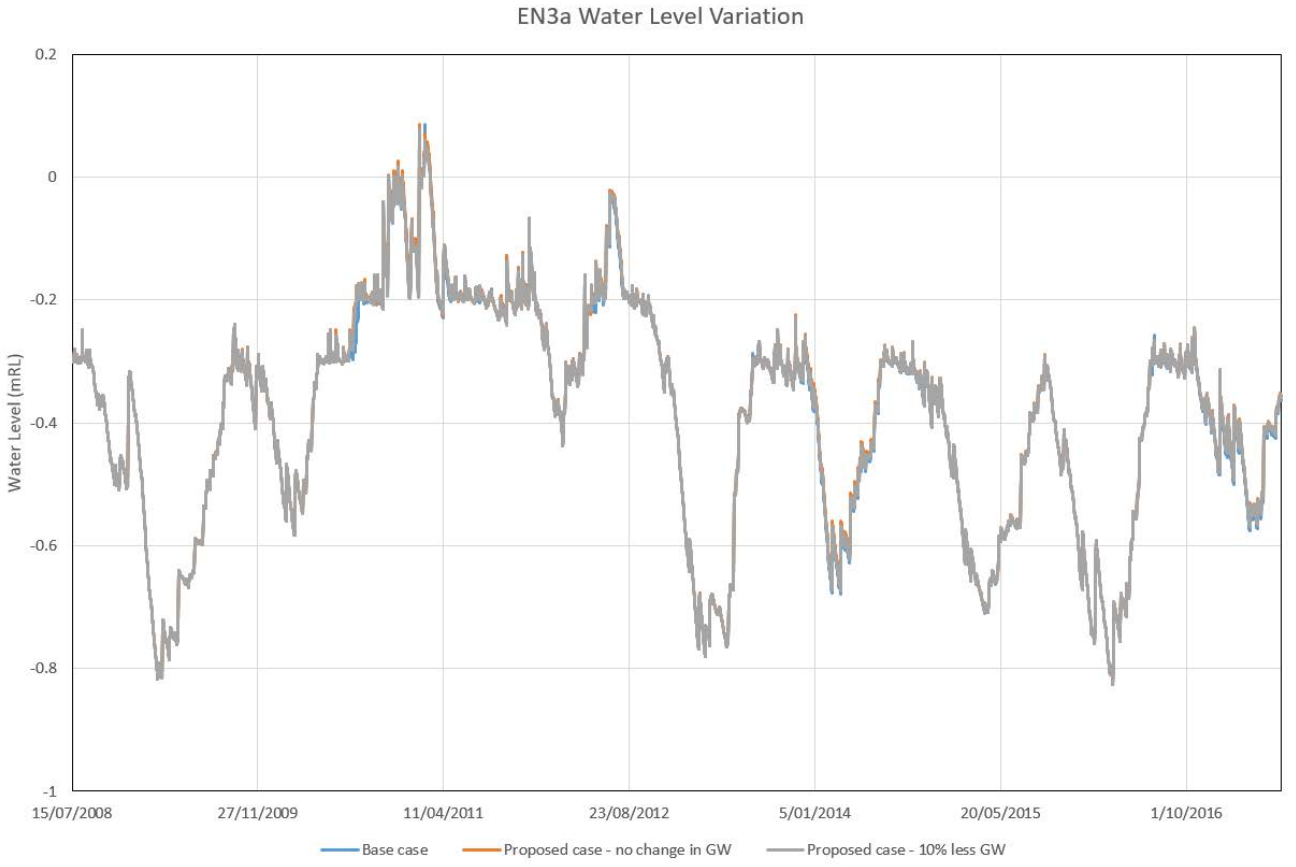

EN2 Water Level Probability of Exceedance
Probability of Exceedance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
Water Level (mRL)
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

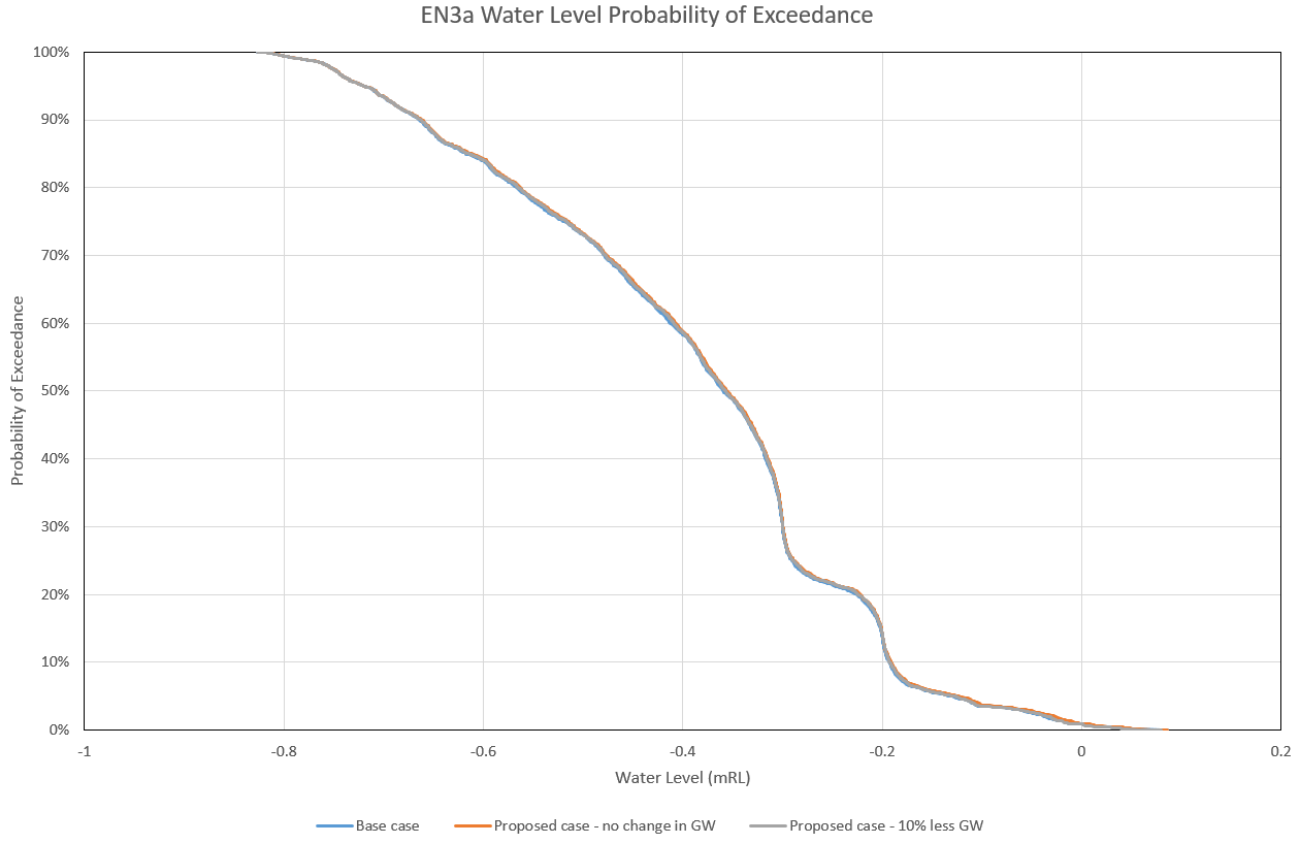

EN2b Water Level Variation
Water Level (mRL)
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
-2.4
15/07/2008
27/11/2009
11/04/2011
23/08/2012
5/01/2014
20/05/2015
1/10/2016
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

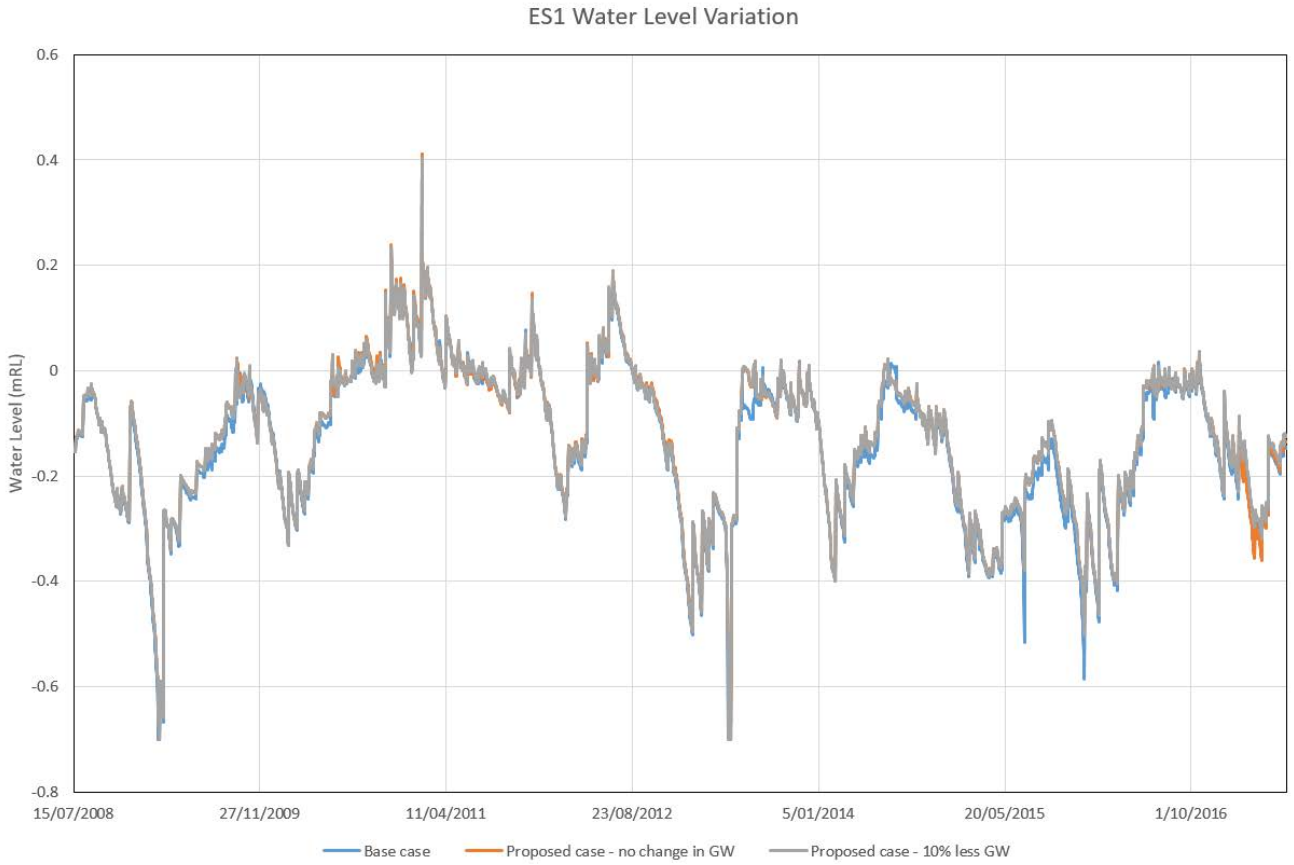

EN2b Water Level Probability of Exceedance
Probability of Exceedance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
-2.5
-2
-1.5
-1
-0.5
0
Water Level (mRL)
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

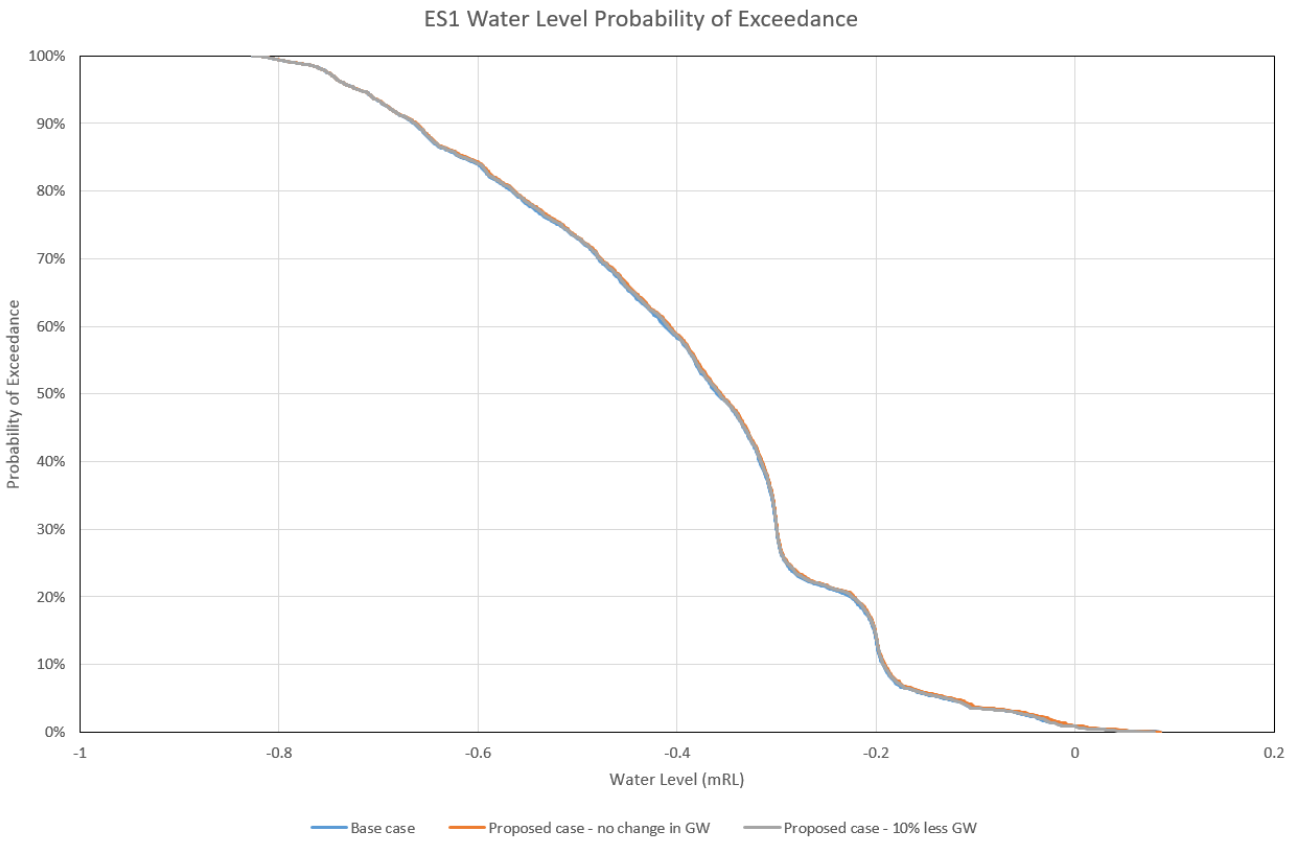

EN3 Water Level Variation
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
Water Level (mRL)
15/07/2008
27/11/2009
11/04/2011
23/08/2012
5/01/2014
20/05/2015
1/10/2016
Base case
Proposed case - no change in GW
Proposed case - 10% less GW


EN3 Water Level Probability of Exceedance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Probability of Exceedance
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
Water Level (mRL)
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

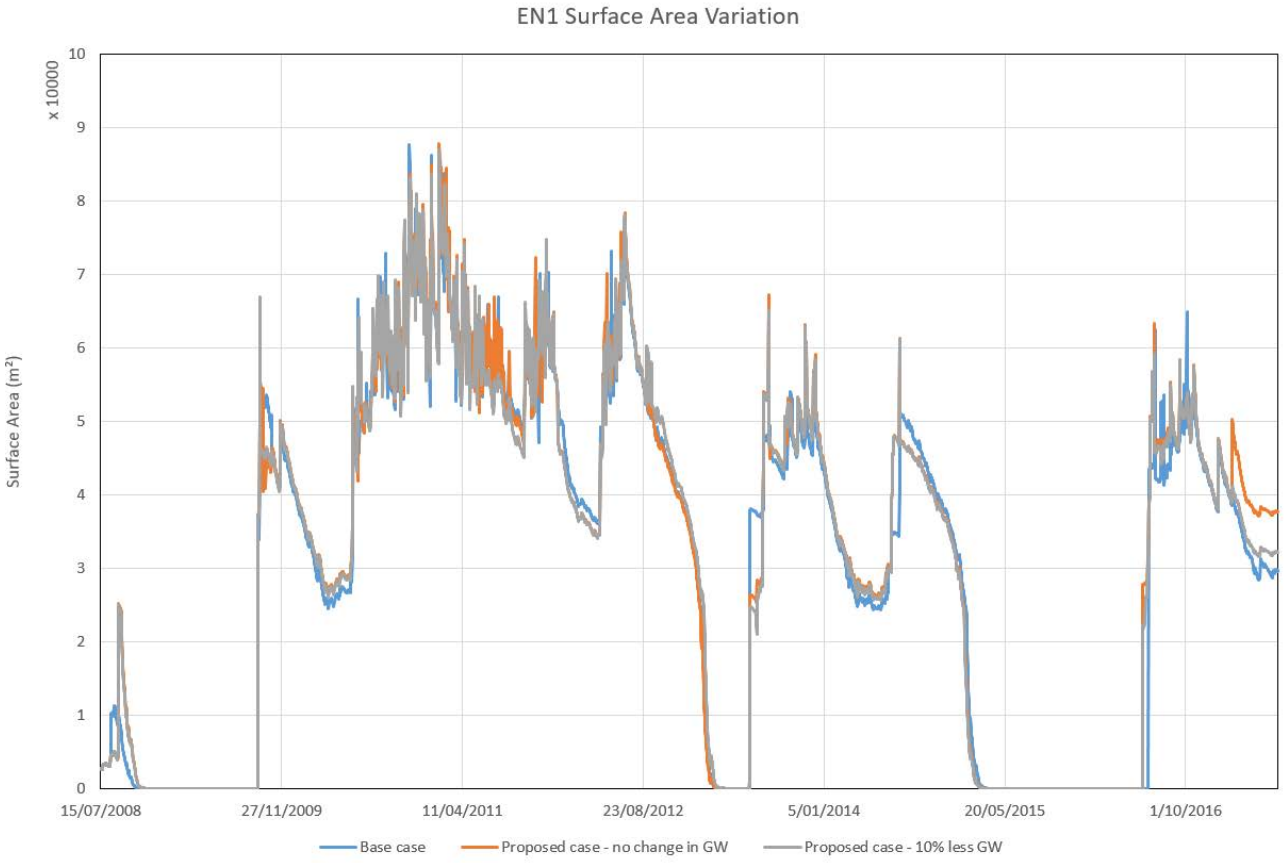

EN3a Water Level Variation
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
Water Level (mRL)
15/07/2008
27/11/2009
11/04/2011
23/08/2012
5/01/2014
20/05/2015
1/10/2016
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

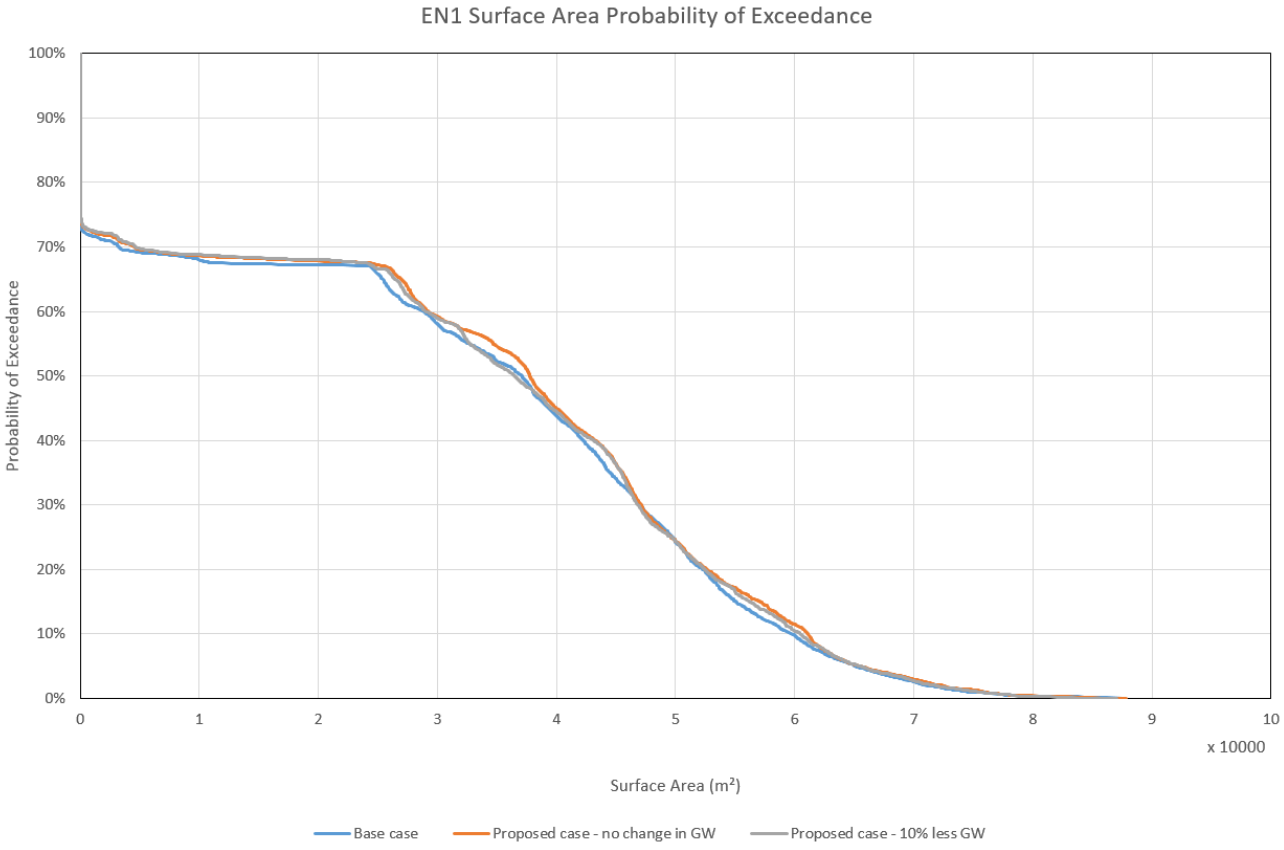

EN3a Water Level Probability of Exceedance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Probability of Exceedance
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
Water Level (mRL)
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

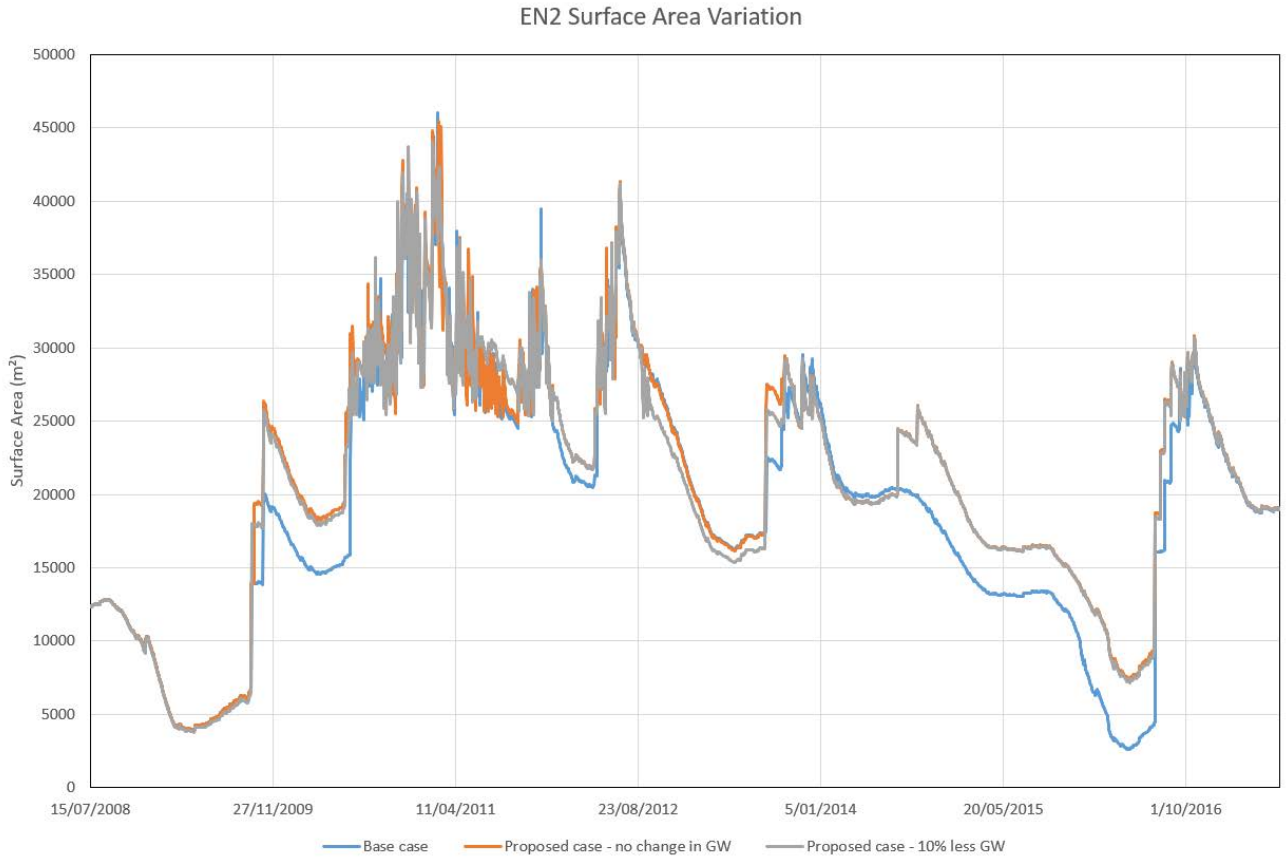

ES1 Water Level Variation
Water Level (mRL)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
15/07/2008
27/11/2009
11/04/2011
23/08/2012
5/01/2014
20/05/2015
1/10/2016
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

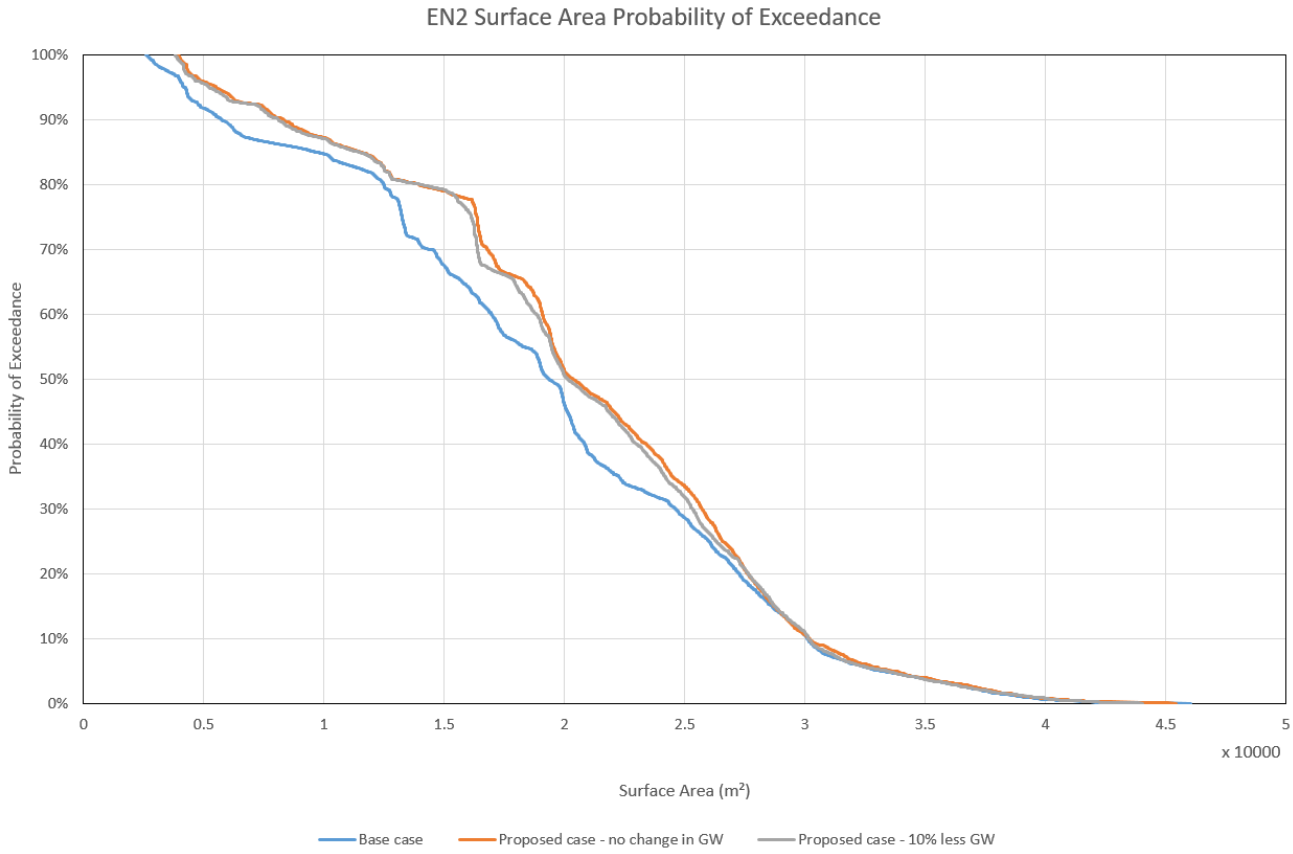

ES1 Water Level Probability of Exceedance
Probability of Exceedance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
-1
-0.8
-0.6
-0.4
-0.2
0
0.2
Water Level (mRL)
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

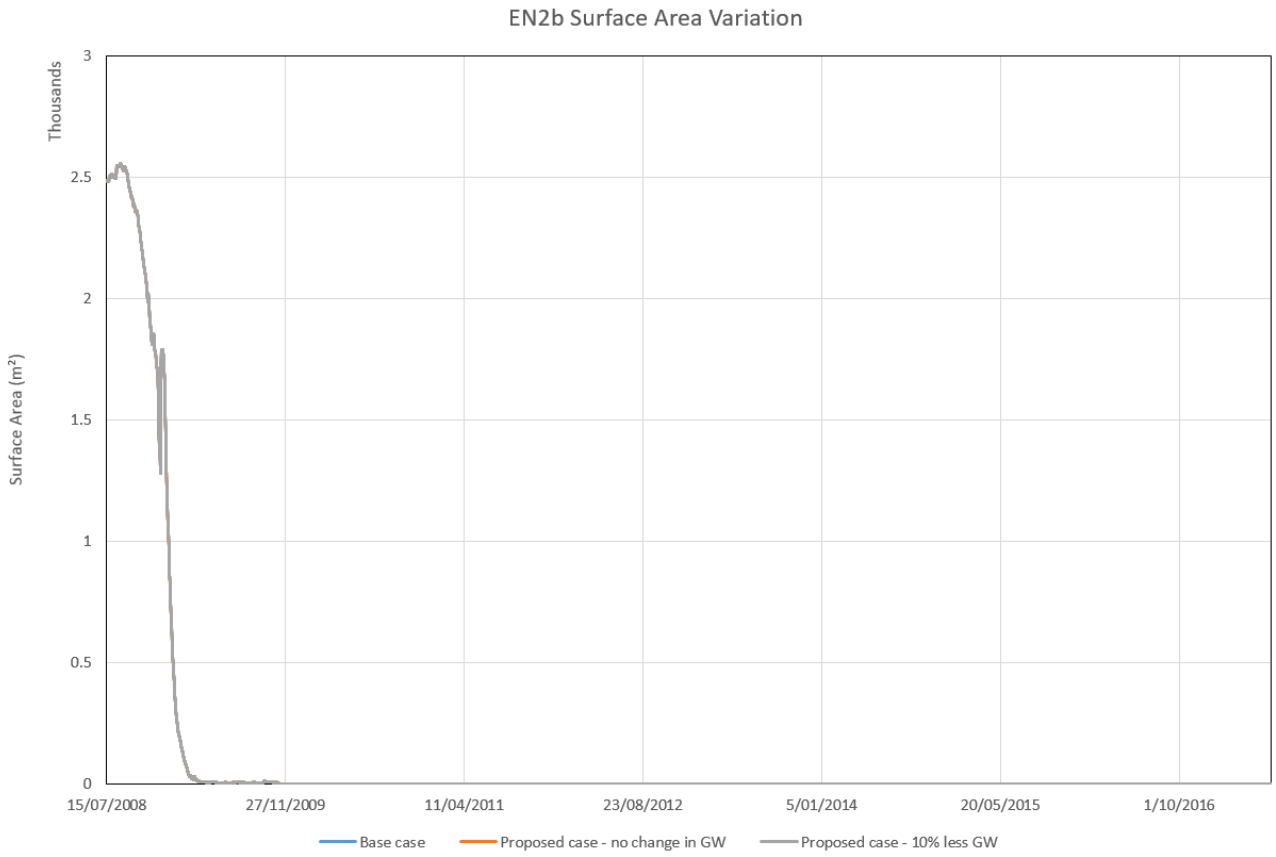
APPENDIX A-2
MODELLED SURFACE AREA VARIATION AND PROBABILITY OF EXCEEDANCE IN WETLAND CELLS

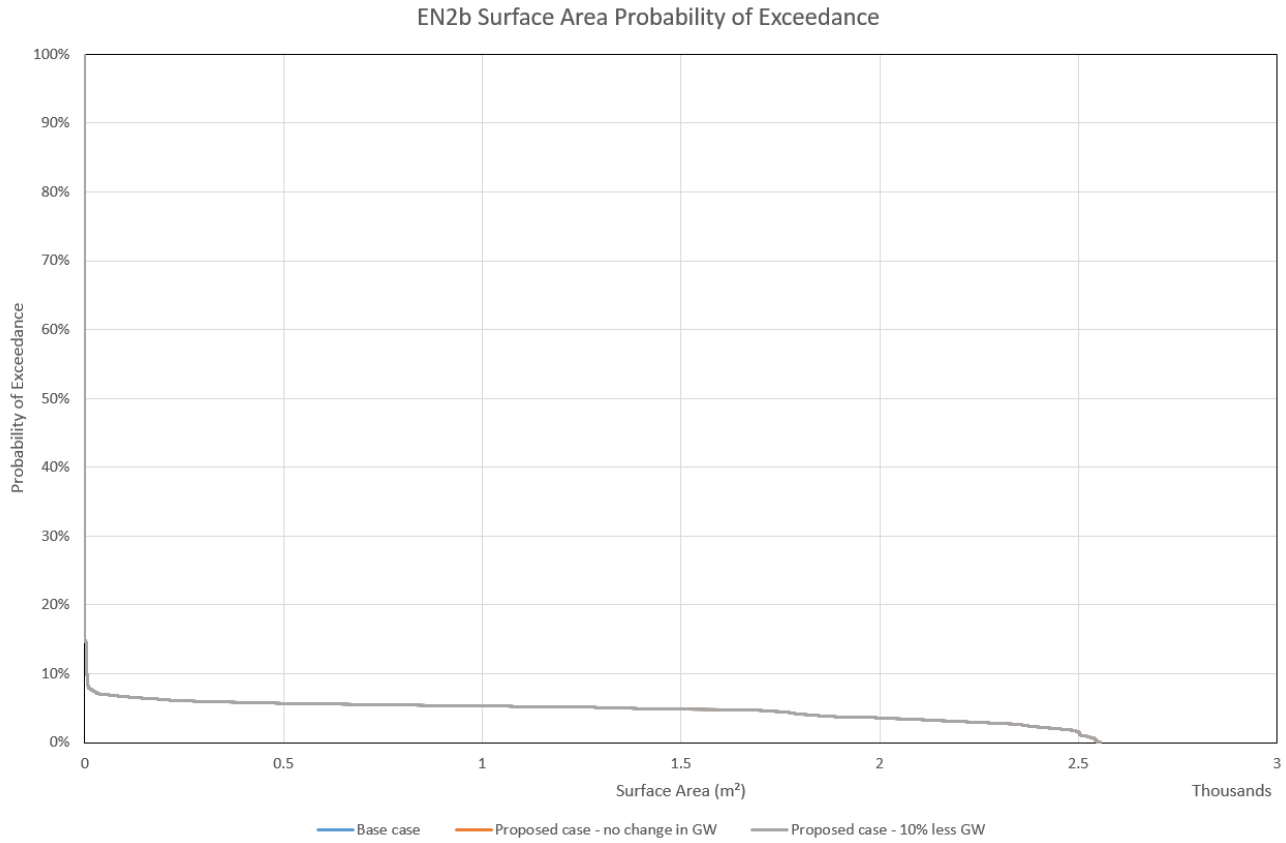

EN1 Surface Area Variation
x 10000
Surface Area (m²)
10
9
8
7
6
5
4
3
2
1
0
15/07/2008
27/11/2009
11/04/2011
23/08/2012
5/01/2014
20/05/2015
1/10/2016
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

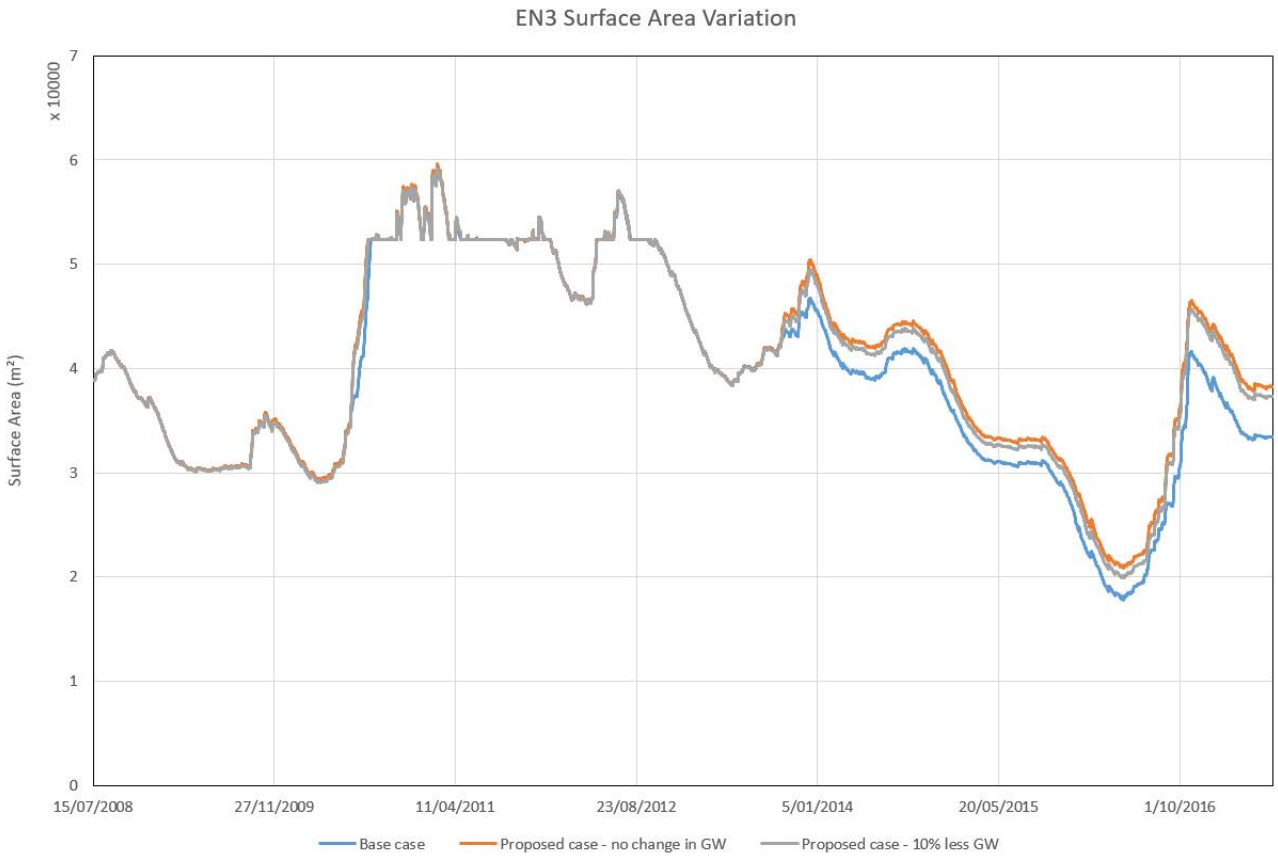

EN1 Surface Area Probability of Exceedance
Probability of Exceedance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
1
2
3
4
5
6
7
8
9
10
x 10000
Surface Area (m²)
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

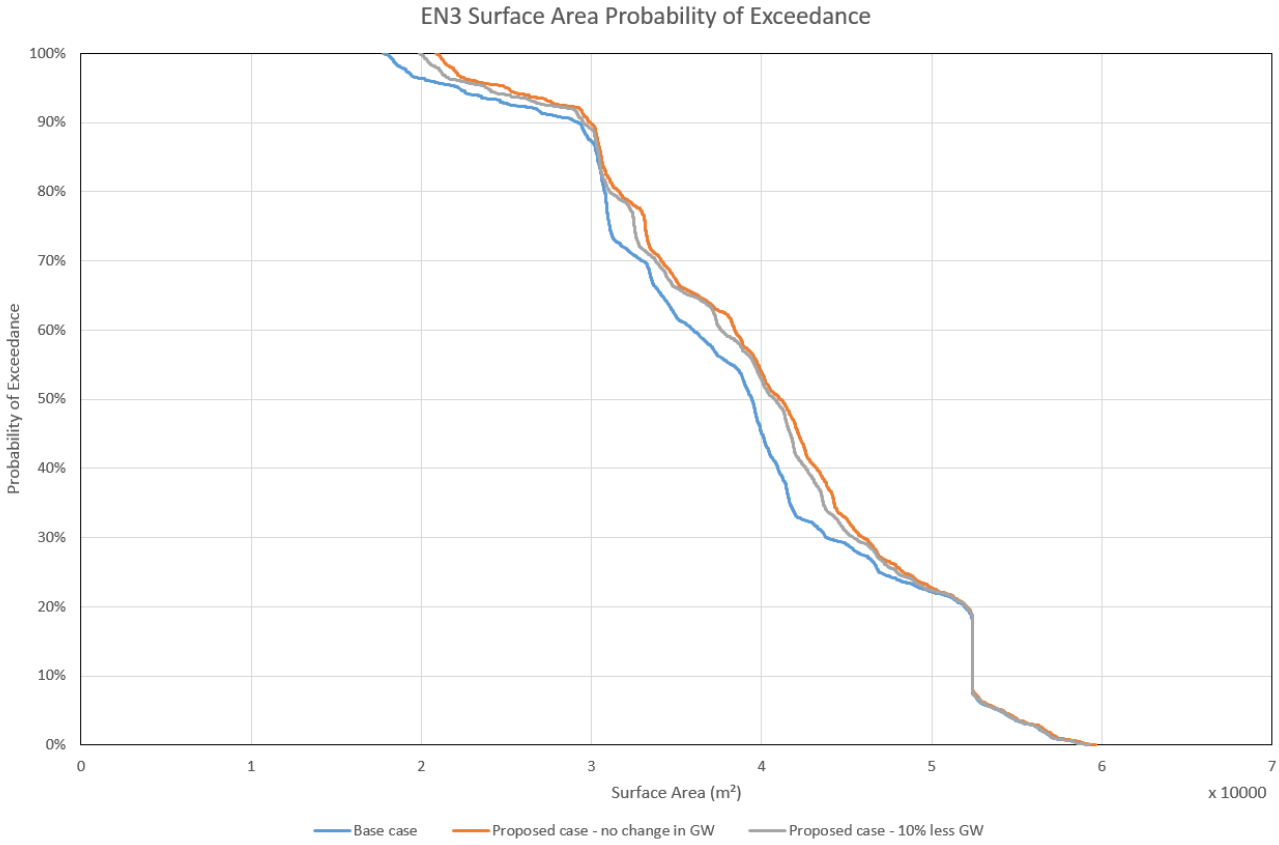

EN2 Surface Area Variation
Surface Area (m²)
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
15/07/2008
27/11/2009
11/04/2011
23/08/2012
5/01/2014
20/05/2015
1/10/2016
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

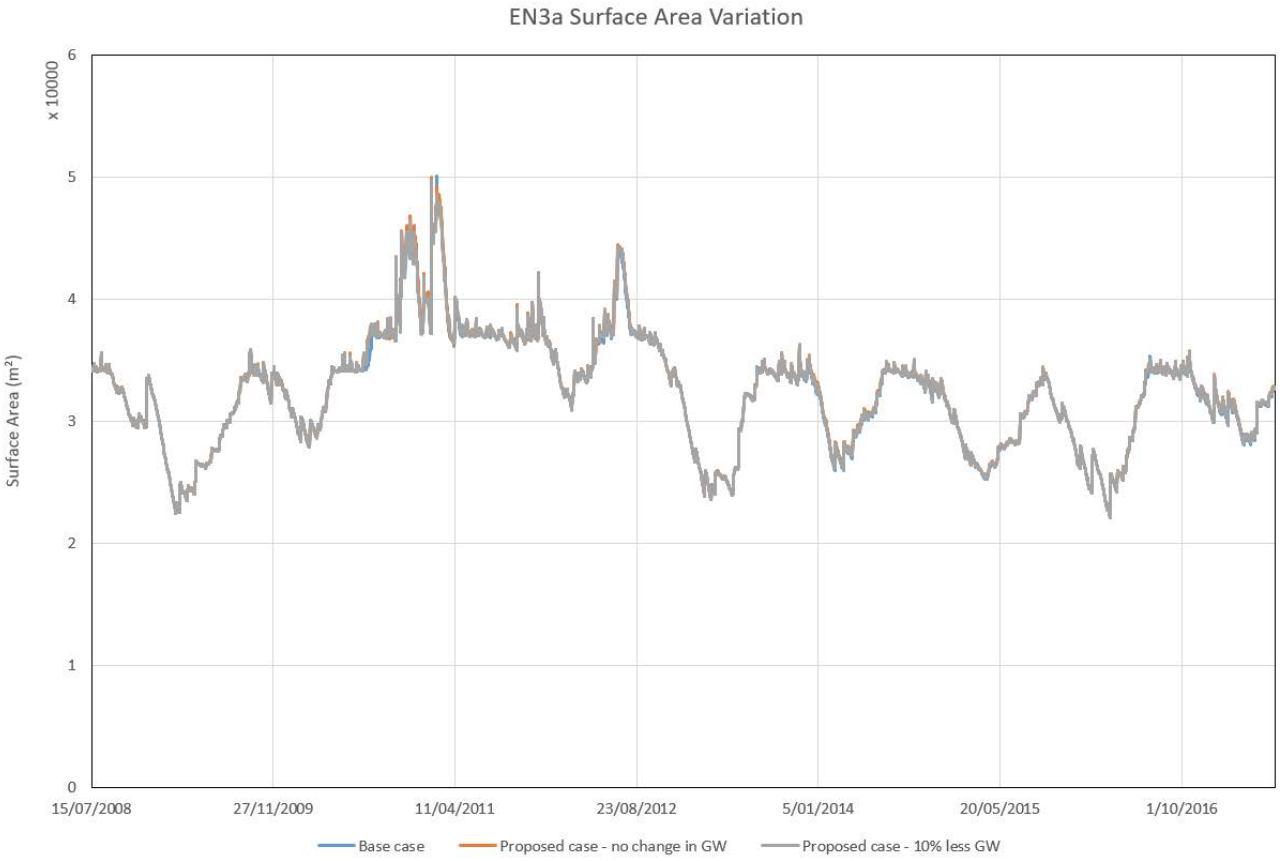

EN2 Surface Area Probability of Exceedance
Probability of Exceedance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
x 10000
Surface Area (m²)
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

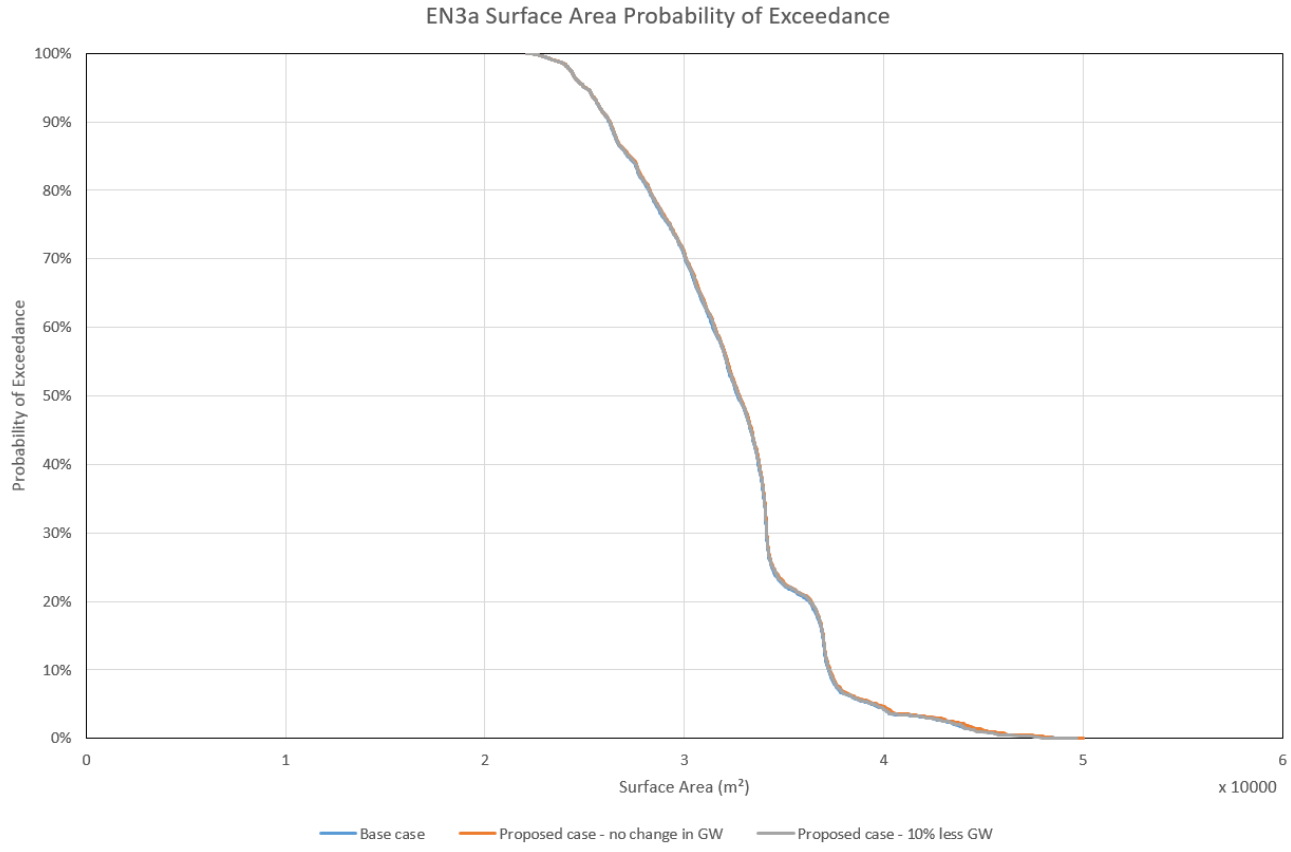

EN2b Surface Area Variation
Thousands
Surface Area (m²)
3
2.5
2
1.5
1
0.5
0
15/07/2008
27/11/2009
11/04/2011
23/08/2012
5/01/2014
20/05/2015
1/10/2016
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

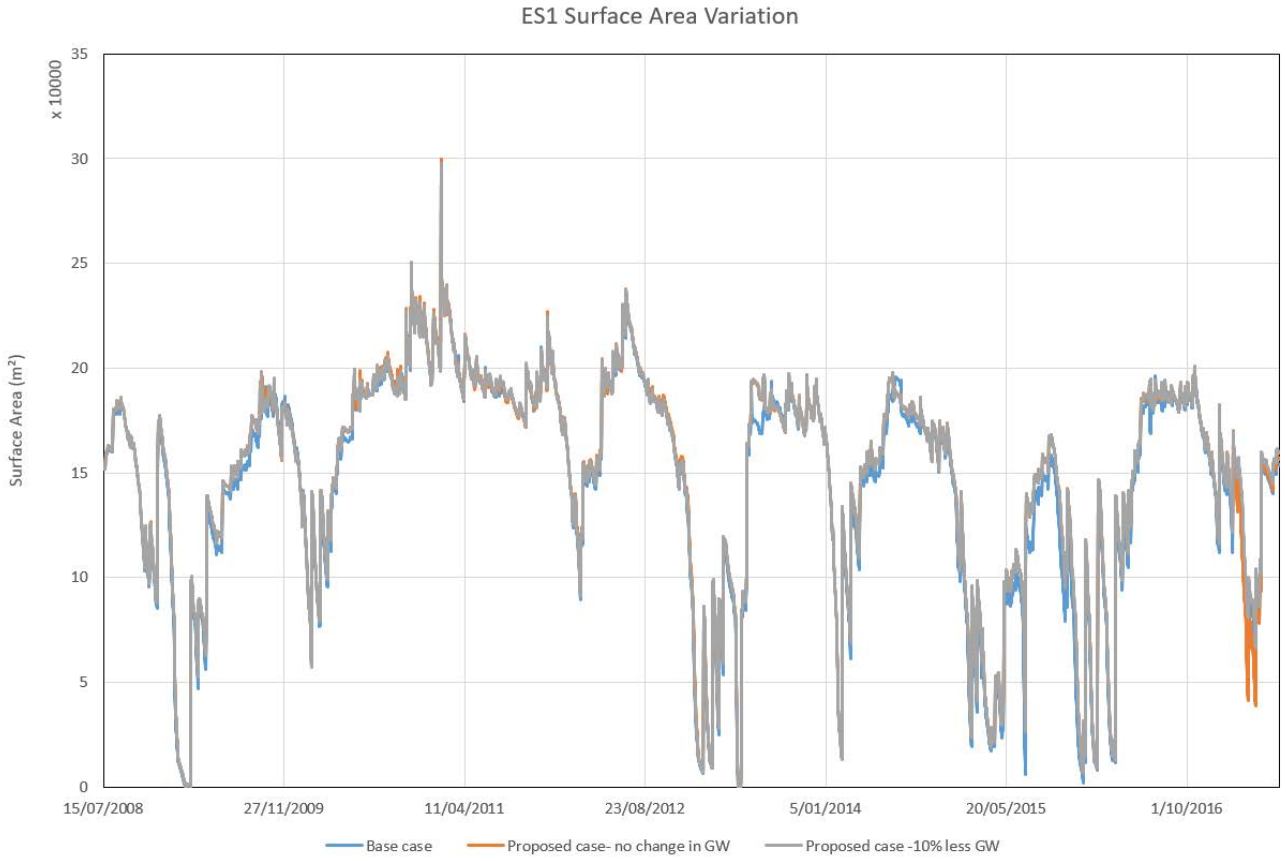

EN2b Surface Area Probability of Exceedance
Probability of Exceedance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
0.5
1
1.5
2
2.5
3
Surface Area (m²)
Thousands
Base case
Proposed case - no change in GW
Proposed case - 10% less GW

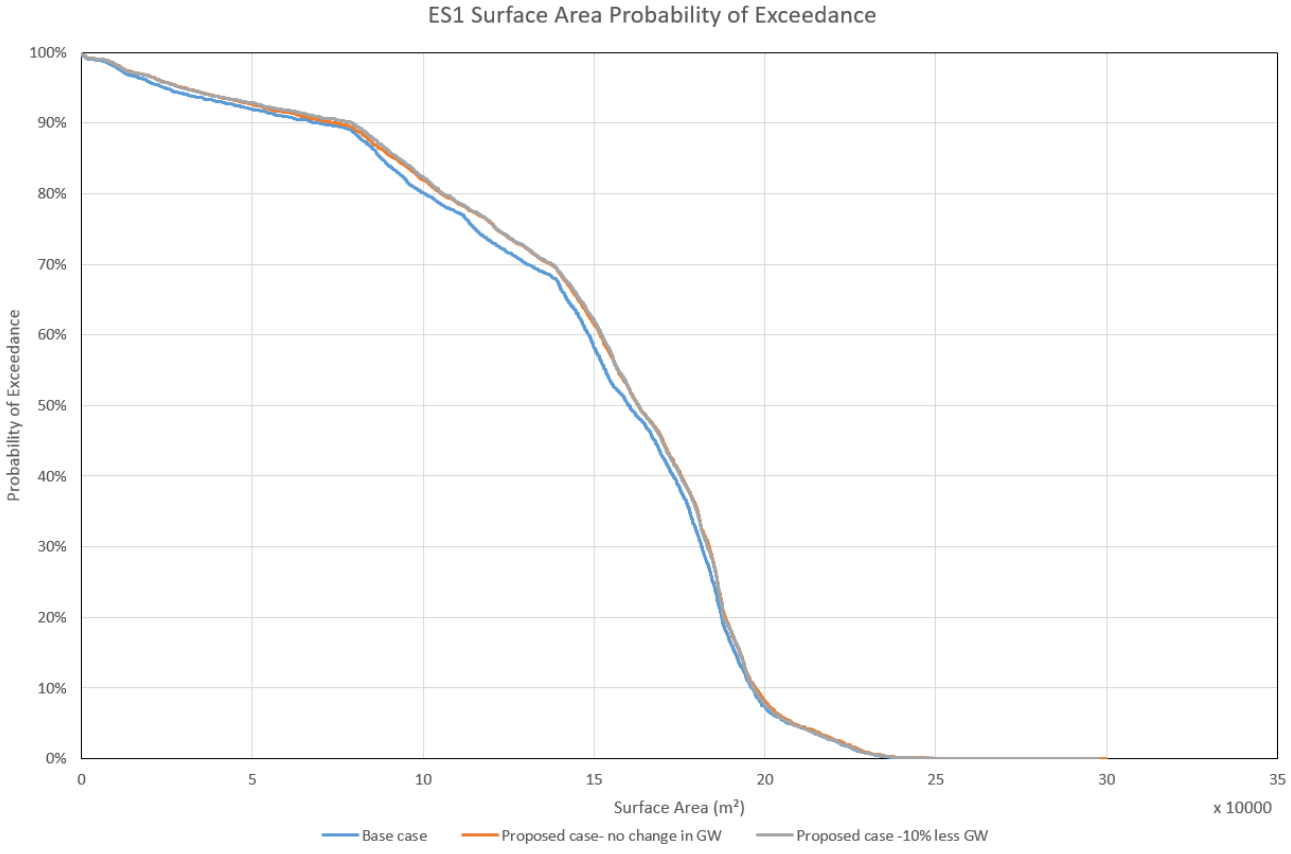

EN3 Surface Area Variation
x 10000
Surface Area (m²)
0
1
2
3
4
5
6
7
15/07/2008
27/11/2009
11/04/2011
23/08/2012
5/01/2014
20/05/2015
1/10/2016
Base case
Proposed case - no change in GW
Proposed case - 10% less GW


EN3 Surface Area Probability of Exceedance
Probability of Exceedance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
1
2
3
4
5
6
7
Surface Area (m²)
x 10000
Base case
Proposed case - no change in GW
Proposed case - 10% less GW


EN3a Surface Area Variation
x 10000
Surface Area (m²)
6
5
4
3
2
1
0
15/07/2008
27/11/2009
11/04/2011
23/08/2012
5/01/2014
20/05/2015
1/10/2016
Base case
Proposed case - no change in GW
Proposed case - 10% less GW


EN3a Surface Area Probability of Exceedance
Probability of Exceedance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
1
2
3
4
5
6
Surface Area (m²)
x 10000
Base case
Proposed case - no change in GW
Proposed case - 10% less GW


ES1 Surface Area Variation
x 10000
Surface Area (m²)
35
30
25
20
15
10
5
0
15/07/2008
27/11/2009
11/04/2011
23/08/2012
5/01/2014
20/05/2015
1/10/2016
Base case
Proposed case- no change in GW
Proposed case -10% less GW


ES1 Surface Area Probability of Exceedance
Probability of Exceedance
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
0
5
10
15
20
25
30
35
Surface Area (m²)
x 10000
Base case
Proposed case- no change in GW
Proposed case -10% less GW

MEMO

TO:	Ray Hatley
FROM:	Bhupatindra Vaidya
SUBJECT:	Mordialloc Embankment - Preliminary Assessment of Change in permeability due to embankment loading
OUR REF:	2135645A-SE-26-WAT-REP-0003 Rev00
DATE:	10 May 2018

1. GENERAL

Embankments are planned for the approaches on OSAR structure overcrossing the Springvale road.

The height of approach embankment varies from 0 to 8 metres. The width of embankment is 42 metres at the top and batters 1V:3H at the sides.

The loading from embankment placement on the subsoil layers will result in a reduction in volume of voids in the soil layers. The effect of void volume reduction on the permeability of subsoil layers is investigated based on an assessment of the available laboratory test results.

2. ASSUMPTIONS

Assumptions used for the assessment:

Assessment is carried out for embankment height of 4 m, 8 m and 10m.

The latest available (at 08/09/2017) ground water level readings in ground water bores GW17-26-12 and GW17-26-13 varied from 0.8m to 2.64m below ground level. For the purpose of this assessment, ground water has been assumed to be 1.5m below existing ground level.

- Pressure change due to embankment loading is based on Boussinesq stress distribution (a point load solution; Boussinesq 1885)
- Change in permeability vs stress change is based on the available consolidation test results from soil samples in the vicinity which is assumed to be valid for all the alluvial soil layers.
- Following available consolidation test results are used:

  Borehole Depth Soil types:

  B17-68160 5.7 m High plasticity, Sandy clay

  B17-68335 2.2 m High plasticity, Sandy clay

  B17-68339 1.2 m silty clay
- The ground profile comprises alternate layers of sand and clay. The change in permeability in sand layer due to increase in stress from embankment loading is expected

Level 15, 28 Freshwater Place
Southbank VIC 3006

Tel: +61 3 9861 1111
Fax: +61 3 9861 1144
www.wsp.com

to be small compared to that in clay layers. However, for this preliminary assessment, the effect of stress on permeability has been conservatively sand layers is assumed to be similar to that in clay layers.

- The depth to bottom of alluvial layer at the site is likely to be within 10m (7m-8m in borehole logs). Below this depth, the more competent Brighton Group formation is likely to encounter. Changes in permeability due to consolidation under embankment loads, is likely to be negligible in the Brighton Group layer. However, the potential change in permeability to greater depth is provided in the event alluvial layer extends further.

- The assessment has been based on test results for soils from a maximum depth of 5.7m and therefore involves some extrapolation for soils at greater depth.

- The effects of soil desiccation above the groundwater table has been ignored.

- Laboratory consolidation tests are based on samples that are small compared to the soil layers represented. As such potential macro effects on groundwater flow are not represented in this analysis.

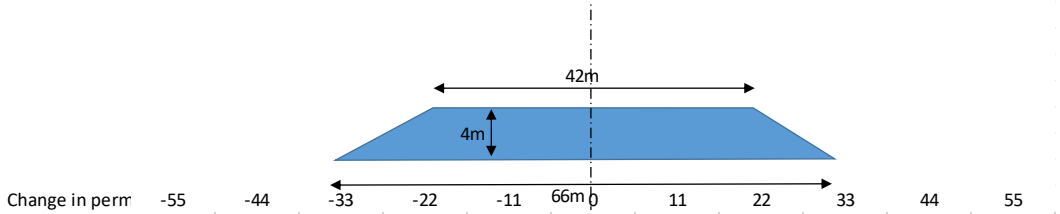
- Laboratory tests measure vertical permeability, whereas groundwater flow is more likely controlled by horizontal permeability. Due consideration of this should be made in the hydrogeologic assessment and analysis.

3. RESULTS

The estimated factors on permeability due to increase in effective stress is provided in Figures 1, 2 and 3 for embankment heights of 4 m, 8 m and 10 m, respectively.

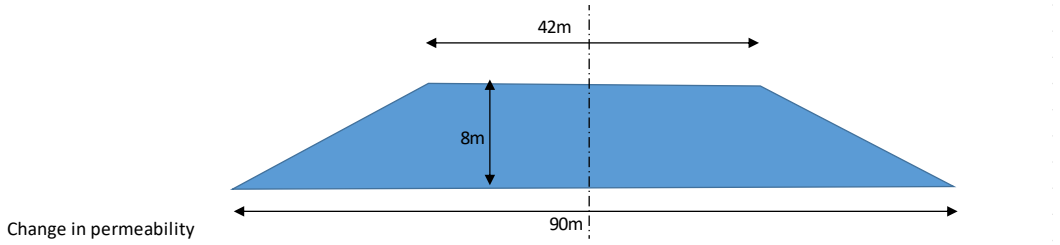
Due to potential variability in permeability characteristics, it is recommended that the permeability factor be varied between 0.5 to 2 times the factors given in the figures illustrating the 3 modelled scenarios:

- Permeability factor for 4 m embankment height
- Permeability factor for 8 m embankment height
- Permeability factor for 8 m embankment height + 2 m surcharge (10 m)



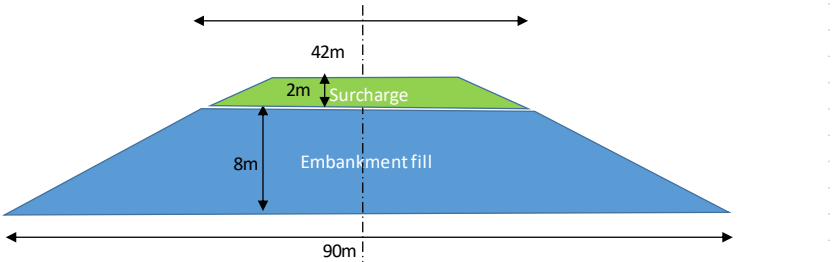
Change in perm Distance,m --> depth,m	-55	-44	-33	-22	-11	0	11	22	33	44	55
0.5	1.00	1.00	0.92	0.20	0.19	0.19	0.19	0.20	0.92	1.00	1.00
1.5	1.00	1.00	0.92	0.39	0.37	0.37	0.37	0.39	0.92	1.00	1.00
2.5	1.00	1.00	0.90	0.45	0.42	0.42	0.42	0.45	0.90	1.00	1.00
3.5	1.00	1.00	0.89	0.50	0.47	0.47	0.47	0.50	0.89	1.00	1.00
4.5	1.00	0.99	0.89	0.54	0.51	0.50	0.51	0.54	0.89	0.99	1.00
5.5	1.00	0.99	0.88	0.58	0.54	0.54	0.54	0.58	0.88	0.99	1.00
6.5	1.00	0.99	0.88	0.61	0.57	0.57	0.57	0.61	0.88	0.99	1.00
7.5	1.00	0.99	0.88	0.64	0.60	0.59	0.60	0.64	0.88	0.99	1.00
8.5	1.00	0.98	0.88	0.67	0.62	0.62	0.62	0.67	0.88	0.98	1.00
9.5	1.00	0.98	0.88	0.69	0.64	0.64	0.64	0.69	0.88	0.98	1.00
10.5	0.99	0.98	0.88	0.71	0.66	0.66	0.66	0.71	0.88	0.98	0.99
11.5	0.99	0.98	0.89	0.73	0.68	0.67	0.68	0.73	0.89	0.98	0.99
12.5	0.99	0.97	0.89	0.75	0.70	0.69	0.70	0.75	0.89	0.97	0.99
13.5	0.99	0.97	0.89	0.76	0.71	0.70	0.71	0.76	0.89	0.97	0.99
14.5	0.99	0.97	0.89	0.78	0.73	0.72	0.73	0.78	0.89	0.97	0.99

Figure 1: Permeability factor for 4 m embankment height



Change in permeability Distance,m --> depth,m	-55	-44	-33	-22	-11	0	11	22	33	44	55
0.5	1.00	0.67	0.19	0.12	0.12	0.12	0.12	0.12	0.19	0.67	1.00
1.5	1.00	0.83	0.37	0.25	0.25	0.25	0.25	0.25	0.37	0.83	1.00
2.5	1.00	0.84	0.42	0.30	0.29	0.29	0.29	0.30	0.42	0.84	1.00
3.5	1.00	0.84	0.47	0.34	0.32	0.32	0.32	0.34	0.47	0.84	1.00
4.5	0.99	0.85	0.50	0.37	0.36	0.36	0.36	0.37	0.50	0.85	0.99
5.5	0.99	0.85	0.54	0.41	0.39	0.39	0.39	0.41	0.54	0.85	0.99
6.5	0.99	0.85	0.57	0.44	0.41	0.41	0.41	0.44	0.57	0.85	0.99
7.5	0.98	0.85	0.59	0.46	0.44	0.44	0.44	0.46	0.59	0.85	0.98
8.5	0.98	0.85	0.61	0.49	0.46	0.46	0.46	0.49	0.61	0.85	0.98
9.5	0.97	0.85	0.63	0.51	0.48	0.48	0.48	0.51	0.63	0.85	0.97
10.5	0.97	0.85	0.65	0.53	0.50	0.50	0.50	0.53	0.65	0.85	0.97
11.5	0.97	0.85	0.67	0.56	0.52	0.52	0.52	0.56	0.67	0.85	0.97
12.5	0.96	0.86	0.68	0.57	0.54	0.54	0.54	0.57	0.68	0.86	0.96
13.5	0.96	0.86	0.70	0.59	0.56	0.55	0.56	0.59	0.70	0.86	0.96
14.5	0.96	0.86	0.71	0.61	0.57	0.57	0.57	0.61	0.71	0.86	0.96

Figure 2: Permeability factor for 8 m embankment height



Change in permeability Distance,m --> depth,m	-55	-44	-33	-22	-11	0	11	22	33	44	55
0.5	1.00	0.67	0.19	0.12	0.10	0.10	0.10	0.12	0.19	0.67	1.00
1.5	1.00	0.83	0.37	0.25	0.21	0.21	0.21	0.25	0.37	0.83	1.00
2.5	1.00	0.84	0.42	0.29	0.25	0.25	0.25	0.29	0.42	0.84	1.00
3.5	1.00	0.84	0.47	0.33	0.29	0.28	0.29	0.33	0.47	0.84	1.00
4.5	0.99	0.85	0.50	0.37	0.32	0.31	0.32	0.37	0.50	0.85	0.99
5.5	0.99	0.85	0.54	0.40	0.34	0.34	0.34	0.40	0.54	0.85	0.99
6.5	0.98	0.85	0.56	0.42	0.37	0.37	0.37	0.42	0.56	0.85	0.98
7.5	0.98	0.85	0.59	0.45	0.40	0.39	0.40	0.45	0.59	0.85	0.98
8.5	0.98	0.85	0.61	0.47	0.42	0.41	0.42	0.47	0.61	0.85	0.98
9.5	0.97	0.85	0.63	0.50	0.44	0.43	0.44	0.50	0.63	0.85	0.97
10.5	0.97	0.85	0.65	0.52	0.46	0.45	0.46	0.52	0.65	0.85	0.97
11.5	0.96	0.85	0.66	0.54	0.48	0.47	0.48	0.54	0.66	0.85	0.96
12.5	0.96	0.85	0.68	0.55	0.50	0.49	0.50	0.55	0.68	0.85	0.96
13.5	0.96	0.85	0.69	0.57	0.52	0.51	0.52	0.57	0.69	0.85	0.96
14.5	0.95	0.85	0.70	0.59	0.53	0.52	0.53	0.59	0.70	0.85	0.95

Figure 3: Permeability factor for 8m embankment height + 2m surcharge, total height of 10 m.

4. APPLICABILITY

As noted above, the assessment of permeability by laboratory testing is based on small samples and may not reflect potential macro effects from the interbedded nature of alluvial deposits.

However, the above provides a generally conservative assessment of embankment load influence on relative permeability of soils.

Provided the recommended variation in the values provided above are used in sensitivity analysis in any hydrogeologic modelling using this assessment, does not indicate modelling is relatively insensitive to soil permeability, then these can be considered a reliable indicator of the effects of the embankments, on ground water flow.

Where modelling indicates results are highly sensitivity to soil permeabilities, a detailed assessment of insitu permeabilities would need to be carried out by both insitu testing and parallel laboratory testing aimed at refining assessment of these parameters.

Reference:

Boussinesq, M. J. (1885), "*Application des potentiels a l'etude de l'equilibre et du movement des solides elastiques, principalement au calcul des deformations et des pressions que produisent, dans ces solides, des efforts quelconques exerces sur une petite partie de leur surface ou de leur interieur: Memoire suivi de notes etendues sur divers points de physique mathematique et d'analyse*," GauthierVillars, Paris, pp. 722. [Google title translation: "Application of the potentials to the study of the equilibrium and the movement of elastic solids, mainly to the computation of the deformations and the pressures that

produce in these solids, any efforts exerces on a small part of their surface or their interior: Memory followed by extended notes on various points of mathematical physics and analysis”]

APPENDIX D

NUMERICAL GROUNDWATER MODELLING REPORT

VICROADS

SEPTEMBER 2018

MORDIALLOC BYPASS

GROUNDWATER MODELLING REPORT

Report Number: 2135645A-SE-26-WAT-REP-0007 REV0

Question today
Imagine tomorrow
Create for the future

Mordialloc Bypass
Groundwater Modelling Report

VicRoads

WSP
Level 15, 28 Freshwater Place
Southbank VIC 3006

Tel: +61 3 9861 1111
Fax: +61 3 9861 1144
wsp.com

REV	DATE	DETAILS
0	16/09/2018	Final

	NAME	DATE	SIGNATURE
Prepared by:	Ellen Kwantes	16/09/2018	
Reviewed by:	Ray Hatley	16/09/2018	
Approved by:	Sean Myers	16/09/2018	

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GLOSSARY

Alluvial	Sediments deposited by flowing water.
Alluvium	General term for unconsolidated deposits of inorganic materials (clay, silt, sand, gravel, boulders) deposited by flowing water.
Alluvium aquifer	An aquifer formed within alluvium. See *Alluvium.*
Aquifer	Rock or sediment in a formation, group of formations or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water to wells and springs.
Aquitard	Saturated geological unit with a relatively low permeability that can store large volumes of water but does not readily transmit or yield significant quantities of water to bores or springs. An aquitard can sometimes, if completely impermeable, be called an aquiclude.
Australian Height Datum (AHD)	A level datum, uniform throughout Australia, that generally approximates mean sea level.
Baseflow	The component of river or stream flow that is derived from groundwater discharge to the river or stream.
Baseline	A basic standard or level, usually regarded as a reference point for comparison.
Bore	Artificially constructed or improved groundwater cavity used for the purpose of accessing or recharging water from an aquifer. Interchangeable with borehole, piezometer.
Borehole	Includes a well, excavation, or other artificially constructed or improved groundwater cavity which can be used for the purpose of intercepting, collecting or storing water from an aquifer; observing or collecting data and information on water in an aquifer; or recharging an aquifer. Interchangeable with bores, wells, piezometers.
Clay	Deposit of particles with a diameter less than 0.002 mm, typically contain variable amounts of water within the mineral structure, and exhibit high plasticity.
Confined aquifer	An aquifer bounded above and below by impervious (confining) layers. In a confined aquifer, the water is under sufficient pressure so that when wells are drilled into the aquifer, measured water levels rise above the top of the aquifer.
Cumulative impact	The combined impact to one or more environmental values delivered by multiple projects being undertaken simultaneously within the same sphere of physical influence.
Drawdown	The change in groundwater level in a bore, or the change in water table elevation in an unconfined groundwater system, due to the extraction of groundwater.
Fault	Zone of displacement in rock formations resulting from forces of tension or compression in the earth's crust.

Formation	General term used to describe a sequence of rock layers.
Groundwater	Water found in the subsurface in the saturated zone below the water table or piezometric surface i.e. the water table marks the upper surface of groundwater systems.
Groundwater flow	The movement of water through openings and pore spaces in rocks below the water table i.e. in the saturated zone.
Groundwater resource	Groundwater available for beneficial use, including human usage, aquatic ecosystems and the greater environment.
Hydraulic conductivity	Measure of the ease with which water will pass through earth material; defined as the rate of flow through a cross-section of one square metre under a unit hydraulic gradient at right angles to the direction of flow (metres per day).
Hydraulic gradient	Change in the hydraulic head over a certain distance.
(Hydraulic) head	Elevation to which water will rise in a borehole connected to a point in an aquifer.
Hydrogeology	The study of the interrelationships of geological materials and processes with water, especially groundwater.
Hydrograph	Graph that shows groundwater or surface water properties as a function of time.
Impact	An event that disrupts ecosystem, community, or population structure and alters the physical environment, directly or indirectly.
Infiltration	The downward movement of water from the atmosphere into the ground; not to be confused with percolation.
Lithology	The physical character of rocks.
Modelling	The creation of a computerised model that simulates natural environment, allows simulations to project future outcomes.
Monitoring bore	A bore used to monitor groundwater levels or quality.
Permeability	The ease with which a fluid can pass through a porous medium and is defined as the volume of fluid discharged from a unit area of an aquifer under unit hydraulic gradient in unit time (metres per day).
Recharge	Recharge is defined as the process by which water is added from outside to the zone of saturation of an aquifer, either directly into a formation, or indirectly by way of another formation.
Runoff	All surface and subsurface flow from a catchment, but in practice refers to the flow in a river i.e. excludes groundwater not discharged into a river.
Semi-confined aquifer	An aquifer that is partly confined by layers of lower permeability material through which recharge and discharge may occur, also referred to as a leaky aquifer.
Stratigraphy	Branch of geology dealing with the classification, nomenclature, correlation, and interpretation of stratified rocks.
Terrestrial	Relating to, consisting of, or representing the Earth; relating to the land as distinct from the water.

Water table	The surface in an unconfined aquifer or confining bed at which the pore water pressure is atmospheric; it can be measured by installing shallow wells extending a few feet into the zone of saturation and then measuring the water level in those wells.
Watercourse	A river, creek or other stream, including a stream in the form of an anabranch or a tributary, in which water flows permanently or intermittently, regardless of the frequency of flow events: — In a natural channel, whether artificially modified or not — In an artificial channel that has changed the course of the stream — It also includes weirs, lakes and dams.
Wetland	In Victoria, wetlands are defined as areas whether natural, modified or artificial, subject to permanent or temporary inundation, that hold static or very slow moving water and develop, or have the potential to develop, biota adapted to inundation and the aquatic environment. Wetlands may be formed by natural processes or human activities. Wetlands include freshwater and saline lakes, swamps and shallow waters in Victoria's estuaries, bays and inlets. The international treaty on wetlands, the Ramsar Convention on Wetlands, uses a broader definition of wetlands which also includes rivers and other shallow marine waters. Wetlands provide many values to the community: — Traditional Owners and Aboriginal people have used wetlands over many tens of thousands of years and they are an important part of Aboriginal cultural heritage. — Wetlands act as sediment traps and filter nutrients from catchments. This helps protect the water quality of rivers, estuaries and marine areas. — Wetlands reduce the impacts of flooding by holding and slowing floodwater. — Wetlands provide habitat for native plants such as river red gum (Eucalyptus camaldulensis), mangroves, saltmarshes and for native animals such as waterbirds, frogs and fish. — Wetlands provide a range of recreational opportunities such as boating, camping, bird watching, fishing and duck hunting which help to support tourism and local economies. Many wetlands in Victoria are recognised for their environmental significance.
Yield	The quantity of water removed from a water resource e.g. yield of a borehole.

ABBREVIATIONS

3D	Three-dimensional
AHD	Australian Height Datum
BOM	Bureau of Meteorology
CHB	Constant Head Boundary
CVFD	control-volume finite difference approach
DELWP	Department of Environment, Land, Water and Planning
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999
EES	Environmental Effects Statement
GHB	General Head Boundary
HSU	Hydrostratigraphic unit
Kh	Horizontal hydraulic conductivity
km	kilometre
Kv	Vertical hydraulic conductivity
L/s	Litre per second
LTA	Lower Tertiary Aquifer
LXRA	Level Crossing Removal Authority
m	metre
mAHD	metres Australian Height Datum
mBGL	metres below ground level
Ml	megalitre
OSAR	Outer Suburban Arterial Roads
QA	Quaternary Aquifer
Ss	Specific storage
SRMS	scaled root mean squared
Sy	Specific yield
UMTD	Upper-Mid Tertiary Aquitard
UTAF	Upper Tertiary Aquifer
VAF	Victorian Aquifer Framework

EXECUTIVE SUMMARY

The Mordialloc Bypass (the Project) is the proposed construction and operation of a new freeway connecting the Dingley Bypass with the Mornington Peninsula Freeway; and is predominately within an existing road reservation (Figure 1.1). The project passes between the western boundary of Braeside Park and the eastern boundary of the Woodlands Estate (constructed) wetlands, traverses constructed wetlands at Waterways and approaches to within a kilometre of the Ramsar-listed Edithvale-Seaford Wetlands. The northern and southern ends of the project pass through or border the South East Green Wedge.

The primary objective of the groundwater modelling was to quantify impacts to groundwater resources and associated environmental values in particular the Edithvale Wetlands in response to the proposed embankments for the Outer Suburban Arterial Roads (OSAR) Project. The modelling also aimed to quantify cumulative impacts associated with the Level Crossing Removal Authority (LXRA) Project.

The design, construction and calibration of the model was tailored to meet the modelling objectives. The model is consistent with the conceptual hydrogeological model in the main report (WSP, 2018) and Section 2 of this report and was calibrated to broadly replicate groundwater levels, and flow directions. Following calibration, the model was used to simulate the impacts of the Project on groundwater resources and associated environmental values.

The following conclusions can be drawn from the groundwater modelling study:

- A three-dimensional groundwater model was developed using the control-volume finite difference code MODFLOW-USG. The calibrated model parameters resulted in a plausible water table with low-lying areas dominated by excess EVT and the dune areas and ridges by excess recharge.
- The modelled water table implies that the Edithvale Wetlands are a net groundwater discharge point via EVT, which is consistent with chemical and isotopic data.
- Construction of bypass embankments will result in loading of the aquifer and a decrease in permeability of the underlying aquifers. The numerical model was used to assess the groundwater effects near the Edithvale Wetlands as a result of the change in permeability beneath the embankments.
- Modelling results indicate that the aquifer loading will result in a very small change in groundwater level (in the order of 10 to 15 cm maximum). The changes range from a small decrease in groundwater level beneath the southern embankment to a small rise in groundwater level beneath the northern embankment. Most of the change is restricted to within the embankment footprint with negligible groundwater level changes outside the embankments.
- Therefore, construction of the embankments and bypass is highly unlikely to have any measurable effect on groundwater levels adjacent to the Edithvale Wetlands, nor groundwater flow contributions to the wetland water balance.

The modelled drawdown effects will be virtually undetectable given that:

- The observed seasonal groundwater level variations are much larger by comparison (~0.5 to 1 m)
- Changes to drainage and hardstand in the area are likely to have a larger influence on groundwater levels (although still negligible).

In the short-term loading of the aquifer by the embankment may cause a temporary rise in groundwater levels adjacent to embankment due to compression of the aquifer matrix. That effect should be mitigated by existing drainage and will dissipate over a short period.

1 INTRODUCTION

1.1 PROJECT OVERVIEW

The Mordialloc Bypass (the Project) is the proposed construction and operation of a new freeway connecting the Dingley Bypass with the Mornington Peninsula Freeway; and is predominately within an existing road reservation (Figure 1.1). The project passes between the western boundary of Braeside Park and the eastern boundary of the Woodlands Estate (constructed) wetlands, traverses constructed wetlands at Waterways and approaches to within a kilometre of the Ramsar-listed Edithvale-Seaford Wetlands. The northern and southern ends of the project pass through or border the South East Green Wedge.

The project corridor is approximately 9.7 km in length, comprising two two-lane 7.5 km long carriageways (with a path for walking and cycling) along the greenfield alignment, and 2.2 km of roadworks required to integrate the project with the Mornington Peninsula Freeway. It is expected that each carriageway will provide for two 3.5 m wide lanes, with a 3.0 m wide outside shoulder and 1.0 m wide inside shoulder. The Mordialloc Bypass will also provide connections from the freeway onto the Dingley Bypass, Centre Dandenong Road, Lower Dandenong Road, Governor Road, Springvale Road and new north facing ramps at Thames Promenade. There will also be an overpass at Old Dandenong Road. Mordialloc Creek and the associated Waterways Wetlands will be spanned by twin 400 metre long bridges.

The proposed alignment allows for a future upgrade of the project to a six lane freeway standard road within the construction footprint.

The proposed alignment is generally located within the existing road reservation, most of which is already covered by Public Acquisition Overlay, and some of which is already in VicRoads' ownership.

The project reservation was conceived in the 1950's and formalised in the 1970's to accommodate a six-lane road to cater for future urban growth. The project area is shown in Figure 1.1. The proposed project consists of:

- Four lane freeway with two lanes in each direction and a divided centre median
- 3.5 metre wide lanes
- 100 km/hr posted speed
- A signalised T-intersection at Dingley Bypass
- Full diamond grade separated interchanges at Lower Dandenong Road, Governor Road and Springvale Road
- A bridge over Old Dandenong Road
- A half-diamond south facing grade separated interchange at Centre Dandenong Road
- Redirection of Woodlands Drive to Lower Dandenong Road via Tarnard Drive and Bell Grove
- An elevated structure over the Mordialloc Creek Wetlands and Bowen Parkway, between the Waterways Estate and Aspendale Gardens
- A shared user path along the entire length of the Mordialloc Bypass to provide connection from Springvale Road to Dingley Bypass.

1.2 PROJECT AREA

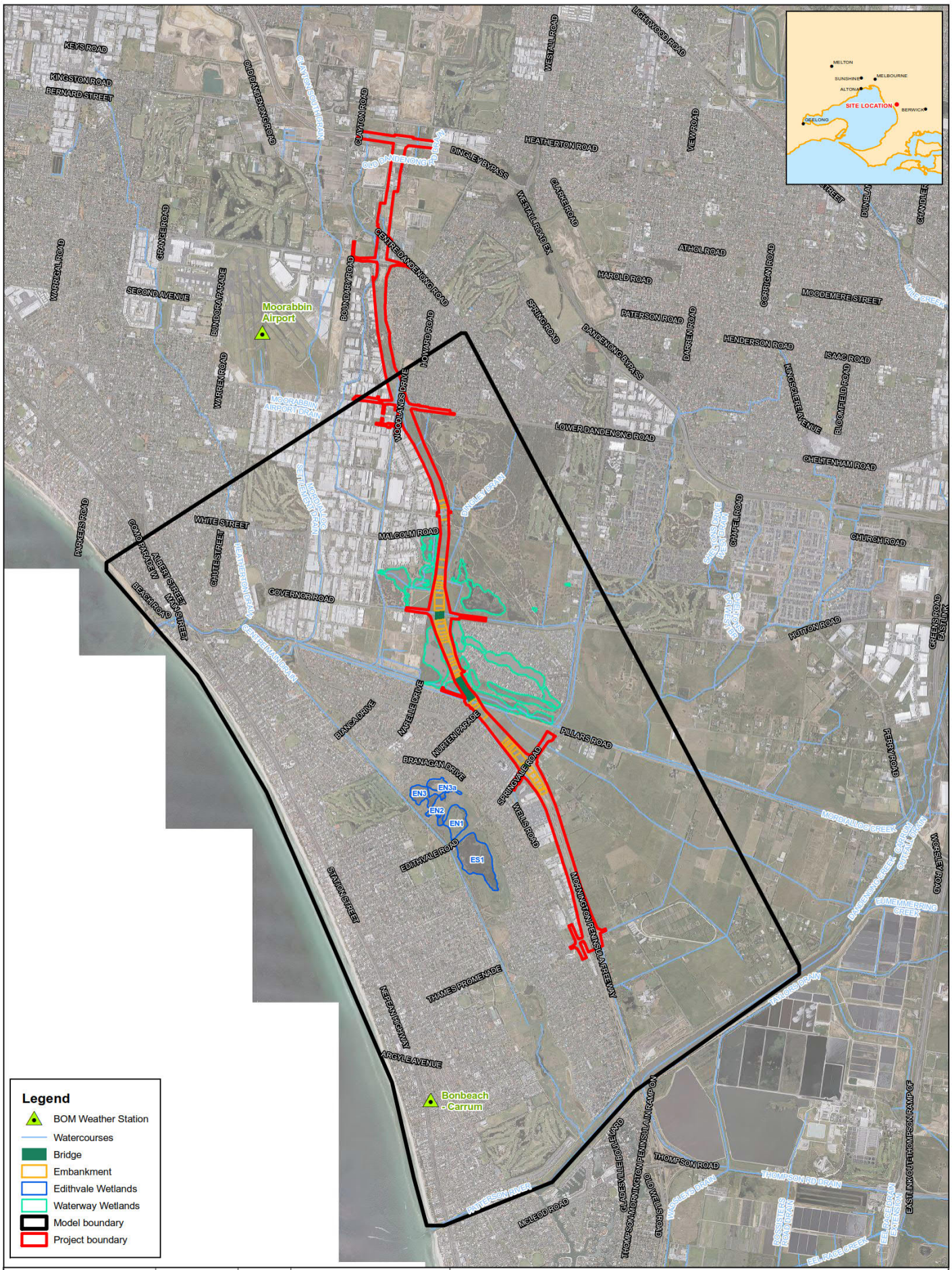
Melbourne's southern movement corridor connects the Mornington Peninsula and Southern and Bayside suburbs to the central city and to National Employment Clusters in Monash and Dandenong. In addition to enabling cross-city movements, the corridor provides road users with access to residential zones, recreation areas and employment and activity centres within the City of Kingston and adjacent municipalities, including the significant national employment cluster in the City of Monash. This project connects the Mornington Peninsula Freeway in the south to the Dingley Bypass to the north.

1.2.1 STUDY AREA

To adequately characterise the hydrogeological conditions, a regional scale understanding is required. Groundwater regimes are complex and can be influenced by broad geographical scales. The study area incorporates the Project area defined above, and includes the broader areas with a 2 km buffer radius extending approximately to Port Philip Bay to the west, Patterson River to the south, Dingley bypass in the north and approximately 2 km to the east of the Project alignment.

This area has been selected as it incorporates important environmental receptors such as the Ramsar listed Edithvale-Seaford Wetlands (Edithvale Wetlands only), Braeside Park Wetlands, Woodlands Industrial Estate Wetlands, Waterways Estate Wetlands, Port Philip Bay and Patterson River. This region is the basis of the groundwater impact assessment with the numerical groundwater model domain being situated within this study area as described in Section 3.1.

The Study area also covers landfill sites located at the northern end of the alignment adjacent Dingley Bypass. The regional characterisation of groundwater conditions from this impact assessment has been incorporated into the Contaminated Land Impact Assessment Technical Impact Assessment Report (Contaminated Land and Acid Sulfate Soil).



Map: 2135645A_GIS_936_A	Author: MB		
Date: 3/09/2018	Approved by: AS		

Data source: VicRoads. Copyright © The State of Victoria, Department of Environment, Land, Water & Planning 2018

0 400 800 m

1:40,000

Coordinate system: GDA 1994 MGA Zone 55

Scale ratio correct when printed at A3

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MAJOR ROAD PROJECTS AUTHORITY

VICTORIA State Government

wsp

Engineering and Technical Services for Mordialloc Bypass Upgrade

Figure 1.1
Site location

1.3 EES SCOPING REQUIREMENTS

One of the Environmental Effects Statement (EES) Scoping Requirements (2018) following key requirements for the EES is to examine:

- '*Potential effects on water environments and related beneficial uses, including as a result of changes to hydrology and groundwater*'.

As it involves groundwater, this requirement involves the characterisation of the local and regional groundwater systems in order to predict short and long-term effects of the project on groundwater flow regime during construction and operation, including interactions between surface water and groundwater, and taking into consideration potential impacts of other relevant infrastructure projects.

The groundwater impact assessment will identify and evaluate effects of the project and relevant alternatives on groundwater and adjacent surface water and floodplains environments in the vicinity of the project works and the Edithvale-Seaford Wetlands, including:

- The likely extent, magnitude and duration (short and long term) of changes to groundwater level or flow paths during construction and operation, considering appropriate climate change scenarios
- Changes to groundwater and surface water quality at all project phases, including from drawdown and rebound of groundwater levels, present contaminants, saline water intrusion into aquifers, sedimentation and downstream effects on ecological values (e.g. groundwater dependent ecosystems, EPBC Act listed communities and the Edithvale-Seaford Wetlands Ramsar site)
- Changes to availability of groundwater for beneficial uses in the vicinity of the project
- Changes to groundwater quality and flow due to project works such as construction and placement of embankments, pilings and other structures in the project area.

1.4 MODELLING OBJECTIVES

The primary objective of the groundwater modelling was to quantify impacts to groundwater resources and associated environmental values in particular the Edithvale Wetlands in response to the proposed embankments for the Outer Suburban Arterial Roads (OSAR) Project. The modelling also aimed to quantify cumulative impacts associated with the Level Crossing Removal Authority (LXRA) Project.

The design, construction and calibration of the model was tailored to meet the modelling objectives. The model is consistent with the conceptual hydrogeological model in Section 2 and was calibrated to broadly replicate groundwater levels, and flow directions. Following calibration, the model was used to simulate the impacts of the Project on groundwater resources and associated environmental values.

Typically, in impact assessments for infrastructure projects, the paucity of time series and spatial data for calibration compared with the proposed development timeframe is such that a class 2 confidence level is the highest feasible. The numerical model developed for this assessment is class 2.

1.5 DATA SOURCES

1.5.1 GROUNDWATER MONITORING NETWORK

The OSAR groundwater monitoring network consists of 36 groundwater monitoring bores and a single leachate monitoring bore (shown on Figure 1.2). The groundwater monitoring bores target the aquifer units of concern being the Quaternary Aquifer (QA) and the Upper Tertiary Aquifer (UTAF). At several locations, two monitoring bores were installed as a 'nested location' to assess the vertical gradient between the QA and UTAF.

Groundwater level monitoring equipment was installed in 20 groundwater monitoring bores. The Solinst © Level Loggers were synchronised and record water levels at 6 hour intervals. A barometric logger was also installed to allow correction of data for atmospheric influences. Additionally, manual groundwater level readings were obtained at each quarterly groundwater sampling event. To date, there have been three quarterly sampling events (August 2017, November 2017 and February 2018).

1.5.2 LEVEL CROSSING REMOVAL AUTHORITY

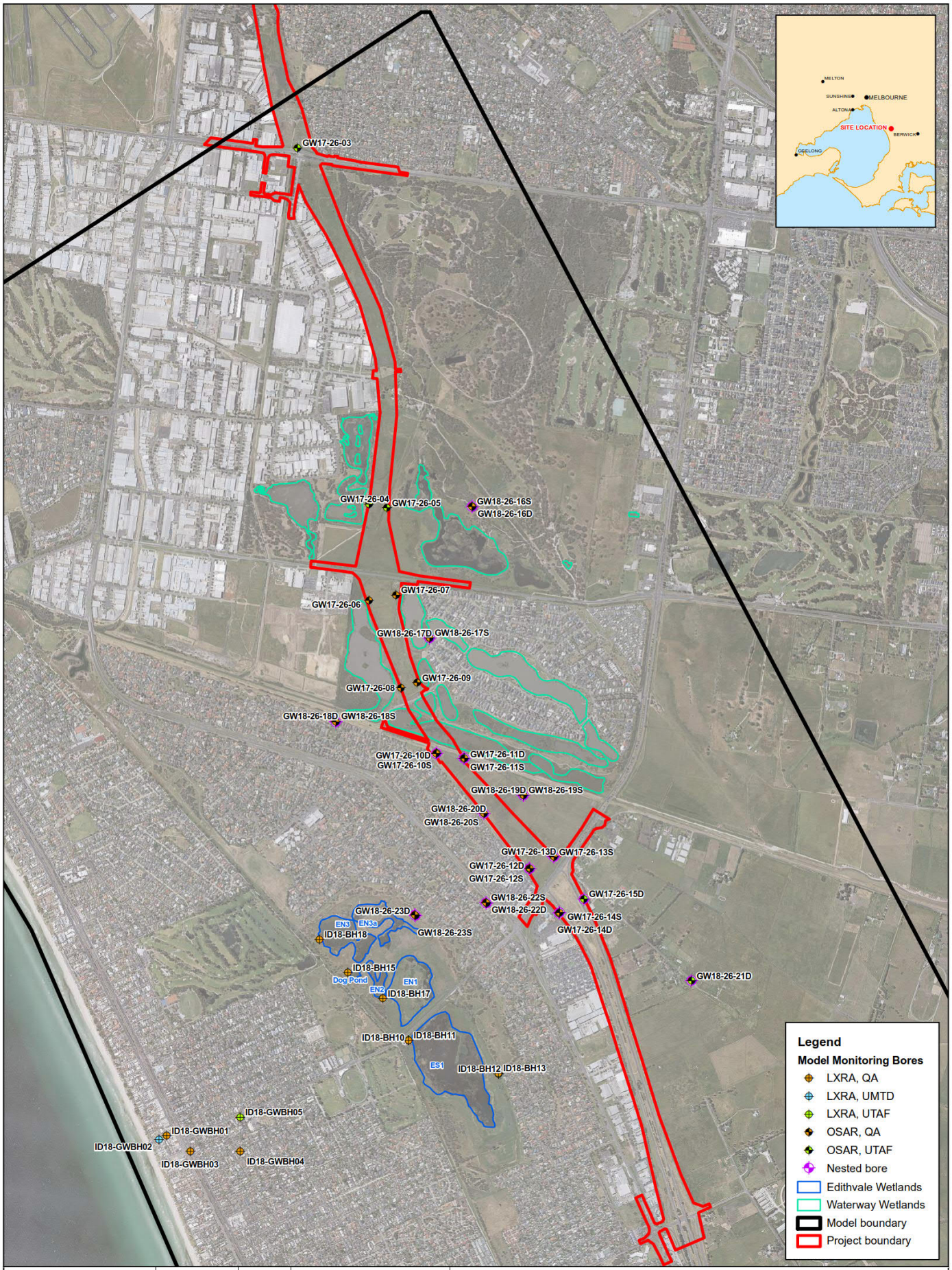
Prior to the referral of Mordialloc Bypass Project, the Edithvale and Bonbeach level crossing removal project was referred to the Minister for Planning who confirmed the requirement for an EES. The Level Crossing Removal Authority (LXRA) and VicRoads projects share a similar geographical region with the Edithvale level crossing removal approximately 2.5 km to the west of the Project alignment within the same hydrogeological regime.

Situated on the Frankston rail line, the LXRA project involves the excavation of significant trench structures to place the rail line and station under Edithvale Road. The trench would be 1,300 m in length with depths up to 15 m with piles extending to 24 m at the deepest part of the trench. This trench structure has the potential to impact the current hydrogeological regime by acting as a barrier to groundwater flow adjacent Port Philip Bay.

The potential impacts to groundwater have been addressed in the LXRA Groundwater Impact Assessment (AECOM GHD JV, 2018) and involve extensive desktop and intrusive site investigations that resulted in the development of a conceptual and numerical groundwater model. Section 4.4 of this report includes a figure displaying the project location and maximum predicted impacts from the LXRA project.

Whist the Mordialloc Bypass does *not* involve the excavation of trench structures, both projects identified the Edithvale portion of the Edithvale-Seaford Wetlands as a sensitive receptor to potential impacts. As such VicRoads and LXRA established a data sharing and cooperative arrangement allowing VicRoads access to LXRA groundwater bores and water quality data. This has allowed the incorporation of select LXRA monitoring bores into the Project groundwater monitoring network. The data obtained to date has assisted in the development and calibration of the Project's own numerical groundwater model.

The LXRA groundwater monitoring network consists of 90 groundwater monitoring bores with water levels and quality from 20 included in this investigation, the locations of which is shown on Figure 1.2. The groundwater monitoring bores target the QA, the UTAF and the Upper-Mid Tertiary Aquitard (UMTD). At several locations, two monitoring bores were installed as a 'nested location' to assess the vertical gradient between the QA and UTAF. Groundwater level monitoring equipment has been installed in nine installed groundwater monitoring bores.



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Coordinate system: GDA 1994 MGA Zone 55

Scale ratio correct when printed at A3

Data source: VicRoads.

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Figure 1.2

Groundwater monitoring network

1.5.3 CLIMATE DATA

Rainfall data was obtained from BOM weather station Moorabbin Airport (86077), shown on Figure 1.1. The average annual rainfall at Moorabbin Airport is 708 mm (1950–2018); highest rainfall occurs between April to December whilst January to March have the lowest long-term monthly averages. Historical data shows that the coastal region at Bonbeach weather station receives similar rainfall on average (710 mm between 1955 and 2018) (BOM, 2018).

Rainfall conditions during the baseline monitoring period were variable but generally below the long-term average with 505 mm recorded in 2015, 712 mm in 2016 and 618 mm in 2017. Actual monthly rainfall totals and long-term averages from Moorabbin Airport weather station are compared for the period March 2017 to February 2018 in Figure 1.3.

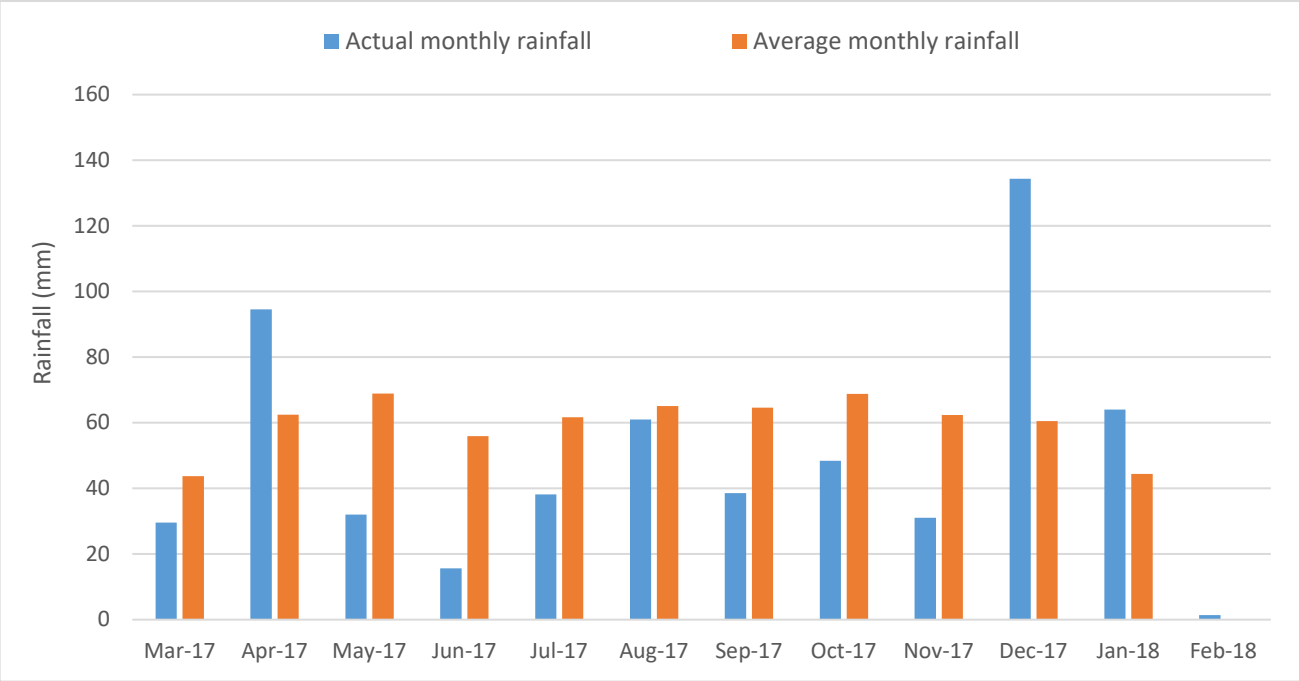

Figure 1.3 Actual and average monthly rainfall for Moorabbin Airport (86077) weather station

Evaporation data was obtained from the Bonbeach (86210) station (SILO, 2018), shown on Figure 1.1. The average annual evaporation at Bonbeach is 1,269 mm (1900–2017). Daily evaporation data is greatest in the summer months of December, January and February with evaporation of 5.5, 6.1, and 5.6 mm/day respectively. The months of May, June and July show the lowest evaporation rates with 1.3 mm/day observed for June. Actual daily evaporation rates are compared to long-term averages for the period March 2017 to February 2018 in Figure 1.4.

Daily evaporation conditions for the baseline monitoring period have been slightly higher than the long-term average with 1,408 mm recorded in 2015, 1,357 mm in 2016 and 1,389 mm in 2017. Annual evaporation totals are generally double the annual rainfall totals.

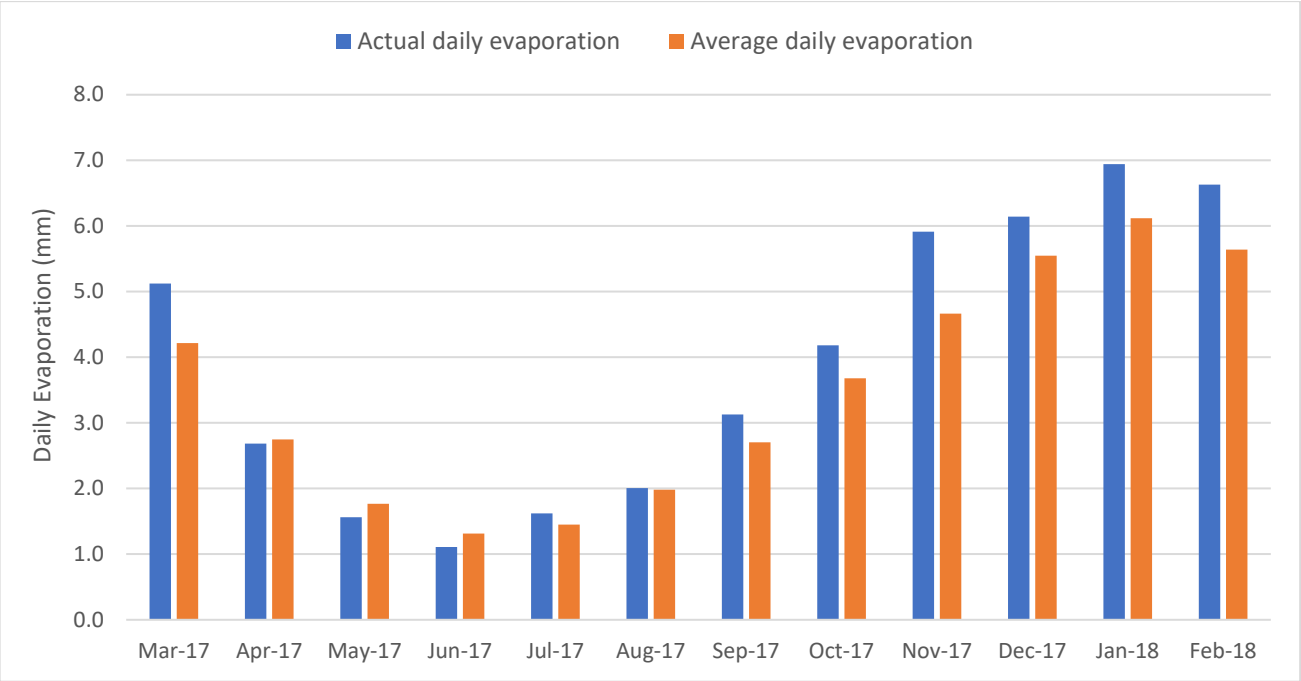

Figure 1.4 Actual and average daily evaporation for Bonbeach (86210) weather station

2 HYDROGEOLOGICAL CONCEPTUALISATION

2.1 HYDROSTRATIGRAPHY

The Victorian Aquifer Framework (VAF), developed by the Department of Environment, Land, Water and Planning (DELWP) (2017), developed and delineated a three-dimensional model of Hydrostratigraphic Units (HSUs) within Victoria. HSUs are comprised of geological materials of similar hydrogeological properties. To ensure that the HSUs behave in as a hydrogeological unit they are generally based on stratigraphic units, although similarity in storage and transfer of groundwater is more of an importance than just stratigraphic units.

The HSUs delineated within the VAF were used in the development of the numerical groundwater model as the VAF provides a consistent state-wide framework defining aquifers and aquitards. The data were refined through observations and results of the drilling and installation of dedicated groundwater monitoring bores and geotechnical investigation.

Within the Study area the HSUs largely align with the geological stratigraphy outlined in Section 5.6 of the main report. Table 2.1 outlines the relevant HSUs identified with detailed description of the HSU in the following section.

Table 2.1 Groundwater resource units present at Mordialloc Bypass (DELWP, 2017a)

GROUNDWATER RESOURCE UNIT (GEOLOGY UNIT)	ESTIMATED DEPTH BELOW SURFACE (m)	GROUNDWATER SALINITY (mg/L)	CHARACTERISTICS
Quaternary Aquifer (QA) – sand, gravels, clay, silt	0–3	1,001–3,500	Unconfined to semi-unconfined water bearing zones.
Upper Tertiary Aquifer (UTAF) (fluvial) – sand, gravel and clay (Red Bluff Sandstone, Brighton Group)	3–16	501–1,000 (N) 1,001–3,500 (S)	Mostly confined by overlying clay, silt and basalt deposits. Completely eroded in some areas. Low productivity.
Upper-Mid Tertiary Aquitard (UMTD) – clay, silt, marl (fractured rock) and minor sand (Fyansford Formation)	16–47	Unknown	Widespread subsurface aquitard with low yields and poor water quality.
Lower Tertiary Aquifer (LTA) - sand, gravel, clay and silt, minor coal (Werribee Formation)	47–53	1,001–3,500	Extensive semi-confined to confined fractured rock water bearing zones.
Mesozoic and Palaeozoic Bedrock (BSE) – basement sedimentary (fractured rock): sandstone, siltstone, mudstone, shale, igneous (fractured rock), includes volcanics, granites, granodiorites Murrindindi Supergroup	>53	<500 (S) 501–1,000 (N)	Widespread subsurface aquitard, generally with low yields and poor water quality.

The Quaternary aquifer is largely associated with the Carrum Carrum Swamp system and is located within the southern portion of the Study area, roughly south of Governor Road. The QA consists of windblown Aeolian sands, clays and silts from the swam system and alluvial sands and gravels, and is therefore laterally variable in character.

Within the southern portion of the Study area the QA consists of an unconfined aquifer forming the water table aquifer. Drilling within the Study area has indicated the QA is generally less than 7 m thick although greater thickness were intersected to the south consistent conceptual understanding, with thickness of >11 m encountered.

The Pleistocene Clay sediments associated with the Carrum Swamp are classified within the QA based on the depositional age. The Pleistocene Clay is a shallow swamp deposit at variable thickness across the Study area and was intersected during drilling within the southern portion of the Study area.

Hydrogeologically, the Pleistocene Clay is reported to act as a local aquitard confining the UTAF (AECOM GHD JV 2018). The lower permeability was confirmed during laboratory permeability tests from core samples obtained during the LXRA drilling program. The lower permeability was also observed during sampling with bores screened with the QA having lower yields.

It is understood that the Pleistocene Clay was excavated through during the reinstatement and construction of the EN3 and Dog Pond cells of the Edithvale Wetlands. The excavation provides a potential connection with the underlying Brighton Sands aquifer and accounts for the distinct water quality characteristics at these locations compared to the water quality of the remaining wetland cells.

The Pleistocene Clay unit was not explicitly represented in the model, but forms part of the model layer representing Quaternary Alluvium.

2.2 EDITHVALE-SEAFORD WETLANDS

To the southwest of the proposed project alignment lies the RAMSAR-listed Edithvale Wetlands. The Edithvale Wetlands have been anthropogenically modified and receive water largely from local stormwater inlets, with groundwater intrusions also occurring (predominantly in the northern portion of the Edithvale Wetlands). Details of the ponds are presented on Figure 1.1. The Edithvale Wetlands comprise of two parts, north and south of Edithvale Road, referred to here as ‘Edithvale South Wetlands’ and ‘Edithvale North Wetlands’:

- *Edithvale South Wetlands* comprises a natural depression on the south side of Edithvale Road with the lowest point being -0.3 m Australia Height Datum (mAHD) (GHD, 2005). Edithvale South Wetlands are predominantly fed by three drains from catchments to the east which initially entered sediment ponds at the edge of the macrophyte zone, with limited discharge from groundwater sources. The winter and spring standing water level generally sits at around 0.00 mAHD, but rises up to 0.78 mAHD during rain events and discharges to Edithvale North Wetlands and Centre Swamp Drain; the invert level of the weir is -0.02 mAHD, and therefore, any water above that level discharges to Edithvale North Wetlands. Reduced rainfall during summer and autumn will result in evaporation and water levels drop below 0.00 mAHD. A manually operated pump on Centre Swamp Drain can pump water when the drain holds water into the northern pool during dry periods.
- *Edithvale North Wetlands* predominantly comprises a series of constructed wetlands within the former floodplain on the north side of Edithvale Road. Stormwater recharge enters the wetland from stormwater drains from the east via two sediment ponds and from Edithvale South Wetland via a pipe under Edithvale Road (known as the overflow pit). A series of weirs control flow of water between different wetland cells and limit total drawdown during prolonged dry or drought conditions. Stormwater supplies these cells from a series of drains and overland flow. A groundwater component of recharge supplements water inflows to EN2, EN3 and EN3a (Figure 1.1) ponds due to their hydraulic connection with the Brighton Sands aquifers, into which they were excavated.

The Centre Main drain forms a discharge point for both Edithvale North and South Wetlands during wet periods.

2.2.1.1 EDITHVALE WETLANDS WATER BALANCE

Developed from the existing LXRA water balance model for the Edithvale Wetlands, a SOURCE water balance model was completed to include changes to runoff caused by the Mordialloc Bypass. The resulting Project water balance model for Edithvale Wetlands modelled impacts to water levels within the wetlands due to changes in in surface water and groundwater contributions (Appendix D of the main report (WSP, 2018)).

As modelled impacts to groundwater did not extend to Edithvale Wetlands, a sensitivity analysis was completed to gauge how reduction of groundwater contributions to the wetlands would impact on water levels within the individual wetland cells. Groundwater contributions were arbitrarily reduced based on 10%, 20% and 30%. The resulting simulations indicated that there was little sensitivity to water levels within the wetlands with potential reduction of groundwater baseflow into the wetland cells.

2.3 EMBANKMENT SURCHARGE EFFECT ON PERMEABILITY

Geotechnical modelling was carried out to calculate the reduction factor of the permeability for 4 and 8 metres embankment height, respectively (refer Appendix A). In order to upscale the permeability factors to the average width of the embankment, a weighted harmonic mean was calculated for each 1 m depth interval. As the proposed embankment height varies between 2 and 9 metres, the weighted harmonic means per depth were extrapolated (and interpolated) using linear regression to estimate the permeability factors for 2, 3, 5, 6, 7 and 9 metres embankment height. The results are presented in Table 2.2. Depending on the thickness of the first two model layers an average of the permeability factor covering the same depth was applied to incorporate the impact of the embankment in the groundwater model.

Table 2.2 Permeability factor per depth for 2-9 metres embankment

DEPTH (m)	EMBANKMENT THICKNESS (m)							
	2	3	4	5	6	7	8	9
0.5	0.46	0.41	0.37	0.33	0.29	0.25	0.20	0.16
1.5	0.70	0.65	0.60	0.54	0.49	0.44	0.39	0.33
2.5	0.75	0.70	0.64	0.59	0.54	0.49	0.44	0.39
3.5	0.79	0.74	0.69	0.63	0.58	0.53	0.48	0.43
4.5	0.82	0.77	0.72	0.67	0.62	0.57	0.52	0.46
5.5	0.84	0.79	0.74	0.69	0.65	0.60	0.55	0.50
6.5	0.86	0.81	0.76	0.72	0.67	0.62	0.58	0.53
7.5	0.87	0.83	0.78	0.74	0.69	0.64	0.60	0.55
8.5	0.89	0.84	0.80	0.75	0.71	0.66	0.62	0.57
9.5	0.89	0.85	0.81	0.77	0.72	0.68	0.64	0.59
10.5	0.90	0.86	0.82	0.78	0.74	0.69	0.65	0.61
11.5	0.91	0.87	0.83	0.79	0.75	0.71	0.67	0.63
12.5	0.92	0.88	0.84	0.80	0.76	0.72	0.69	0.65
13.5	0.921	0.884	0.85	0.811	0.774	0.738	0.70	0.665
14.5	0.931	0.895	0.86	0.822	0.785	0.749	0.71	0.675

2.4 CONCEPTUAL MODEL

A conceptual model is a summary of the current understanding of the groundwater system and the influences on it, including 'natural' processes, such as recharge, as well as man-made stressors. The conceptual model forms the basis for construction of the numerical model.

The conceptual hydrogeological model for the project is described in detail in the main report (WSP, 2018). Maps showing the observed groundwater levels in the QA and UTAF units are shown in Figures 5.14 and 5.15 of the main report. In summary, the construction of the numerical model was guided by the following key characteristics and processes of the conceptual model:

- The study area is underlain by a series of unconsolidated sedimentary aquifers, the hydraulic characteristics of which are reasonably well-understood from previous work and investigations carried out during this study.
- Groundwater flow is generally from the north east to the south west (i.e. towards the coast).
- The water table is shallow over most of the study area (within several metres of the surface) and therefore the groundwater system is strongly influenced by surface drainage features, evapotranspiration, rainfall recharge, and recharge from surface runoff and flooding.
- The QA and the UTAF aquifers are unconfined and semiconfined (respectively) and hydraulically connected. Locally, hydraulic gradients (and therefore groundwater flow) can have an upward component in the UTAF aquifer.
- Groundwater abstraction from pumping bores is minor; however, the influence of nearby pumping is apparent in some monitoring bores in the vicinity of the project.
- The wetlands represent topographical lows that are either permanently or seasonally inundated with water. They are variably connected to the groundwater system and are sustained through groundwater discharge and periodic surface water runoff.
- The low elevation of the Edithvale Wetlands and surrounding groundwater table (periodically below sea level) suggests that the system is a net groundwater sink due to losses through evapotranspiration.

The conceptual understanding of hydrogeological conditions within the existing environment are presented in the two cross-sections (shown on Figure 2.1). **Error! Reference source not found.** displays the north-south cross-section through the alignment and a west-east cross-section from Port Phillip bay through the Edithvale Wetlands to the alignment.

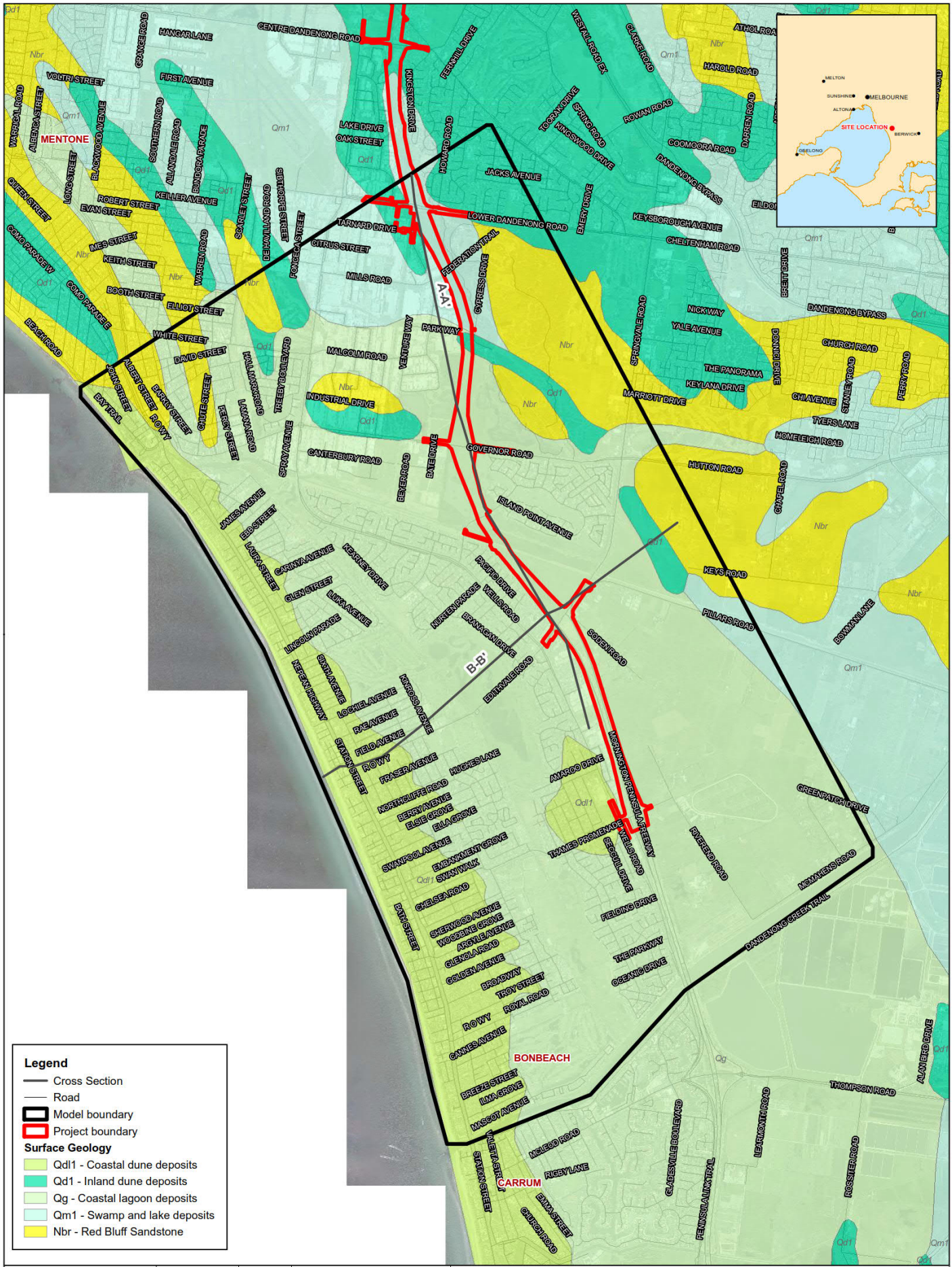

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Figure 2.1
Geology map showing cross-section locations

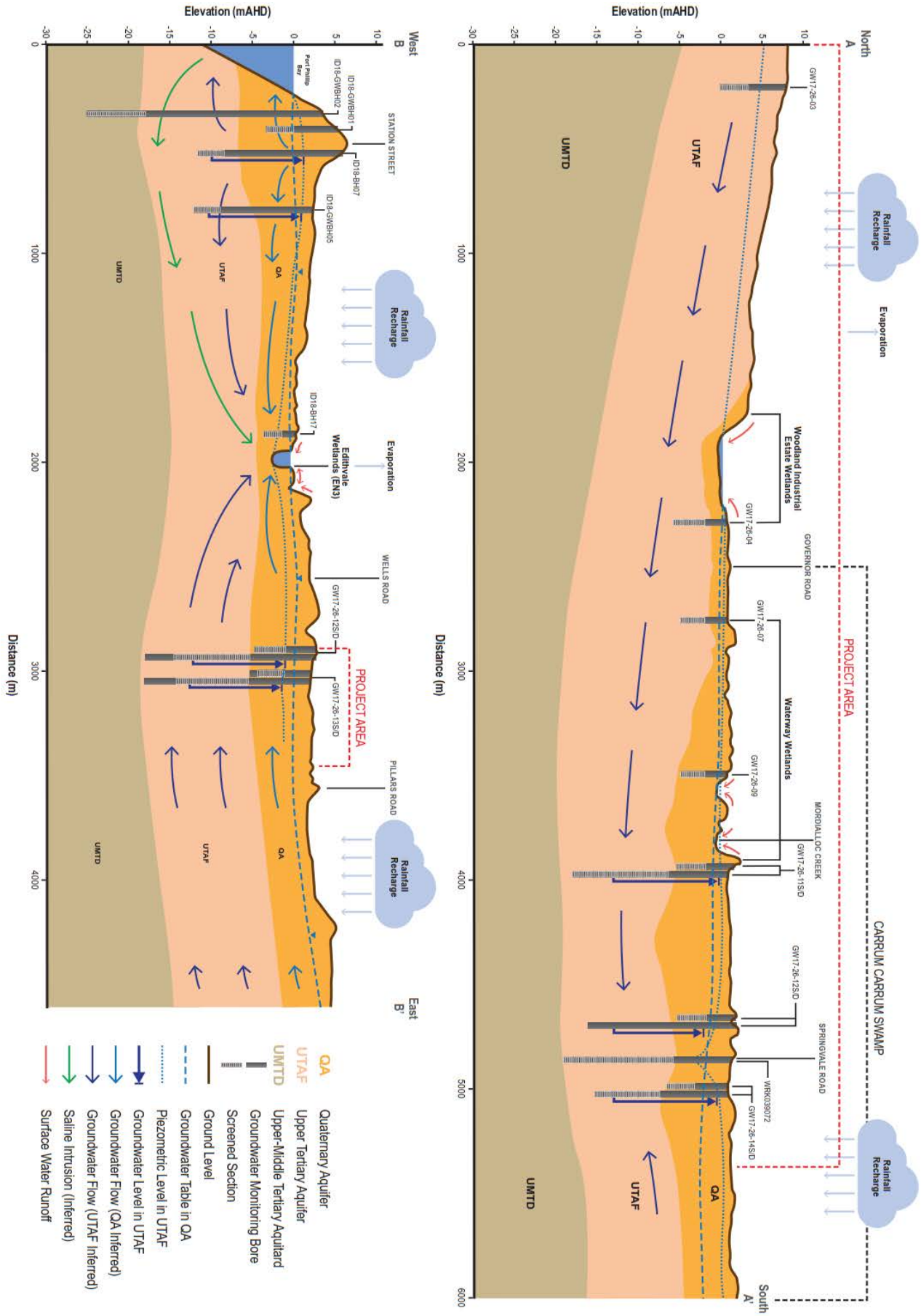


Figure 2.2 Conceptual hydrogeological cross-sections

3 NUMERICAL GROUNDWATER MODELLING

3.1 MODEL CLASSIFICATION

The Australian groundwater modelling guidelines (Barnett et al, 2012) provide guiding principles and minimum standards of numerical groundwater models. The guidelines recommend that the overall reliability, complexity and confidence level of the model should be assessed and agreed prior to construction of the model, and if possible re-assessed at a later stage in the modelling project. The confidence level classification comprises three classes; class 1, class 2 and class 3, in order of increasing confidence level. The level of confidence typically depends on the available data, calibration procedures, consistency between the calibration conditions and predictive analysis scenario, and the level or severity of stresses being simulated. A table of quantifiable indicators with which to assess a model's confidence level based on those attributes is included in the modelling guidelines.

Typically, in impact assessments for infrastructure projects, the paucity of time series and spatial data for calibration compared with the proposed development timeframe is such that a class 2 confidence level is the highest feasible. The numerical model developed for this assessment is class 2.

Independent peer review of the numerical groundwater model has been undertaken by Anthony Smith of CDM Smith.

3.2 MODEL DESIGN

3.2.1 MODEL CODE

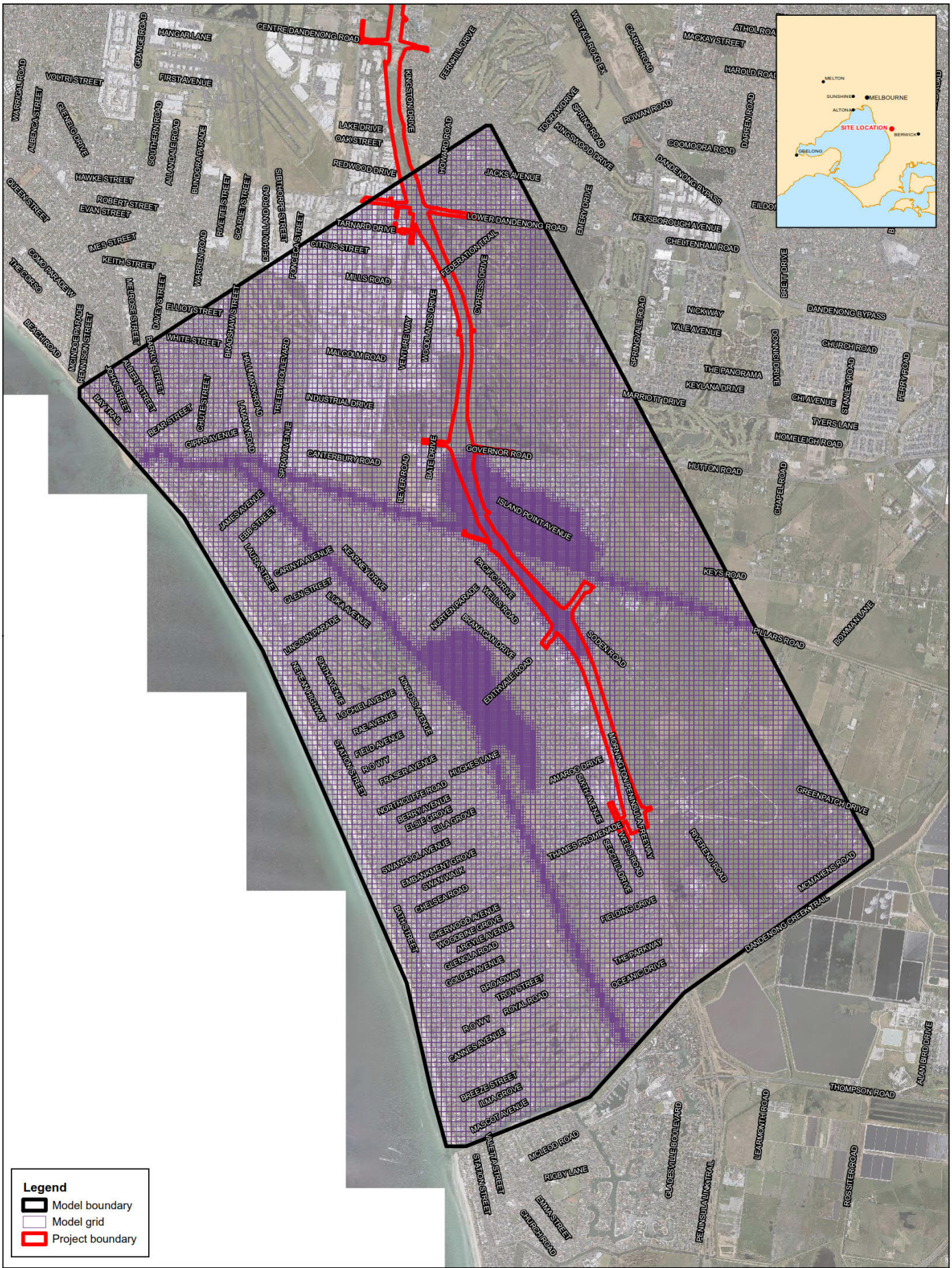
Numerical modelling was carried out using MODFLOW USG and the Groundwater Vistas Version 7 user interface. MODFLOW-USG (Panday et al., 2013) utilises a control-volume finite difference approach (CVFD), and is well suited to impact assessment modelling in which water source interactions and precise water balance estimates are important. MODFLOW USG allows for refined and unstructured grids and variably saturated flow conditions.

3.2.2 MODEL GEOMETRY

The model domain is 8 km by 10.35 km. The major hydrostratigraphic units are represented by 4 model layers, pinched out where they are absent or less than a threshold of 0.1 m thick. The model cell size is 50 x 50 m over most of the model domain, but has been refined using quad-tree refinement to 12.5 x 12.5 m around the project area and at the Edithvale Wetlands. Cells outside the model domain are defined as inactive. The total number of active model cells after refinement is 138,860 (34,715 per layer).

Model boundaries are located approximately 1 km from the proposed embankments to prevent boundary effects on model outcomes. The model domain is shown on Figure 3.1.

The model domain extends far enough to allow the effects of cumulative impacts from the LXRA project to be assessed, although results of the LXRA modelling indicate that impacts from that project are very unlikely to extend to the Edithvale Wetlands (shown on Figure 3.1).



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Date: 3/09/2018	Approved by: AS	1:35,000	wsp
Data source: VicRoads. *Copyright © The State of Victoria, Department of Environment, Land, Water & Planning 2018*		Coordinate system: GDA 1994 MGA Zone 55 Scale ratio correct when printed at A3	**Engineering and Technical Services for Mordialloc Bypass Upgrade** Figure 3.1 Model domain

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3.2.3 MODEL LAYERS

The groundwater system and hydrogeological units were represented by four model layers as summarised in Table 3.1.

Recent LiDAR data (shown on Figure 3.2) was used for the top elevation of the model. The elevations and thicknesses of the model layers were developed using grid files of geological layers exported from the Victorian Aquifer Framework database. The base of the quaternary aquifer and the base of the Upper Tertiary Aquifer (UTAF) were amended where recent bore data from the LXRA and Mordialloc Bypass project is available to create a more accurate layer depth in those areas.

The Pleistocene Clay unit, identified in various previous studies (SKM, 2009; AECOM GHD JV, 2018) at the base of the alluvium, was represented by lowering the hydraulic conductivities in layer 1 where the clay layer has been identified.

The modelled zonation for layer 1 alluvium is shown in Figure 2.1 as it is consistent with the surface geology. The higher hydraulic conductivities in zone 1 of layer 1 reflect the dune deposits that exist in these areas. Single values for hydraulic conductivity were used for other layers.

Table 3.1 Model layers

LAYER	GROUNDWATER RESOURCE UNIT	LITHOLOGY
1	Quaternary Aquifer (QA)	Alluvium (Coastal lagoon deposits, Swamp and lake deposits) (thin, locally variable and surficial). Includes Cranbourne Sands (aeolian dune deposits)
2	Upper Tertiary Aquifer (UTAF)	Red Bluff Sandstone, Brighton Group (fluvial) – sand, gravel and clay
3	Upper-Mid Tertiary Aquitard (UMTD) (Fyansford Formation)	Fyansford Formation (Gellibrand Marl) – clay, silt, marl (fractured rock) and minor sand
4	Lower Tertiary Aquifer (LTA)	Werribee Formation – sand, gravel, clay and silt, minor coal

No geological faults have been incorporated into the groundwater flow model.

3.2.4 BOUNDARY CONDITIONS

3.2.4.1 INITIAL HEADS

The model was run in steady state, assuming average conditions over the baseline period of 1995 to 2015, to obtain representative initial heads for the transient calibration run. The model was calibrated by varying key parameters such as recharge, evapotranspiration and aquifer parameters within reasonable value ranges in order to obtain a close match with observed groundwater levels.

3.2.4.2 SURFACE DRAINAGE

The surface water drainage network is indicated on Figure 3.2. Surface drainage features are digitised as shapefiles which contain attributes such as channel elevations, depths and widths, and an estimate of the hydraulic conductivity of the channel substrate (for calculation of drain or stream-bed conductance).

The river package was used to simulate the Patterson river, which runs along the southern boundary of the model. The drain package was used to simulate other river and creek reaches. Artificial drains are an important aspect of the current landscape and are likely to have a strong control on groundwater levels in low-lying areas. Importantly, artificial drains are located along the proposed western side of the embankment. Those drain features are represented as MODFLOW Drains that are continuously active throughout the calibration period and following the proposed development. The drains adjacent to the embankment have the potential to mitigate potential transient rises in groundwater level associated with emplacement of the embankment, but would not influence drawdown effects if the groundwater level decreased below the level of the drain invert.

The Edithvale Wetlands were simulated using the MODFLOW evapotranspiration package (EVT). In the EVT package, an ET rate is specified at a given ET surface elevation (in this case the ground surface or mean wetland water level). The rate of ET loss decreases linearly with depth below the ET surface to a specified extinction depth, often influenced by the dominant vegetation rooting depth (in this case mostly grasses with an assumed rooting depth of 1 to 2 metres). The EVT package was used to represent the wetland in recognition that the wetland water levels are, on average, maintained below mean sea level by evapotranspiration. An alternative approach would have been to use the MODFLOW River package, in which the wetland water levels would be specified according to the observed water levels and surface water inputs. The former and adopted approach is appropriate for initial assessment of the extent of groundwater level change associated with the embankment. If initial modelling had indicated that groundwater level changes would extend to the wetland, then a more rigorous treatment of the wetland using a MODFLOW River or Stream package coupled with a surface water balance model would have been adopted. Since this was not indicated the more detailed methodology was not deemed necessary and was not employed.

3.2.4.3 RECHARGE AND EVAPOTRANSPIRATION

A small proportion of total rainfall recharges the groundwater system via infiltration through the unsaturated zone. The remainder is lost as surface runoff via rivers and streams, and as evapotranspiration. The rate of recharge to the alluvial dune sediments differs from the rate of recharge to coastal lagoon deposits and areas where Brighton Group is exposed due to the difference in thickness and permeability of the unsaturated zone.

Aquifer recharge was applied to the model using the MODFLOW recharge package (RCH). Rainfall recharge was applied uniformly as per the LXRA numerical groundwater model (AECOM GHD JV, 2018). The average rainfall recharge applied in the LXRA model is 1.365×10^{-4} m/day (7% of rainfall). A recharge rate of 100% actual rainfall was applied to the Edithvale and Waterway Wetlands areas.

Evapotranspiration was applied using the MODFLOW EVT package. Evapotranspiration was applied uniformly as per the LXRA numerical groundwater model (AECOM GHD JV, 2018). The upper end of the evapotranspiration applied in the LXRA model is 6.84×10^{-4} m/day (approximately 17.5% of average actual EVT from the Bureau of Meteorology (BOM)). Evapotranspiration was set at 17.5% of the annual actual rate with an extinction depth of 1.2 m across the model domain, consistent with the predominantly grassy vegetation. Evapotranspiration at the Edithvale and Waterway Wetlands areas was set at 70% of actual ET in winter and 85% of actual ET in summer, to approximate open water evaporation where the water ponded above the model surface (Allen et al., 1998).

3.2.4.4 GENERAL AND CONSTANT HEAD BOUNDARIES

A no-flow boundary was applied to the northern boundary of the model. A MODFLOW general head boundary (GHB) was applied to the eastern boundary of the model. The head for the eastern boundary was set between 5 and 2 mBGL decreasing towards the Patterson River (southern model boundary) and the GHB was set at a distance of 1000 m. The western boundary (Port Phillip Bay) was represented by a constant head boundary (CHB) of 0 mAHD. The southern boundary of the model (Patterson River) was represented by a river boundary (refer section 3.2.4.2). The conductance of the general and constant head boundaries is based on the hydraulic conductivity of geological material in the adjacent model cell.

3.2.4.5 PUMPING BORES

The well boundary was used to simulate licenced extraction of groundwater from five active pumping bores in the model domain. Details are presented in Table 3.2. Pumping bores for which the entitlement volume (3 bores) was not known or the status was ‘decommissioned or not used’ (3 bores) were not included.

For transient calibration, the pumping schedule was varied during the year with 75% of the entitlement assumed to occur in the summer months (December, January and February) and 25% in Spring (10% in September and 15% in October).

Table 3.2 Pumping bore details

BORE ID	EASTING	NORTHING	ENTITLEMENT (ML/yr)	ENTITLEMENT (m^3/d)	MODEL LAYER	DEPTH (m)	USE
WRK032660	337513.2	5787484	60	164.3835616	3	56	Irrigation
WRK043168	336452	5792444	20	54.79452055	3	30	Irrigation
WRK046823	332702	5791193	5	13.69863014	4	91	Irrigation
WRK057581	335710	5793908	3.5	9.589041096	3	33	Irrigation
WRK039072	336293.2	5789584	3.5	9.589041096	2	23.8	S&D, Irrigation

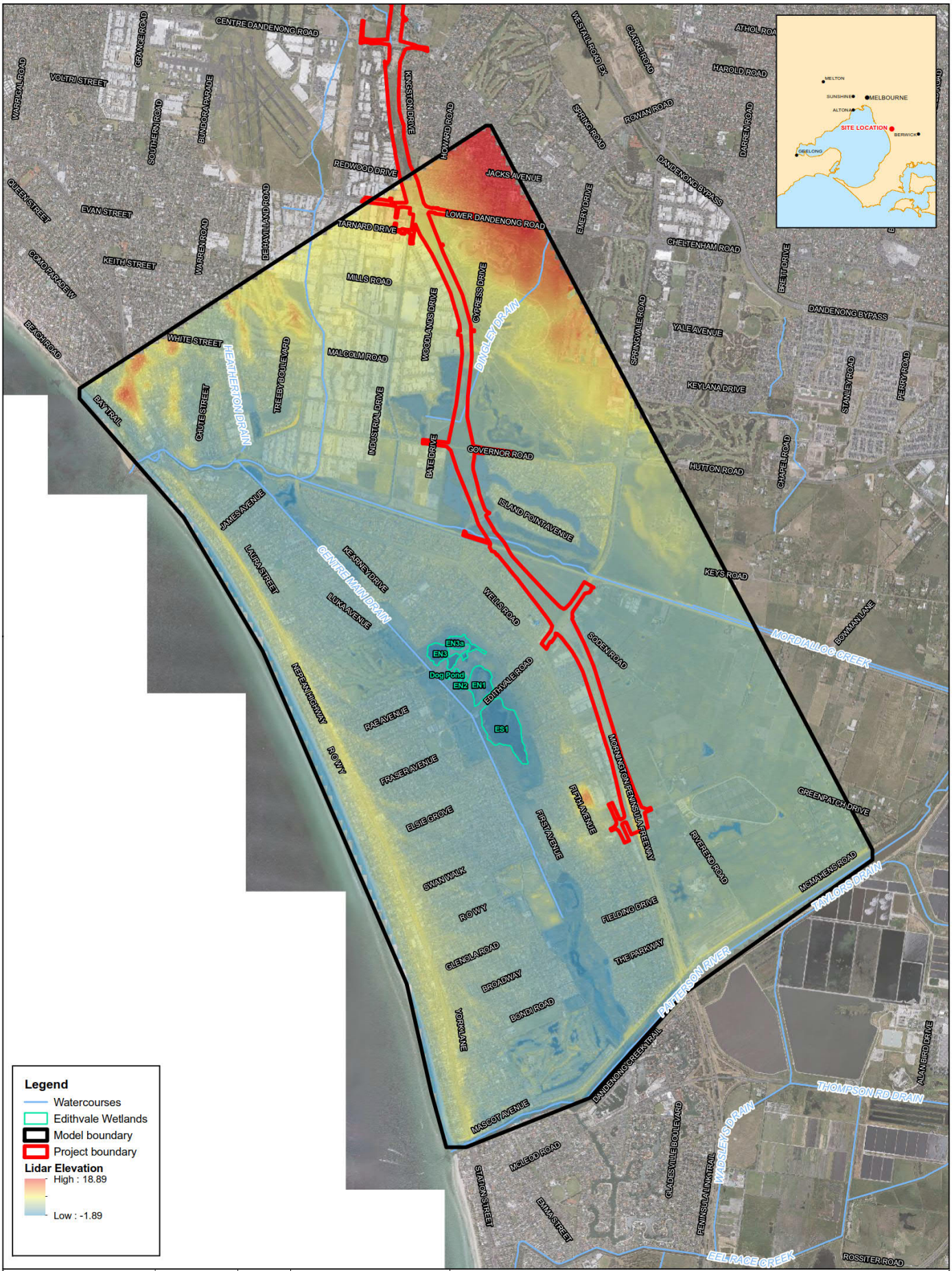
3.2.4.6 PUMPING BORE CALIBRATION

WSP undertook an additional calibration run of the model to match observed pumping responses in groundwater monitoring bores screened in the QA and UTAF units (model layers 1 and 2) at nested sites GW17-26-12, GW17-26-13, GW17-26-14 and GW17-26-15. The pumping rate for the pumping bore that is located on the southern embankment (WRK039072) was increased by 100 times (350 ML/year). While the simulated groundwater levels did not match the observed water levels perfectly, it was a better fit. The calibrations statistics were slightly better when pumping was included, with an unweighted scaled RMS error of 9.4% and a weighted scaled RMS error of 7.2%.

3.2.5 SIMULATION PERIOD AND TEMPORAL DISCRETISATION

The time periods adopted for the model runs were as follows:

1. A steady state period to 2015, representing average conditions between 1995 and 2015 (baseline). The model was calibrated under steady state conditions to match modelled groundwater levels with observed.
2. Transient stress periods of monthly duration representing current hydrogeological conditions for the period of groundwater monitoring and a few years prior (January 2015 to February 2018). The model parameters were further changed where necessary to improve the transient fit between modelled and observed groundwater responses.
3. Transient stress periods of monthly duration representing the proposed embankment running from March 2018 to March 2021.



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Date: 3/09/2018	Approved by: AS	

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Coordinate system: GDA 1994 MGA Zone 55

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Figure 3.2

Lidar elevation data and surface water features

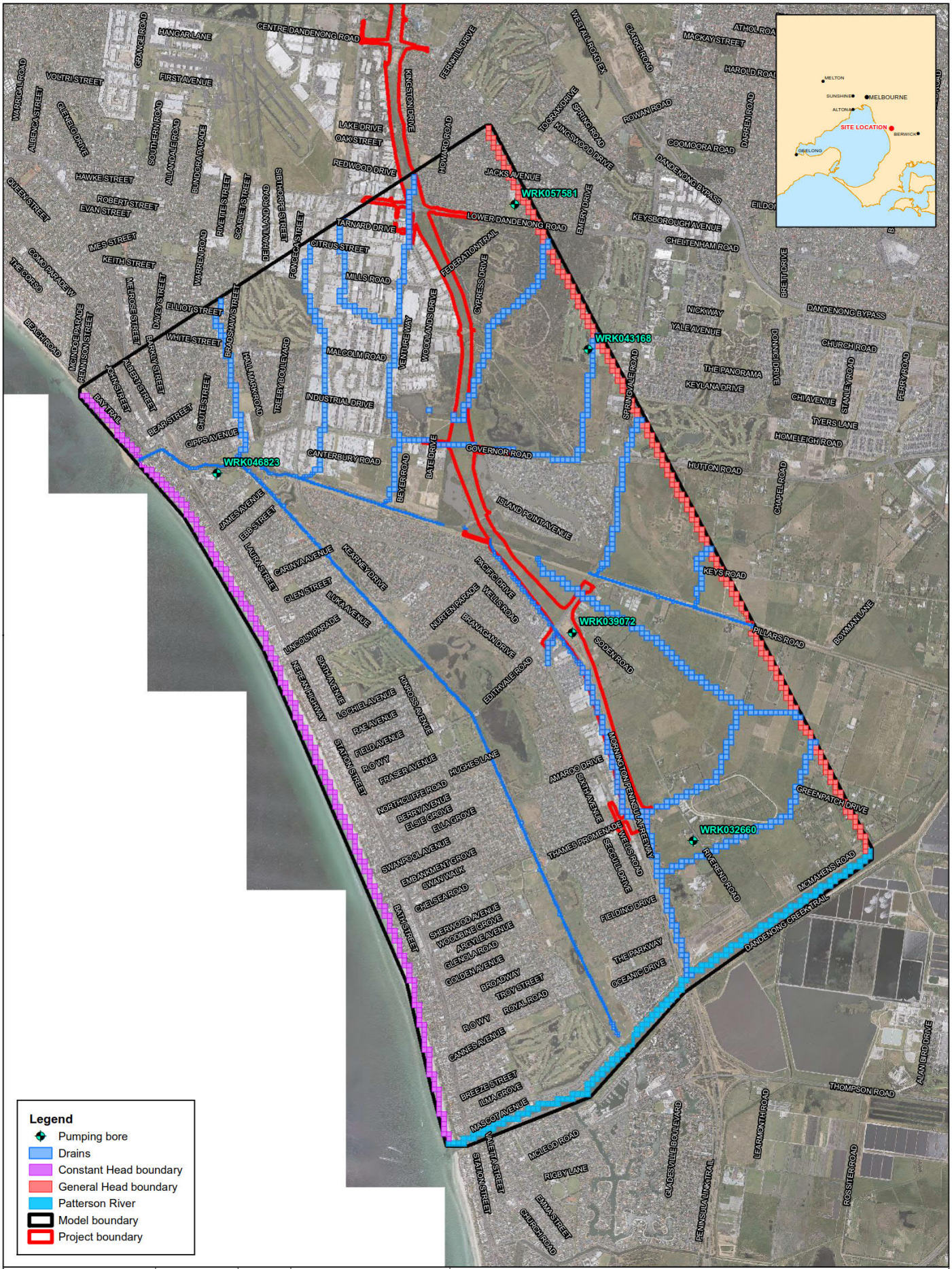

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Figure 3.3
Model boundary conditions

3.3 MODEL CALIBRATION

3.3.1 CALIBRATION APPROACH

Model calibration includes the changing of model parameter values within realistic bounds until the model outputs fit historical measurements, such that the model can be accepted as a reasonable representation of the physical system of interest (Barnett et al. 2012). Manual calibration methods were applied to improve the ability of the model to match observed water levels. A summary of model performance in relation to observed water levels is presented in Section 3.3.2.

The model calibration is usually assessed using statistical measures such as the Scaled Root Mean Squared (SRMS) error, and a predefined value of goodness of fit between simulated and observed values. A target SRMS error of less than 10 percent is commonly considered acceptable and an SRMS error of less than five percent is typically considered characteristic of a very well calibrated regional scale model. However, it is noted that the SRMS statistic is scaled to the total range in head elevations and therefore models with relatively flat topography (such as in the Project area) may be unable to achieve very low SRMS values. The calibrated model should have a mass balance error of less than 1% (Barnett et al., 2012).

There are also other criteria that can be used to assess the quality of model calibration and whether or not the model is fit for purpose, including:

- The model converges with an acceptably small convergence error and the model is numerically stable i.e. the simulated results are mathematically sound and the model is robust enough to be run multiple times during calibration and uncertainty analysis (Barnett et al., 2012).
- The model behaves in a manner consistent with the hydrogeological conceptual model and can replicate key features of the hydrogeological system including:
  - Fluctuations in groundwater levels are consistent with the natural range variations in response to changes in rainfall and evaporation
  - Groundwater flow directions are consistent with topography and observed groundwater levels, with groundwater discharging to the wetlands, surface water courses and Port Phillip Bay.

3.3.2 CALIBRATION RESULTS

Calibration of the groundwater model has focussed on historical matching of groundwater levels. A total of 166 groundwater level observations were available at 43 sites for the period August 2017 to February 2018. Of these, 20 sites only had a manual groundwater level measurement available for February 2018. Twenty-three sites had continuous 6-hourly logger data and for these sites the monthly average was used for model calibration. The sites are located at the project site, the Edithvale and Waterways Wetlands and at the coast of Port Phillip Bay. Groundwater level observations were available for model layers 1, 2 and 3. Monitoring observations that were clearly affected by pumping were de-weighted to reduce their influence on the calibration objective function.

The transient calibration of the model was undertaken by simulating groundwater levels between January 2015 and February 2018. An initial steady state run was undertaken to establish initial heads and allow the model to stabilise prior to the transient simulation.

The calibration achieved was considered to show good correlation between simulated and observed heads, with a scaled root mean squared (SRMS) value of less than 7.4%, which is below the 10% threshold and considered acceptable for a regional scale model (refer Table 3.3).

The calibrated model has a mass balance error of 0.0%, which is below the accepted threshold of 1 % (Barnett et al., 2012).

Table 3.3 Calibration statistics for the transient run

CALIBRATION STATISTICS	WEIGHTED	UNWEIGHTED
Residual Mean	-0.07	-0.45
Absolute Residual Mean	0.36	0.74
Residual Std. Deviation	0.54	0.91
Sum of Squares	49.4	169.9
RMS Error	0.55	1.01
Min. Residual	-3.56	-3.56
Max. Residual	1.12	1.12
Number of Observations	166	166
Range in Observations	7.37	7.37
Scaled Residual Std. Deviation	0.07	0.12
Scaled Absolute Residual Mean	0.049	0.10
Scaled RMS Error (%)	7.4%	13.7%

3.3.2.1 HYDRAULIC PROPERTIES

Calibrated model hydraulic properties for each layer are presented in Table 3.4. The modelled zonation for layer 1 alluvium is shown in Figure 2.1 as it is consistent with the surface geology. The higher hydraulic conductivities in zone 1 of layer 1 reflect the dune deposits that exist in these areas. Single values for hydraulic conductivity were used for other layers. The specific storage (Ss) was set at 10^{-5} and the specific yield (Sy) was set at 0.1 for each layer.

Table 3.4 Initial and calibrated model hydraulic properties

LAYER	GROUNDWATER RESOURCE UNIT	ZONE	OSAR SLUG TEST DATA RANGE (Kh)	LXRA DATA RANGE PRIOR TO CALIBRATION (Kh)	INITIAL Kh INPUT VALUES	CALIBRATED Kh (m/day)	CALIBRATED Kv (m/day)
1	QA – Coastal and inland dune deposits	1	na	0.01-41	10	10	1
	QA – Coastal lagoon, swamp and lake deposits	11	0.04-0.65	na	0.28	1	0.1
	QA – Swamp and lake deposits	12	na	na	0.28	1	0.1
2	UTAF		0.03-3.93	0.001-6	0.35	0.7	0.07
3	UMTD		na	0.001-1	1	0.5	0.05
4	LTA		na	0.1-10	5	5	0.5

The calibrated model parameters are in good agreement with the field and literature hydraulic properties compiled in Section 5.7 of the main report (WSP, 2018).

3.3.2.2 HYDRAULIC HEADS

Figure 3.4 presents a summary of the groundwater level calibration, comparing observed (measured) versus modelled heads for the transient calibration period. Overall, there is good correlation between observed and modelled water levels. Water levels are over predicted in some areas and under predicted other areas. A map showing the calibration targets and residuals is presented in Figure 3.5.

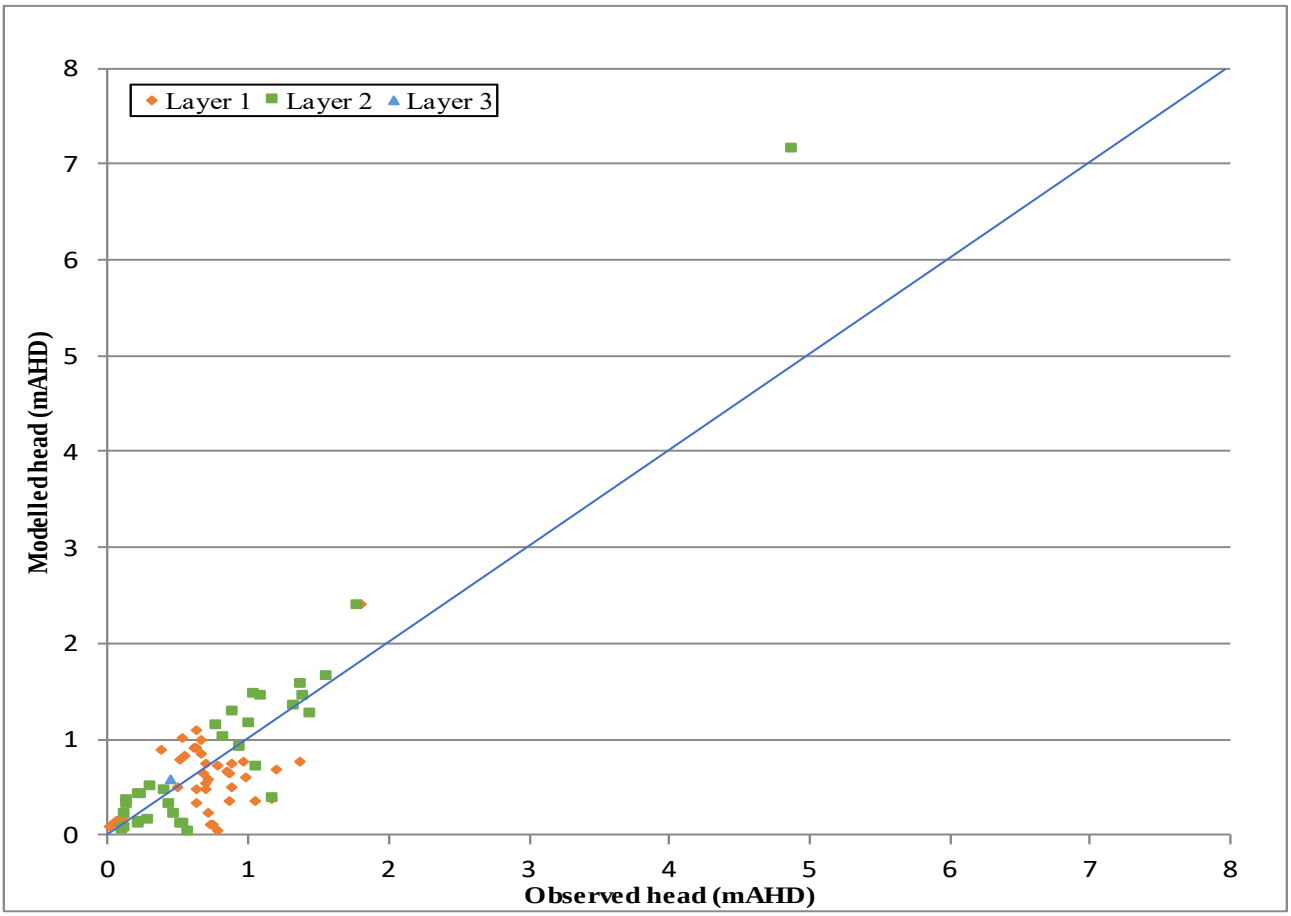

Figure 3.4 Observed vs modelled heads

The model reported an unweighted RMS error of 1.01 m and a weighted RMS error of 0.55 m for the transient calibration period. RMS error is a statistic similar to standard deviation in that it is a measure of the variation in observed and modelled water levels about the mean. Observations are weighted prior to calibration based on the reliability of data. A weighting 0.1 was applied to monitoring bores at sites GW17-26-12, GW17-26-13, GW-26-14 and GW-26-15 as data for these bores is considered to be unreliable as these bores are clearly influenced by a pumping bore as observed in the hydrographs (refer Figure 3.6 below and Section 3.2.4.6).

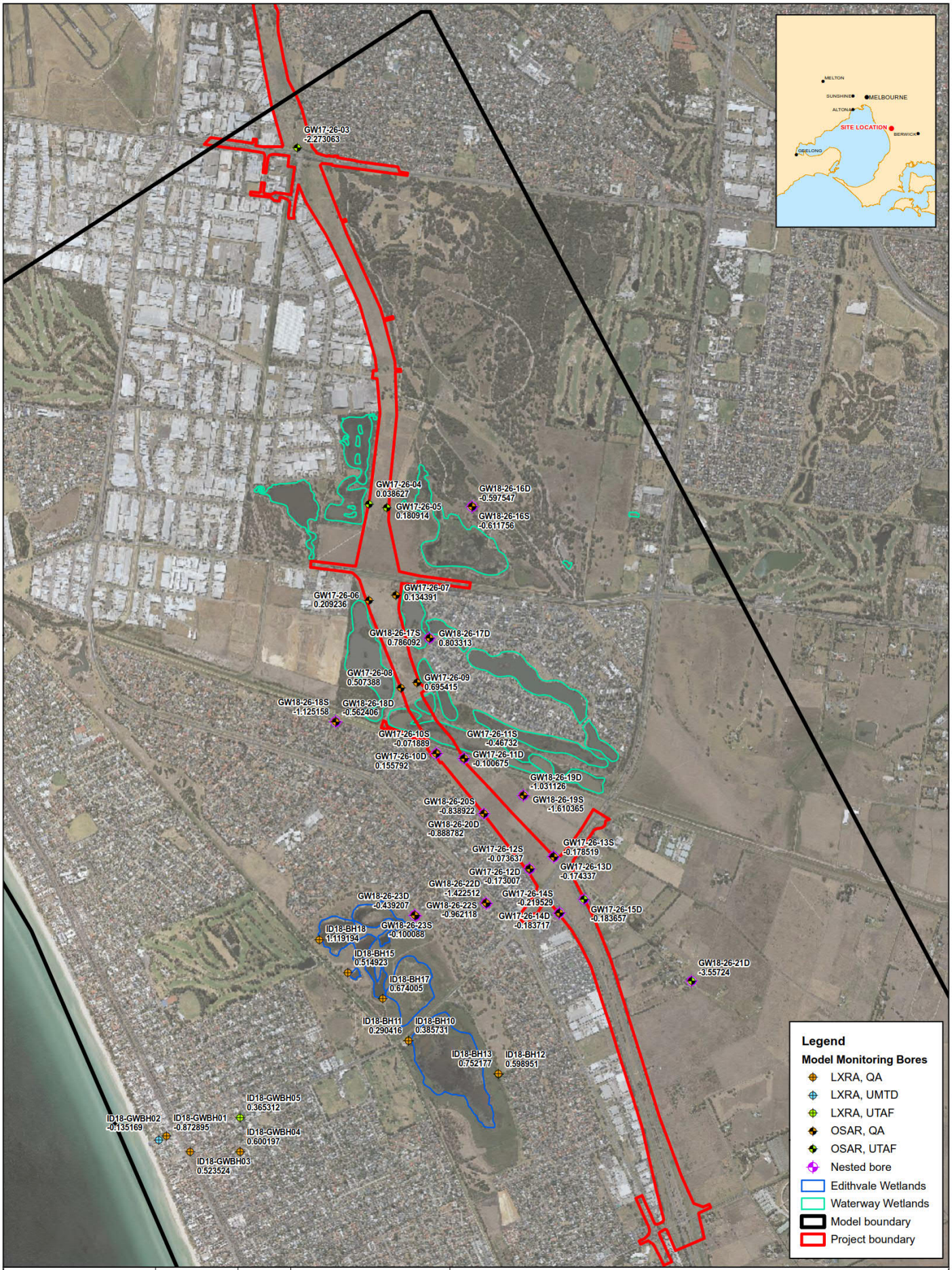

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Figure 3.5
Calibration targets and residuals

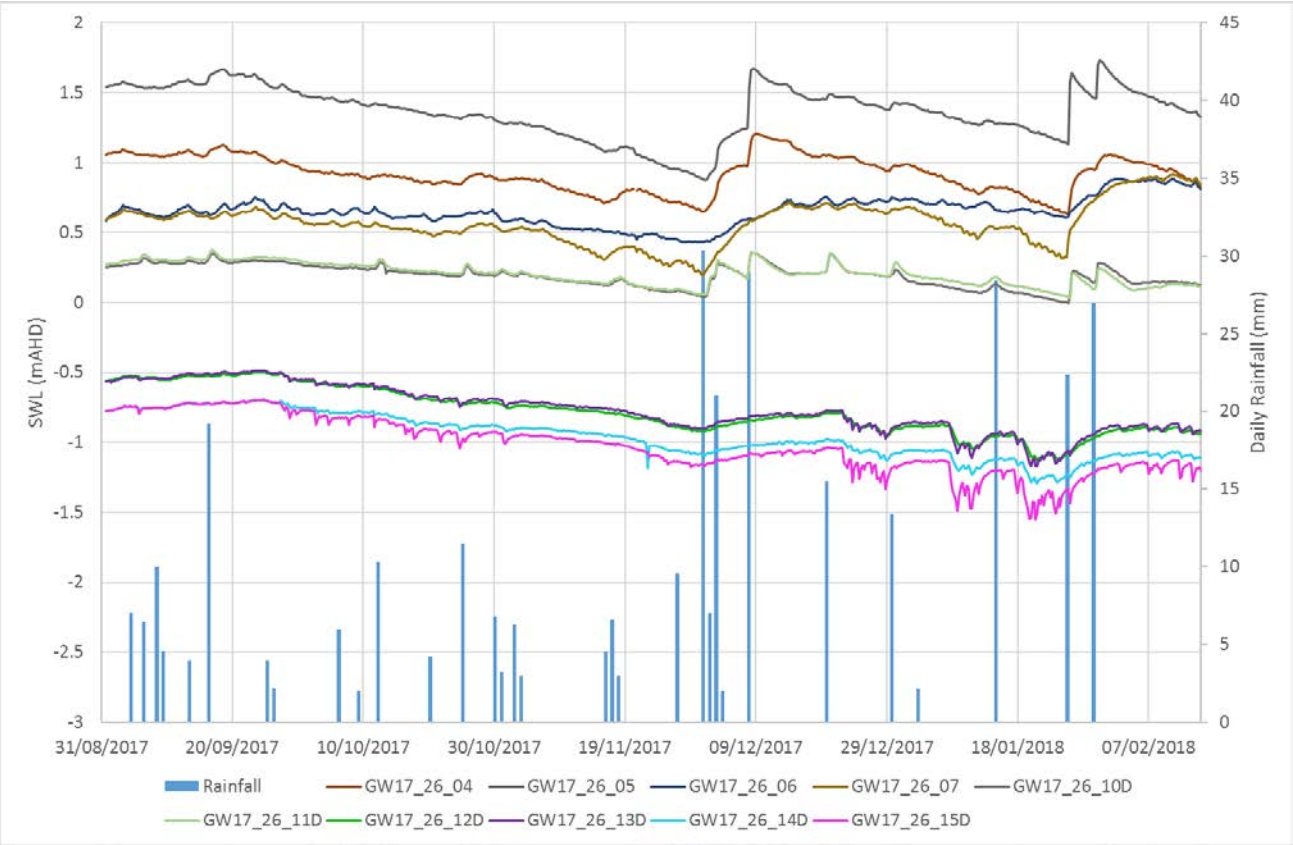


Figure 3.6 UTAF aquifer water levels with daily rainfall

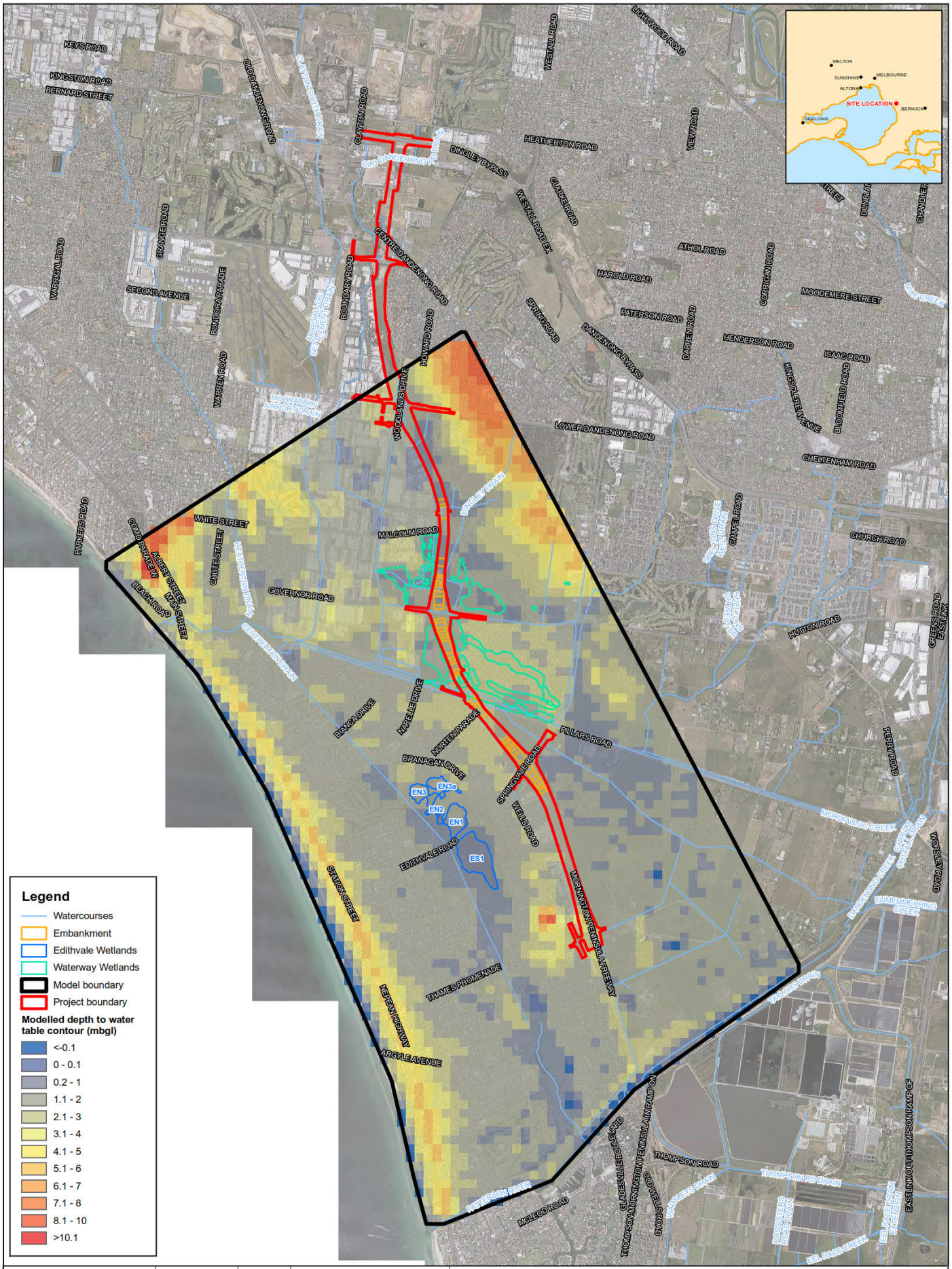
Overall, vertical head differences are acceptably represented by the model. It should be noted that groundwater levels in QA unit (layer 1) and the UTAF unit (layer 2) differ by a maximum of 1 m in the field observations in February 2018.

The following vertical head gradients are observed in the model at the nested bore sites (shown on Figure 1.2) (nested sites 12 to 15 have been excluded as these are affected by a pumping bore):

- Nested sites 10 and 17: Simulated heads in the UTAF are slightly higher than the QA, indicating an upward gradient as is observed
- Nested sites 11, 18 and 19: Simulated heads are the same in the UTAF and the QA, while a slight upward gradient is observed
- Nested sites 16, 20, 22 and 23: Simulated heads are slightly lower in the UTAF than the QA, indicating a downward gradient as is observed

The ratio of RMS to the total head change across the calibration targets is the scaled RMS. The model reported an unweighted scaled RMS error of 13.7% and a weighted scaled RMS error of 7.4% for the transient calibration period.

Hydrographs for all monitoring bore locations for the calibration period are shown in Appendix B. The modelled depth to water table in February 2018 is shown in Figure 3.7 and the modelled groundwater table (mAHD) is shown in Figure 3.8.



Map: 2135645A_GIS_973_A	Author: MB		
Date: 4/09/2018	Approved by: AS		

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Coordinate system: GDA 1994 MGA Zone 55
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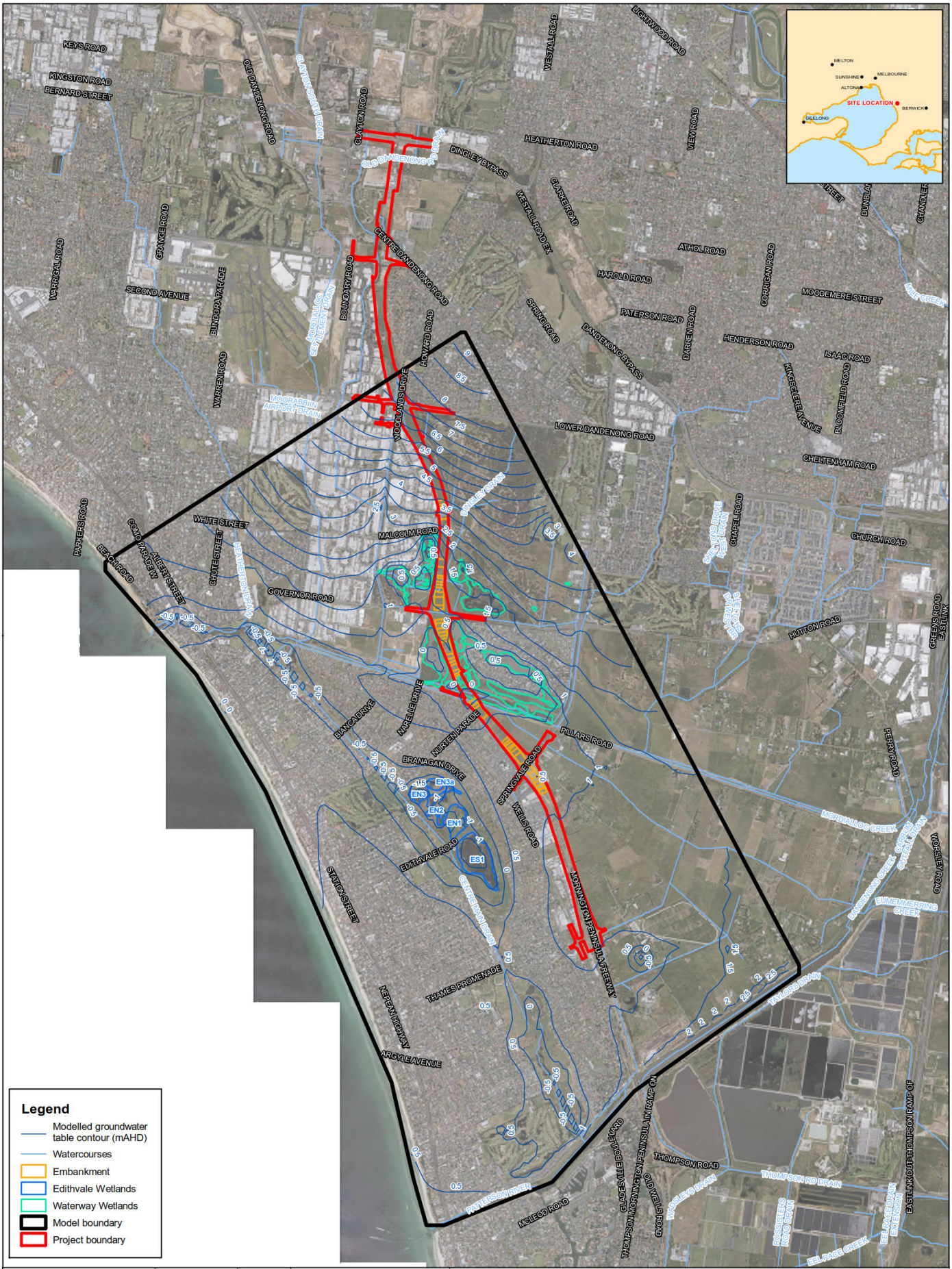
Figure 3.7
Modelled depth to water table (mbgl) (February 2018)



Legend

- Modelled groundwater table contour (mAHD)
- Watercourses
- Embankment
- Edithvale Wetlands
- Waterway Wetlands
- Model boundary
- Project boundary

Map: 2135645A_GIS_974_A2	Author: MB
Date: 17/08/2018	Approved by:

0 400 800 m

1:40,000

Coordinate system: GDA 1994 MGA Zone 55

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Figure 3.8
Modelled groundwater table (mAHD)

3.3.2.3 WATER BALANCE

The mass balance for the calibrated model across the model domain is summarised in Table 3.5. The modelled mass balance error is low at 0.0%.

Recharge (84%) is the main component of inflows. Groundwater outflow is dominated by evapotranspiration providing 70% of groundwater outflow. Outflow via drains and minor creeks accounts for ~22% of groundwater discharge and reflects the importance of these features in controlling groundwater levels in low-lying areas. Drains that are adjacent to the proposed embankment have a simulated discharge of approximately 0.05 ML/day indicating that they currently have a role in maintaining groundwater levels adjacent to the proposed embankment. In addition, those drains would mitigate an impact related to a rise in groundwater level, but not an impact related to drawdown of groundwater.

Table 3.5 Water balance, calibration run

COMPONENT	GROUNDWATER INFLOW (RECHARGE) (ML/d)	GROUNDWATER OUTFLOW (DISCHARGE) (ML/d)	NET (ML/d)
Recharge	6.10	–	6.10
Evapotranspiration	–	5.08	-5.08
Rivers (Patterson River)	0.78	0.08	0.70
Drains (other rivers/creeks)	–	1.58	-1.58
Pumping wells	–	0.26	-0.26
General head boundary	0.12	0.00	0.12
Storage	0.24	0.24	0.00
TOTAL	**7.24**	**7.24**	**0.00**

3.3.3 SENSITIVITY ANALYSIS

A sensitivity analysis assessed the response of the transient model calibration to changes in the model input parameters. The objective of the sensitivity analysis was to rank the input parameters in terms of their influence on a model output; in this case, the calibration objective function. The objective calibration objective function is the weighted sum of squared residuals (residuals being the difference between monitoring observations and modelled observations). Parameter sensitivity was estimated manually by varying selected parameters by an arbitrary increment and evaluating the resulting change in the model objective function (i.e. calibration).

The sensitivity analysis assessed the impact of:

- Increasing/decreasing the horizontal and vertical hydraulic conductivity of all hydraulic conductivity zones by a lower multiplier of 0.1 and an upper multiplier of 10
- A specific yield for all unconfined layers of 0.05 and 0.5
- Increasing/decreasing the streambed conductance of Patterson River by a lower multiplier of 0.1 and an upper multiplier of 10
- Increasing/decreasing recharge by a lower multiplier of 0.1 and an upper multiplier of 10
- Increasing/decreasing evapotranspiration by a lower multiplier of 0.1 and an upper multiplier of 10.

The results indicate the most sensitive parameters to be:

- Horizontal hydraulic conductivity of zone 11 in layer 1 (Decrease in Kh by one order of magnitude: ΔSRMS of 7.8%), and in layers 2 (ΔSRMS of 7.9%) and 3 (ΔSRMS of 8.1%)
- Recharge in all zones in layer 1 (Increase in recharge by one order of magnitude: ΔSRMS of 10.8%)
- Evapotranspiration (Decrease in EVT rate by one order of magnitude: ΔSRMS of 10.1%).

Additional sensitivity analysis was conducted to test the impact of additional embankment height above that of the reference design on groundwater flow. The outcomes of this is discussed in the technical memo presented Appendix E.

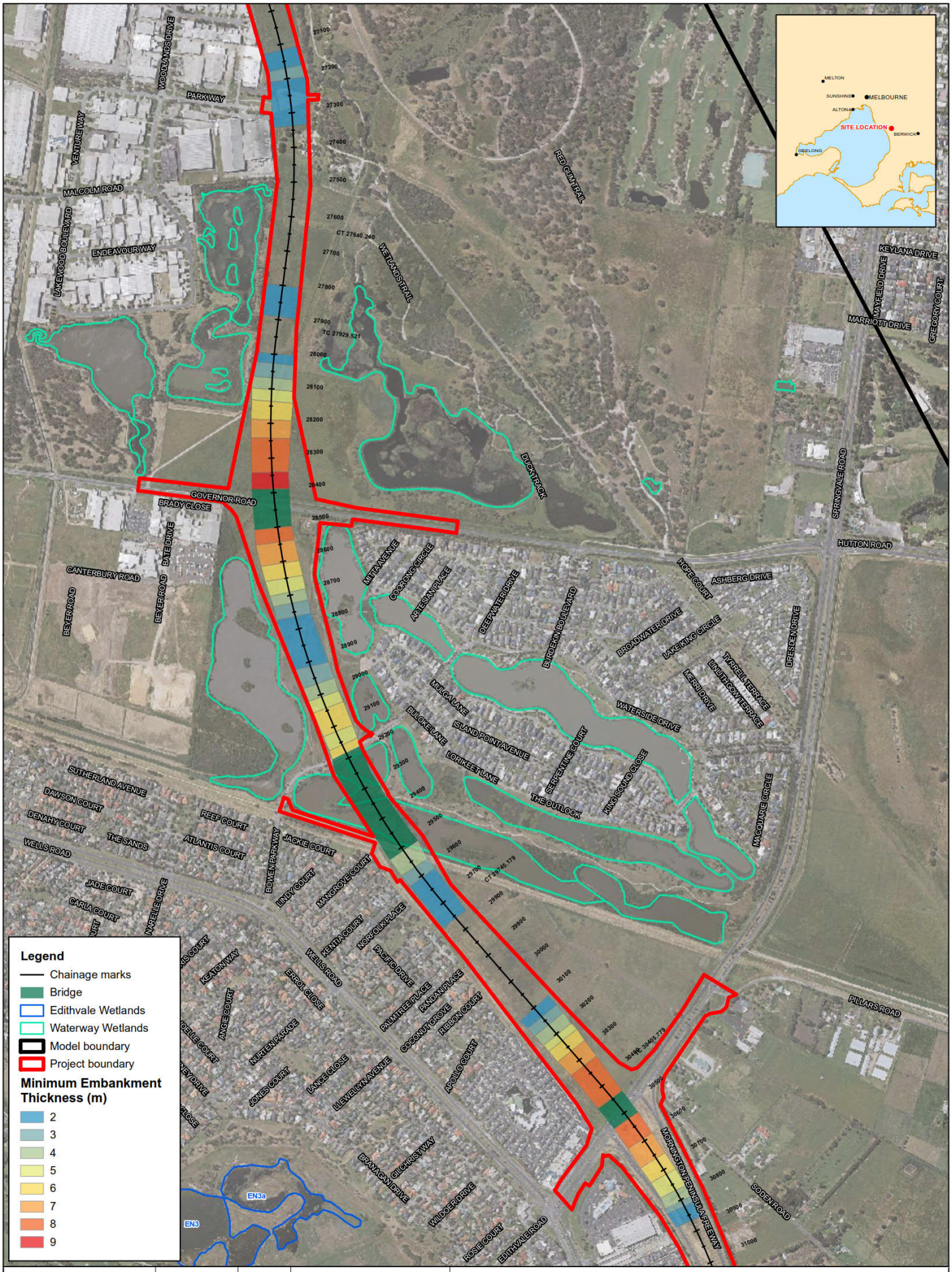
4 MODEL PREDICTIONS

4.1 APPROACH

The predictive model runs were carried out under steady state and transient conditions to assess average and seasonal impacts respectively. For impact scenarios, the effects of the embankments were imposed on aquifer conditions according to the various embankment heights as shown in Figure 4.1, and as further described below. Predictive runs were undertaken with and without the proposed embankments and the impact determined as the difference between the two runs for each stress period. This approach ensured that modelled impact estimates were solely due to the embankment and not small changes in rainfall and evapotranspiration over time (transient disequilibrium effects).

The reduction in hydraulic conductivity due to compaction effects from the proposed embankments was assessed by conservative geotechnical modelling (assuming compressive clay bearing lithology), as described in Section 2.3. A hydraulic conductivity reduction factor was applied to the areas below the embankment in model layer 1 and 2 for the predictive run (refer to Appendix C). The permeability reduction factors were scaled according to the height of the embankment for each segment.

The Time-Variant Materials (TVM) package was used to change the hydraulic conductivity (Kh and Kv) by the calculated reduction factor for the future stress periods in the impact scenarios. Recharge (RCH) and EVT were reduced to zero beneath the embankment. It is assumed that the surface will be sealed and impervious.



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Date: 4/09/2018	Approved by: AS		

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Coordinate system: GDA 1994 MGA Zone 55

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Figure 4.1

Embankment thickness - Freeway

4.2 PREDICTED WATER LEVEL CHANGES DUE TO EMBANKMENTS

The predicted groundwater table changes due to the embankments for the steady state scenario are shown in Figure 4.2. The maximum drawdown is 6 cm at the southern embankment section and a maximum water level rise of 11 cm is observed at the northernmost embankment. The change only occurs beneath the embankment itself and there is negligible drawdown outside of the embankment footprint.

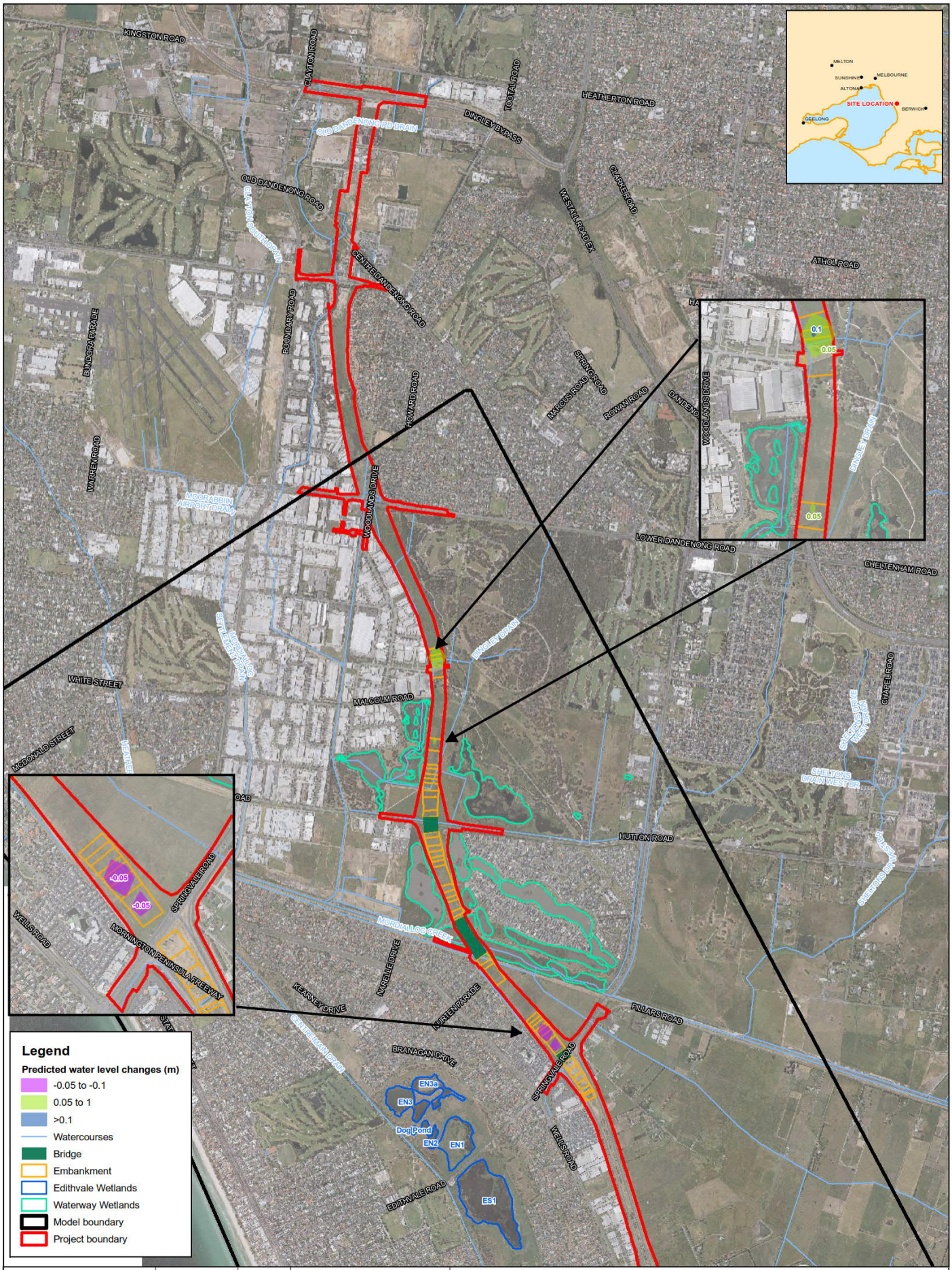
The predicted groundwater table changes due to the embankments for the transient scenario are shown in Figures 4.3 (June 2020, winter) and 4.4 (December 2020, summer). In June 2020, the maximum drawdown is 3.6 cm at the southern embankment section and a maximum water level rise of 5.1 cm is observed at the northernmost embankment. The modelled change only occurs beneath the embankment itself.

In December 2020, the maximum drawdown is 11 cm at the southern embankment section and a maximum water level rise of 13 cm is observed at the northernmost embankment. Most of the drawdown occurs beneath the embankment itself and is <5 cm immediately adjacent to the embankment.

The modelled drawdown effects will be virtually undetectable given that:

- The observed seasonal groundwater level variations are much larger by comparison (~0.5 to 1 m)
- Changes to drainage and hardstand in the area are likely to have a larger influence on groundwater levels (although still negligible)
- In the short-term loading of the aquifer by the embankment may cause a temporary rise in groundwater levels adjacent to embankment due to compression of the aquifer matrix. That effect should be managed by existing drainage and will dissipate over a short period.

Hydrographs for the predictive model run are presented in Appendix D.



Map: 2135645A_GIS_969_A	Author: VD
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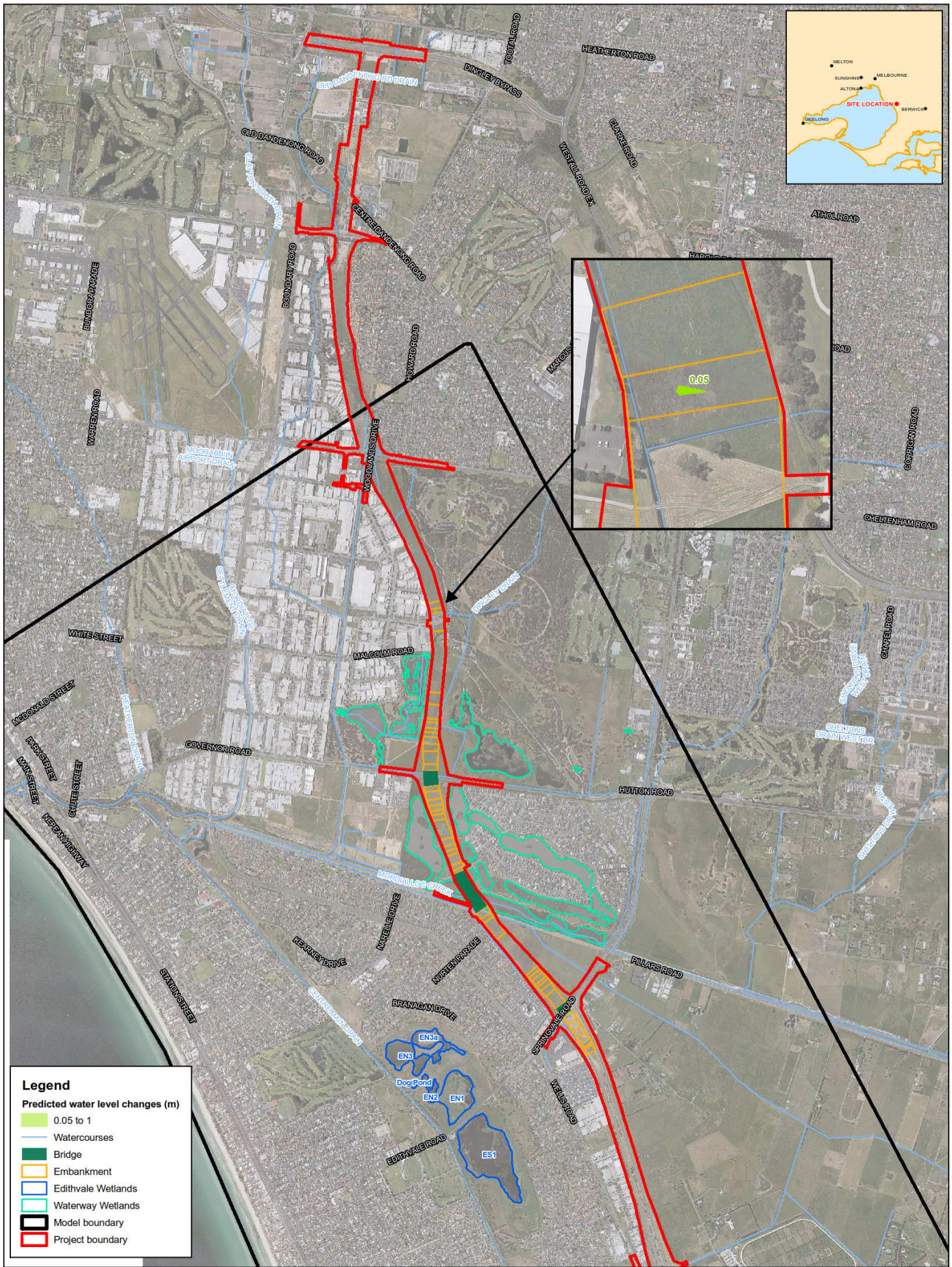
Figure 4.2
Predicted groundwater table changes (Steady state scenario)



Map: 2135645A_GIS_971_A	Author: VD
Date: 4/09/2018	Approved by: AS

0 250 500 m

1:26,000

Coordinate system: GDA 1994 MGA Zone 55

Scale ratio correct when printed at A3

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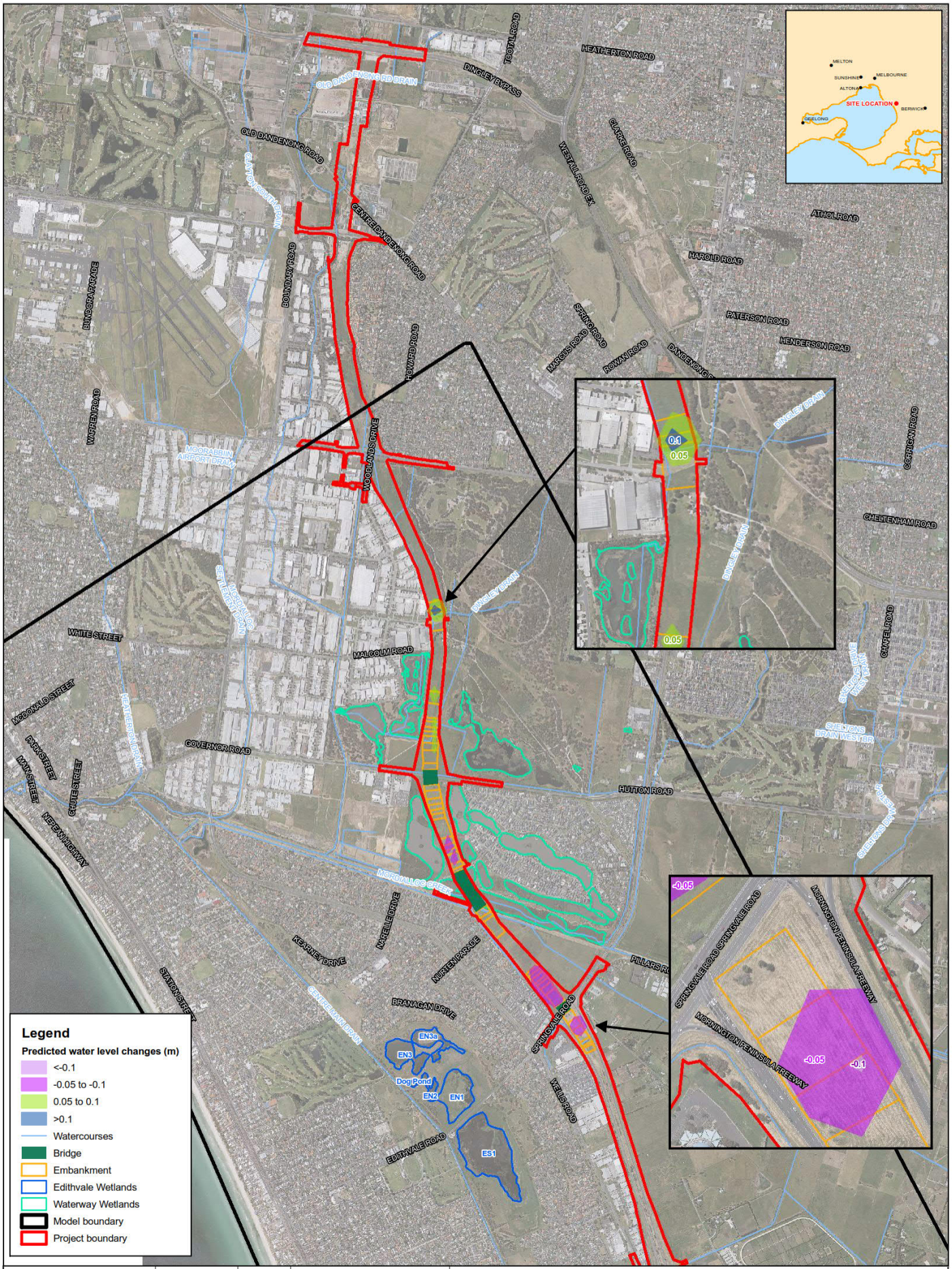
Figure 4.3

Predicted groundwater table changes (June)



Map: 2135645A_GIS_972_A	Author: VD	
Date: 4/09/2018	Approved by: AS	

0 250 500 m

1:26,000

Coordinate system: GDA 1994 MGA Zone 55

Scale ratio correct when printed at A3

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Figure 4.4

Predicted groundwater table changes (December)

4.3 PREDICTED CHANGES TO GROUNDWATER INFLOWS AT EDITHVALE WETLANDS

The groundwater model was also used to predict changes in the groundwater component of the Edithvale Wetlands. This was done using Hydro-Stratigraphic Unit (HSU) zones for the wetland areas in layer 1 and 2 and summarising the inflows and outflows. A separate water balance model has been created by surface water experts in which the modelled groundwater component is used as verification.

The modelled monthly recharge (R) and evapotranspiration (ET) fluxes were collated for a one year period for a model scenario with and without embankments. The fluxes were converted from a volume (m^3/day) to a rate (mm/day) by dividing the flux by the surface area of each wetland pond. The average rates for R and ET from the six different wetland ponds are summarised in Table 4.1. For each wetland cell it is assumed that the net loss due to EVT (minus recharge) is balanced by, and equal to, the groundwater discharge component ('Net ET' in Table 4.1). Note that net ET is negative for the months April, July and August when rainfall exceeds EVT. The difference in groundwater discharge to the wetlands (= Net ET) as a result of changes in hydraulic gradient near the embankments is negligible ($<10^{-3}$ mm/d) compared with other water balance components (surface water input, rainfall, and EVT).

Table 4.1 Modelled recharge and evapotranspiration and calculated net evapotranspiration at Edithvale Wetlands for modelling scenario with and without embankments for the period March 2020 – February 2021

SCENARIO	WITH EMBANKMENTS			WITHOUT EMBANKMENTS			CHANGE
Month	**Recharge (mm/d)**	**ET (mm/d)**	**Net ET (mm/d)**	**Recharge (mm/d)**	**ET (mm/d)**	**Net ET (mm/d)**	**Net ET (mm/d)**
Mar-20	0.95	2.95	2.00	0.95	2.95	2.00	-0.0014
Apr-20	3.03	1.76	-1.28	3.03	1.76	-1.28	-0.0004
May-20	1.02	1.03	0.01	1.02	1.03	0.01	-0.0002
Jun-20	0.50	0.73	0.23	0.50	0.73	0.23	-0.0002
Jul-20	1.22	1.09	-0.13	1.22	1.09	-0.13	-0.0002
Aug-20	1.96	1.38	-0.58	1.96	1.38	-0.58	-0.0002
Sep-20	1.24	2.08	0.83	1.24	2.08	0.83	-0.0005
Oct-20	1.55	3.16	1.61	1.55	3.17	1.61	-0.0009
Nov-20	0.99	3.82	2.82	0.99	3.82	2.83	-0.0018
Dec-20	4.31	4.72	0.41	4.31	4.72	0.41	-0.0011
Jan-21	2.05	4.59	2.54	2.05	4.59	2.54	-0.0018
Feb-21	0.04	3.46	3.42	0.04	3.47	3.42	-0.0020

4.4 CUMULATIVE IMPACTS

The modelling shows that the slight changes to the groundwater level do not reach beyond the embankments themselves and will not significantly impact groundwater levels adjacent to the wetland, nor will they significantly change the rate of groundwater discharge to the wetlands. The LXRA report findings indicate that changes to the water table elevation as a result of that project will not extend as far as the Edithvale Wetlands (refer Figure 4.5). Therefore, no cumulative impacts to the wetland are expected as a result of both the OSAR and LXRA projects.

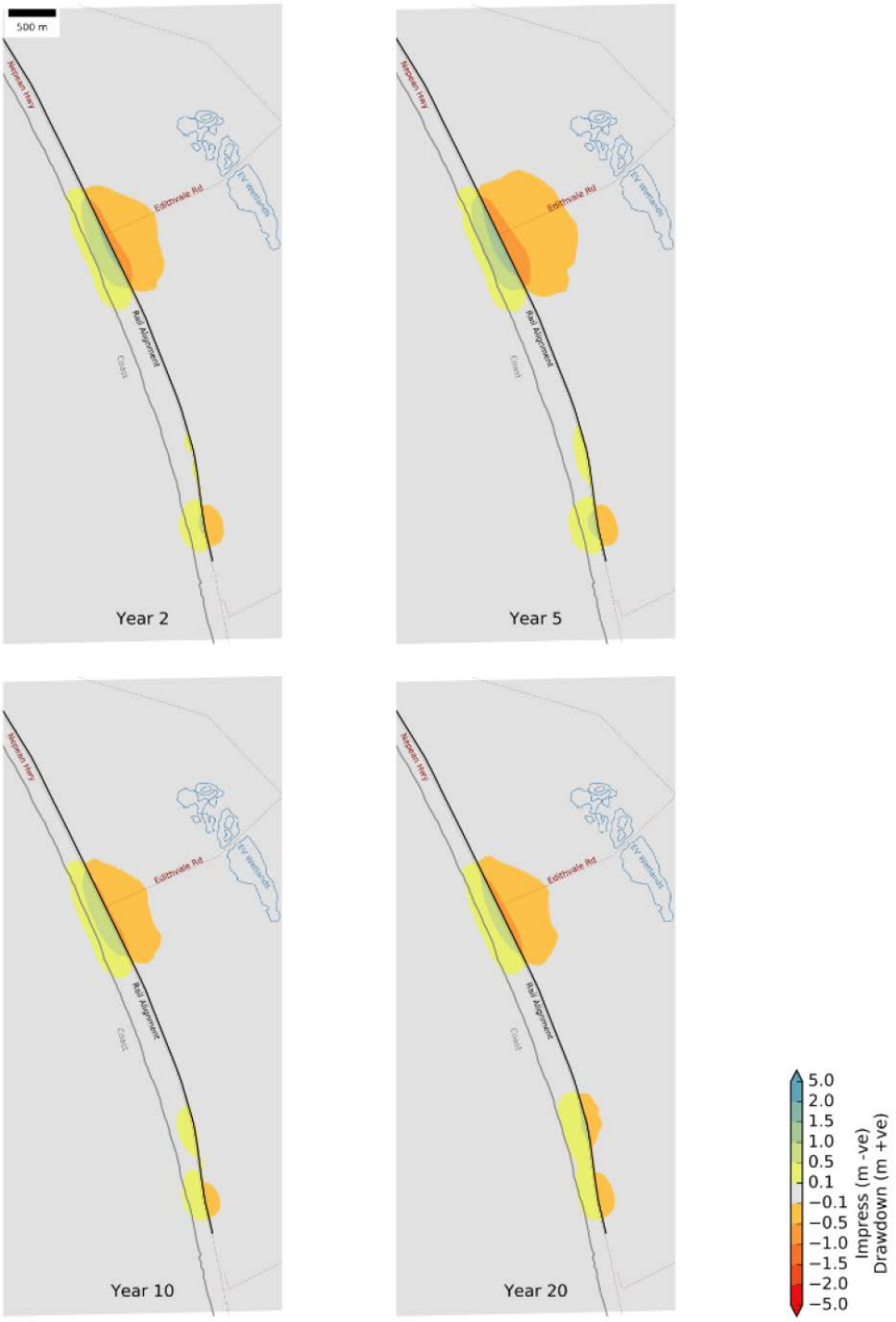

Figure 4.5 Predicted groundwater level changes – model years 2, 5, 10 and 20
(Source: LXRA Numerical groundwater modelling report (AECOM GHD, 2018)

4.5 UNCERTAINTY ANALYSIS

An analysis of predictive uncertainty was carried out using a calibration-constrained Monte-Carlo approach, whereby the model is run numerous times, each run using parameters that are randomly selected from assumed probability distributions. The approach is commonly applied to complex numerical simulations with many parameters that are not precisely or uniquely known. The numerous model results can be filtered to retain only those for which the calibration statistics are acceptable. In this way, a statistical distribution of a groundwater drawdown impact (for example) can be generated, for which all underlying simulations contain plausible combinations of parameter values. The analysis was carried out using the Groundwater Vistas interface which itself calls on the parameter estimation program PEST (Doherty, 2016).

The uncertainty analysis for this modelling work used the steady state models for which average values are used for recharge and EVT. The steady state model was used because it has a much shorter run-time than the transient simulation which is an important consideration when hundreds of model runs are being undertaken. The baseline model used the calibrated parameters listed in Table 4.2. Parameter probability distributions were defined with a mean value (the calibrated value) and a standard deviation. Hydraulic conductivity was assigned a log-normal distribution whereas rainfall and recharge were assigned a normal distribution. In addition to the applied standard deviations, maximum and minimum bounds were defined for each parameter to ensure that no extremely unlikely values were selected. Storage parameters were not assessed with the steady state set-up. The assumed distributions for parameters are summarised in Table 4.2 below. The impact model was parameterised in the same way as the baseline model, but with the addition of multiple hydraulic conductivity zones beneath the planned embankments, each with a defined probability distribution ranging from a multiplier of 0.1 for the minimum and the maximum of the host K zone for the maximum (2) (these are not listed in the table below).

Table 4.2 Parameter probability distributions

PARAMETER	ZONE	MEAN (CALIBRATED VALUE)	MINIMUM	MAXIMUM
Kx/Kz	1	10/1	0.01/0.001	41/4.1
Kx/Kz	11	1/0.1	0.01/0.001	2/0.2
Kx/Kz	12	1/0.1	0.01/0.001	2/0.2
Kx/Kz	2	0.7/0.07	0.001/0.0001	6/0.6
Kx/Kz	3	0.5/0.05	0.001/0.0001	1/0.1
Kx/Kz	4	5/0.5	0.1/0.01	10
Recharge	1	0.000114	0.000057	0.000228
Recharge	2 (wetlands)	0.00163	0.000816	0.00326
ET rate	1	0.000715	0.000358	0.00143
ET rate	2 (wetlands)	0.00321	0.00161	0.00642
ET extinction depth	1	1.2	0	10
ET extinction depth	2 (wetlands)	1.2	0	10

A total of 100 parameter realisations were generated and run. The groundwater level effect at each piezometer was calculated for each of the runs, allowing the probability density function (PDF) to be determined. The results are shown in Table 4.3 and Figure 4.6 to Figure 4.8 for selected piezometers located between the embankment and the Edithvale Wetlands. The decision was made to leave all the runs in as they all have a reasonable absolute residual mean (as reasonable parameter bounds were used) ranging from 0.51 to 0.83 m which is within the observed seasonal groundwater level variations (~0.5 to 1.0 m).

Table 4.3 Predicted range in groundwater level change prediction for selected piezometers between the embankment and Edithvale Wetlands.

PIEZOMETER	DISTANCE FROM EDITHVALE WETLANDS (M)	PREDICTED CHANGE IN GROUNDWATER LEVEL (M)	PERCENTILE RANGE OF ESTIMATES (P5-P95)
GW17-26-12S	710	-0.041	-0.35 to 0.057
GW18-26-22S	400	-0.014	-0.023 to -0.0062
GW18-26-23S	55	-0.0050	-0.0087 to -0.0014

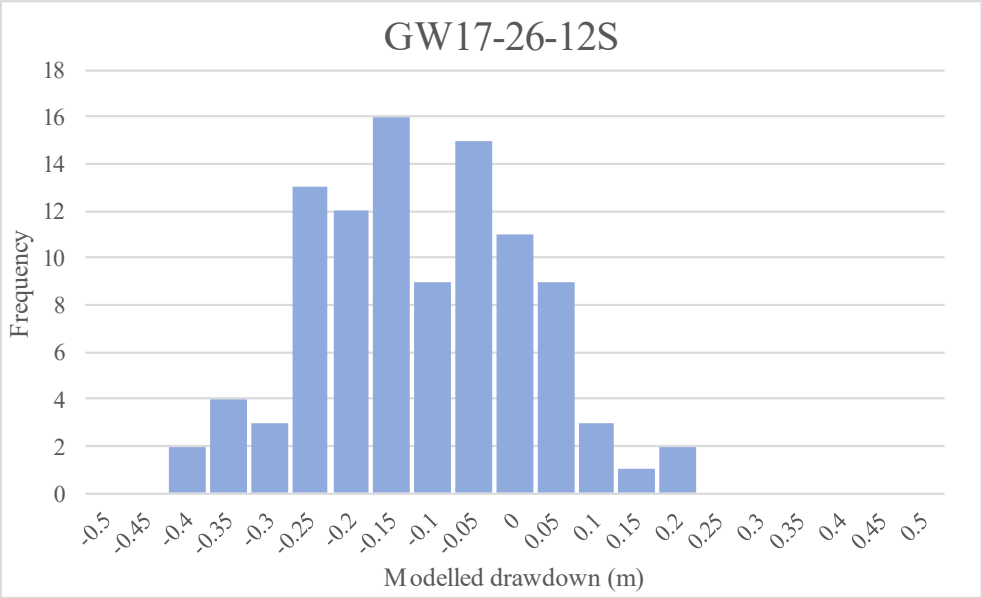

Figure 4.6 Probability density function at piezometer GW17-26-12S

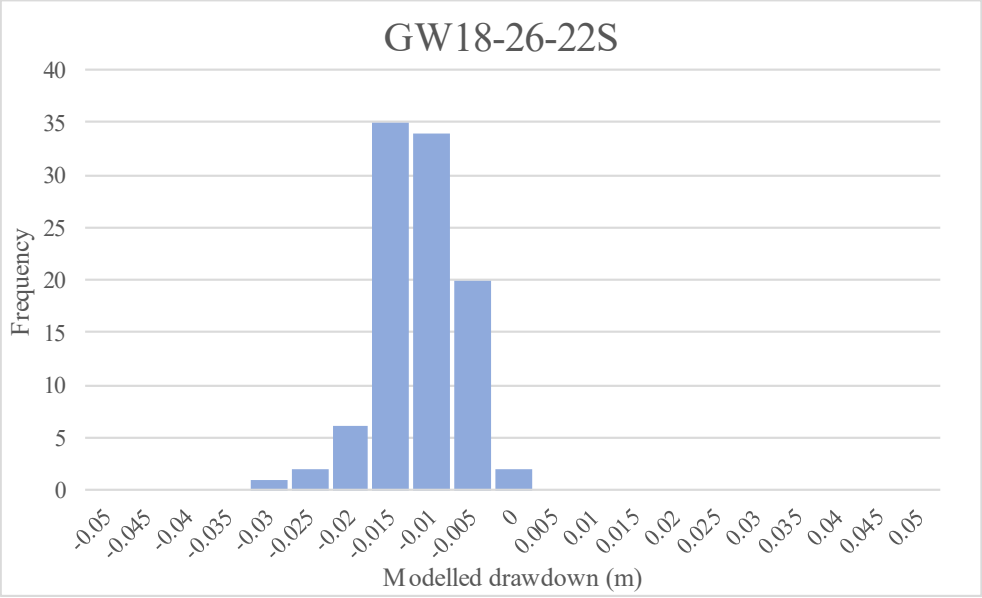

Figure 4.7 Probability density function at piezometer GW18-26-22S

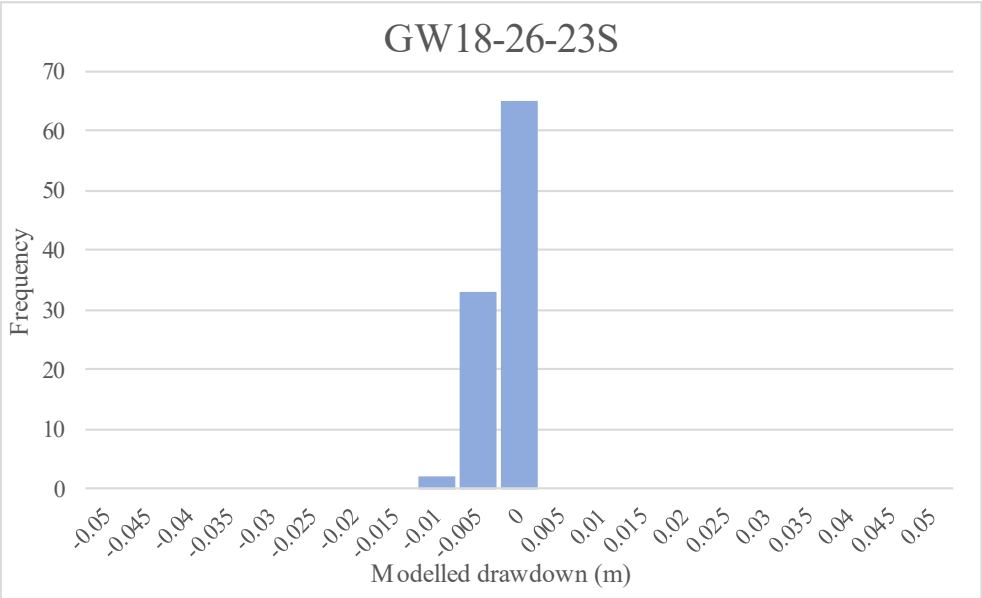

Figure 4.8 Probability density function at piezometer GW18-26-23S

The results show that predicted groundwater impacts are similar (negligible) for all uncertainty runs, providing additional confidence in the prediction under calibrated conditions.

4.5.1 CLIMATE CHANGE

Climate models indicate that rainfall is likely to decline in the project area over the next 50 years (Petheram, 2002; Table 4.4). The project site is located in the Bunyip catchment in which rainfall is predicted to decline by up to 52.8% (P90) in 2065 compared with current rainfall. The recommended approach for assessing the effects of climate change on regional unconfined aquifers is to factor the groundwater recharge by a percentage as determined from climate modelling by Petheram (2002). In this study, the assessment of climate change was carried out as part of the uncertainty analysis, whereby the expected range in rainfall in 2065 (from climate modelling) is incorporated into the range in rainfall recharge applied on the uncertainty (Monte-Carlo) analysis described in Section 4.5.

Table 4.4 Projected change in recharge for regional unconfined aquifers in the Bunyip sedimentary basin (Adopted form DELWP, 2016)

AVERAGE ANNUAL RAINFALL (mm) (1975-2014)	CHANGE RELATIVE TO CURRENT CLIMATE BASELINE (%)					
	YEAR 2040			YEAR 2065		
	10th Percentile	50th Percentile	90th Percentile	10th Percentile	50th Percentile	90th Percentile
860	6.7%	-10.2%	-32.2%	4.9%	-13.1%	-52.8%

The minimum bound for rainfall recharge in the uncertainty analysis was defined as half the calibrated parameter (-50%) and the maximum bound was defined as double the calibrated parameter (+50%). This range substantially overlaps with the specified range for rainfall recharge in Table 4.4. The uncertainty in predictions of groundwater drawdown depicted in the probability density functions in Section 4.5 therefore include the effects of varying applied rainfall over a range similar to that recommended by Petheram (2002). It is concluded that groundwater impact to the Edithvale Wetlands as a result of the embankments is unlikely to be significant under the currently accepted climate change scenarios.

5 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions can be drawn from the groundwater modelling study:

- A three-dimensional groundwater model was developed using the control-volume finite difference code MODFLOW-USG. The calibrated model parameters resulted in a plausible water table with low-lying areas dominated by excess EVT and the dune areas and ridges by excess recharge.
- The modelled water table implies that the Edithvale Wetlands are a net groundwater discharge point via EVT, which is consistent with chemical and isotopic data.
- Construction of bypass embankments will result in loading of the aquifer and a decrease in permeability of the underlying aquifers. The numerical model was used to assess the groundwater effects near the Edithvale Wetlands as a result of the change in permeability beneath the embankments.
- Modelling results indicate that the aquifer loading will result in a very small change in groundwater level (in the order of 0.10 to 0.15 m, maximum). The changes range from a small decrease in groundwater level beneath the southern embankment to a small rise in groundwater level beneath the northern embankment. Most of the change is restricted to within the embankment footprint with negligible groundwater level changes outside the embankments.
- Therefore, construction of the embankments and bypass is highly unlikely to have any measurable effect on groundwater levels adjacent to the Edithvale Wetlands, nor groundwater flow contributions to the wetland water balance.

The modelled drawdown effects will be virtually undetectable given that:

- The observed seasonal groundwater level variations are much larger by comparison (~0.5 to 1.0 m)
- Changes to drainage and hardstand in the area are likely to have a larger influence on groundwater levels (although still negligible).

In the short-term loading of the aquifer by the embankment may cause a temporary rise in groundwater levels adjacent to embankment due to compression of the aquifer matrix. That effect should be mitigated by existing drainage and will dissipate over a short period.

The design is still at concept stage and will be further refined, particularly where passing through environmentally sensitive areas, to minimise the road footprint. It is recommended that the model be rerun once the design is finalised.

6 MODEL ASSUMPTIONS AND LIMITATIONS

6.1 SCOPE OF SERVICES

This report has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client and WSP (scope of services). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

6.2 RELIANCE ON DATA

In preparing the report, WSP has relied upon data, surveys, analyses, and other information provided by the client and other individuals and organisations, most of which are referred to in the report. Except as otherwise stated in the report, WSP has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. WSP will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to WSP.

6.3 MODEL ASSUMPTIONS

The groundwater flow model simulates a simplified version of a complex geological and hydrogeological system. This simplification is required to allow the model to be run and utilised within a reasonable timeframe. Further, the model assumptions that were incorporated were deemed appropriate and acceptable given the purpose of the model (i.e. to develop a model to simulate changes in groundwater levels in response to the proposed embankments). In this context, the assumptions made are considered to be conservative in respect of the scale of the groundwater impacts that are predicted (i.e. the assumptions, when compounded, would tend to overestimate the scale of the impact).

A summary of the assumptions incorporated into the model, and their resulting limitations, include:

- The model is based on the conceptual hydrogeological model in Section 2.
- Groundwater level and hydraulic property data is not available for the entire model domain. The groundwater model has drawn on groundwater level and hydraulic property data available for the OSAR and LXRA projects, which is considered to provide a good indication of values as these are located in the same hydrogeological environment. The model has been calibrated to available groundwater level data and hydraulic properties are within reasonable ranges.
- The number of layers within the model has been limited to four. Vertical discretisation of the model layers is deemed appropriate and reasonable for the purpose of determining the likely impact to groundwater and the wetlands from the proposed development in the study area.
- The quaternary aquifer has been assigned a minimum thickness of 2 m for the purposes of modelling however in some parts of the project area the quaternary aquifer is less than 2 m thick. Also, the model was unable to replicate the variably saturated nature of the quaternary aquifer. Drawdown impacts to alluvium are therefore likely to be over-predicted.

6.4 REPORT FOR BENEFIT OF CLIENT

The report has been prepared for the benefit of the client (and no other party), but may be relied upon by the administering authority or others. WSP assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of WSP or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Except as provided below, parties other than the client should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

BIBLIOGRAPHY

- AECOM GHD JV (2018) Edithvale and Bonbeach Level Crossing Removal Project – Environmental Effects Statement, Appendix E- EES Technical Report A – Numerical Groundwater Modelling Report, LXRA-LX31-00-GE-EES-0002, Rev 0., February 2018.
- Allen R, Pereira L, Raes D, Smith M (1998) FAO Irrigation and drainage paper No. 56: Crop evapotranspiration (guidelines for computing crop water requirements). Food and Agriculture Organisation of the United Nations.
- Barnett et al (2012) Australian groundwater modelling guidelines, Waterlines report, National Water Commission, Canberra.
- Bureau of Meteorology (BOM) (2018).
- Department of Environment, Land, Water and Planning (DELWP) (2016) Guidelines for Assessing the Impact of Climate Change on Water Supplies in Victoria, v7.0, dated December 2016, ISBN 978-1-76047-346-4.
- Department of Environment, Land Water and Planning (DELWP) (2018). Scoping Requirements for Mordialloc Bypass Environment Effects Statement Melbourne.
- DELWP (2017) Victorian Aquifer Framework.
- Doherty, J. (2016). *PEST: Model-Independent Parameter Estimation User Manual Part I: PEST, SENSAN and Global Optimisers*. Watermark Numerical Computing.GHD (2005) Edithvale Seaford Wetlands Review of Wetlands Operations, GHD, Victoria.
- Panday, S., Langevin, C. D., Niswonger, R. G., Ibaraki, M., & Hughes, J. D. (2013). MODFLOW–USG Version 1: An unstructured grid version of MODFLOW for simulating groundwater flow and tightly coupled processes using a control volume finite-difference formulation. U.S. Geological Survey.
- Petheram C, Walker Gl, Grayson R, Theirfelder T and Zhang L (2002) Towards a framework for predicting impacts of land-use on recharge: 1. A review of recharge studies in Australia. Australian Journal of Soil Research: 40(3) 397-417.
- SILO Climate Data (Long Paddock) 2017, viewed 12 March 2018, https://legacy.longpaddock.qld.gov.au/silo/.
- SKM (2009) The Victorian Aquifer Framework - Summary report. Unpublished report.
- WSP (2018) Mordialloc Bypass - Groundwater Impact Assessment, Report number 2135645A-SE-26-WAT-REP-0006 Rev0a, May 2018.

APPENDIX A

GEOTECHNICAL MODELLING MEMO

MEMO

TO:	Ray Hatley
FROM:	Bhupatindra Vaidya
SUBJECT:	Mordialloc Embankment - Preliminary Assessment of Change in permeability due to embankment loading
OUR REF:	2135645A-SE-26-WAT-REP-0003 Rev00
DATE:	10 May 2018

1. GENERAL

Embankments are planned for the approaches on OSAR structure overcrossing the Springvale road.

The height of approach embankment varies from 0 to 8 metres. The width of embankment is 42 metres at the top and batters 1V:3H at the sides.

The loading from embankment placement on the subsoil layers will result in closure of voids in the soil layers. The effect of void closure on the permeability of subsoil layers is investigated based on the available laboratory test results.

2. ASSUMPTIONS

Assumptions used for the assessment:

Assessment is carried out for embankment height of 4 m, 8 m and 10m.

The latest available (at 08/09/2017) ground water level readings in ground water bores GW17-26-12 and GW17-26-13 varied from 0.8m to 2.64m below ground level. For the purpose of this assessment a ground water depth of 1.5m below existing ground level is assumed.

- Pressure change due to embankment loading is based on Boussinesq stress distribution (a a point load solution; Boussinesq 1885)
- Change in permeability vs stress change is based on the available consolidation test results from soil samples in the vicinity which is assumed to be valid for all the alluvial soil layers.
- Following available consolidation test results are used:

  Borehole Depth Soil types:

  B17-68160 5.7 m High plasticity, Sandy clay

  B17-68335 2.2 m High plasticity, Sandy clay

  B17-68339 1.2 m silty clay
- The ground profile comprises alternate layers of sand and clay. The change in permeability in sand layer due to increase in stress from embankment loading is expected

Level 15, 28 Freshwater Place
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Tel: +61 3 9861 1111
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to be minimal as compared to that in clay layers. However, for the purpose of preliminary assessment, the effect of stress on permeability in sand layers is assumed to be similar to that in clay layer.

— The depth to bottom of alluvial layer at the site is likely to be within 10m (7m-8m in borehole logs). Below this depth, the more competent Brighton Group formation is likely to encounter. Changes in permeability due to embankment is likely to be negligible in the Brighton Group layer. However, the potential change in permeability to deeper depth is provided in the event alluvial layer extends to deeper depth.

3. RESULTS

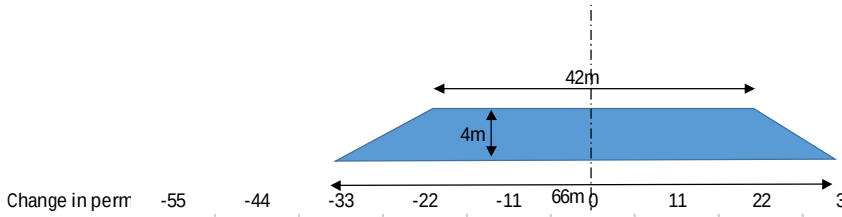
The estimated factors on permeability due to increase in effective stress is provided in Figures 1, 2 and 3 for embankment heights of 4 m, 8 m and 10 m, respectively.

Due to potential variability in permeability characteristics, it is recommended that the permeability factor be varied between 0.5 to 2 times the factors given in the figures illustrating the 3 modelled scenarios:

— Permeability factor for 4 m embankment height

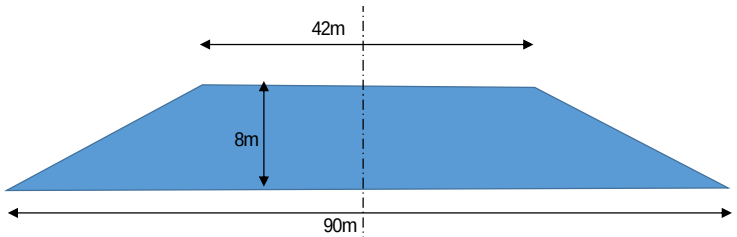
— Permeability factor for 8 m embankment height

— Permeability factor for 8 m embankment height + 2 m surcharge (10 m)



Change in perm Distance,m --> depth,m	-55	-44	-33	-22	-11	0	11	22	33	44	55
0.5	1.00	1.00	0.92	0.20	0.19	0.19	0.19	0.20	0.92	1.00	1.00
1.5	1.00	1.00	0.92	0.39	0.37	0.37	0.37	0.39	0.92	1.00	1.00
2.5	1.00	1.00	0.90	0.45	0.42	0.42	0.42	0.45	0.90	1.00	1.00
3.5	1.00	1.00	0.89	0.50	0.47	0.47	0.47	0.50	0.89	1.00	1.00
4.5	1.00	0.99	0.89	0.54	0.51	0.50	0.51	0.54	0.89	0.99	1.00
5.5	1.00	0.99	0.88	0.58	0.54	0.54	0.54	0.58	0.88	0.99	1.00
6.5	1.00	0.99	0.88	0.61	0.57	0.57	0.57	0.61	0.88	0.99	1.00
7.5	1.00	0.99	0.88	0.64	0.60	0.59	0.60	0.64	0.88	0.99	1.00
8.5	1.00	0.98	0.88	0.67	0.62	0.62	0.62	0.67	0.88	0.98	1.00
9.5	1.00	0.98	0.88	0.69	0.64	0.64	0.64	0.69	0.88	0.98	1.00
10.5	0.99	0.98	0.88	0.71	0.66	0.66	0.66	0.71	0.88	0.98	0.99
11.5	0.99	0.98	0.89	0.73	0.68	0.67	0.68	0.73	0.89	0.98	0.99
12.5	0.99	0.97	0.89	0.75	0.70	0.69	0.70	0.75	0.89	0.97	0.99
13.5	0.99	0.97	0.89	0.76	0.71	0.70	0.71	0.76	0.89	0.97	0.99
14.5	0.99	0.97	0.89	0.78	0.73	0.72	0.73	0.78	0.89	0.97	0.99

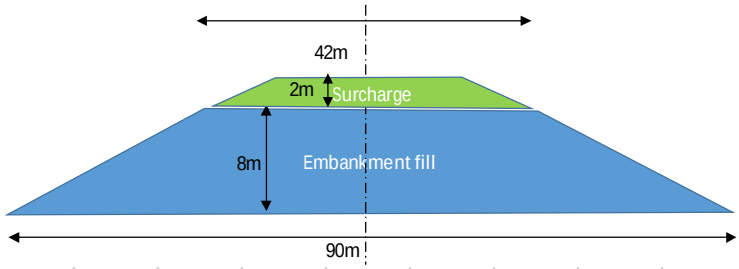
Figure 1: Permeability factor for 4 m embankment height



Change in permeability

Distance,m -->	-55	-44	-33	-22	-11	0	11	22	33	44	55
depth,m											
0.5	1.00	0.67	0.19	0.12	0.12	0.12	0.12	0.12	0.19	0.67	1.00
1.5	1.00	0.83	0.37	0.25	0.25	0.25	0.25	0.25	0.37	0.83	1.00
2.5	1.00	0.84	0.42	0.30	0.29	0.29	0.29	0.30	0.42	0.84	1.00
3.5	1.00	0.84	0.47	0.34	0.32	0.32	0.32	0.34	0.47	0.84	1.00
4.5	0.99	0.85	0.50	0.37	0.36	0.36	0.36	0.37	0.50	0.85	0.99
5.5	0.99	0.85	0.54	0.41	0.39	0.39	0.39	0.41	0.54	0.85	0.99
6.5	0.99	0.85	0.57	0.44	0.41	0.41	0.41	0.44	0.57	0.85	0.99
7.5	0.98	0.85	0.59	0.46	0.44	0.44	0.44	0.46	0.59	0.85	0.98
8.5	0.98	0.85	0.61	0.49	0.46	0.46	0.46	0.49	0.61	0.85	0.98
9.5	0.97	0.85	0.63	0.51	0.48	0.48	0.48	0.51	0.63	0.85	0.97
10.5	0.97	0.85	0.65	0.53	0.50	0.50	0.50	0.53	0.65	0.85	0.97
11.5	0.97	0.85	0.67	0.56	0.52	0.52	0.52	0.56	0.67	0.85	0.97
12.5	0.96	0.86	0.68	0.57	0.54	0.54	0.54	0.57	0.68	0.86	0.96
13.5	0.96	0.86	0.70	0.59	0.56	0.55	0.56	0.59	0.70	0.86	0.96
14.5	0.96	0.86	0.71	0.61	0.57	0.57	0.57	0.61	0.71	0.86	0.96

Figure 2: Permeability factor for 8 m embankment height



Change in permeability

Distance,m -->	-55	-44	-33	-22	-11	0	11	22	33	44	55
depth,m											
0.5	1.00	0.67	0.19	0.12	0.10	0.10	0.10	0.12	0.19	0.67	1.00
1.5	1.00	0.83	0.37	0.25	0.21	0.21	0.21	0.25	0.37	0.83	1.00
2.5	1.00	0.84	0.42	0.29	0.25	0.25	0.25	0.29	0.42	0.84	1.00
3.5	1.00	0.84	0.47	0.33	0.29	0.28	0.29	0.33	0.47	0.84	1.00
4.5	0.99	0.85	0.50	0.37	0.32	0.31	0.32	0.37	0.50	0.85	0.99
5.5	0.99	0.85	0.54	0.40	0.34	0.34	0.34	0.40	0.54	0.85	0.99
6.5	0.98	0.85	0.56	0.42	0.37	0.37	0.37	0.42	0.56	0.85	0.98
7.5	0.98	0.85	0.59	0.45	0.40	0.39	0.40	0.45	0.59	0.85	0.98
8.5	0.98	0.85	0.61	0.47	0.42	0.41	0.42	0.47	0.61	0.85	0.98
9.5	0.97	0.85	0.63	0.50	0.44	0.43	0.44	0.50	0.63	0.85	0.97
10.5	0.97	0.85	0.65	0.52	0.46	0.45	0.46	0.52	0.65	0.85	0.97
11.5	0.96	0.85	0.66	0.54	0.48	0.47	0.48	0.54	0.66	0.85	0.96
12.5	0.96	0.85	0.68	0.55	0.50	0.49	0.50	0.55	0.68	0.85	0.96
13.5	0.96	0.85	0.69	0.57	0.52	0.51	0.52	0.57	0.69	0.85	0.96
14.5	0.95	0.85	0.70	0.59	0.53	0.52	0.53	0.59	0.70	0.85	0.95

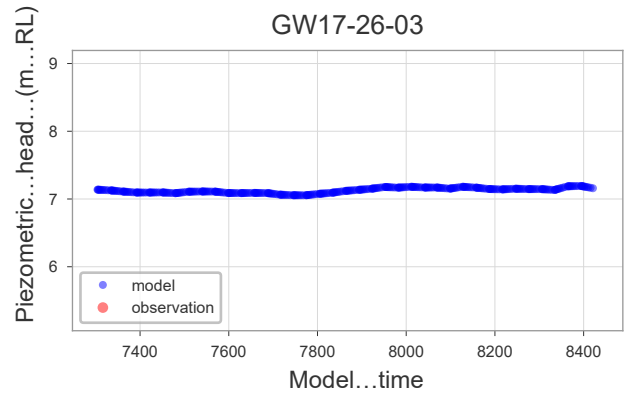
Figure 3: Permeability factor for 8m embankment height + 2m surcharge, total height of 10 m.

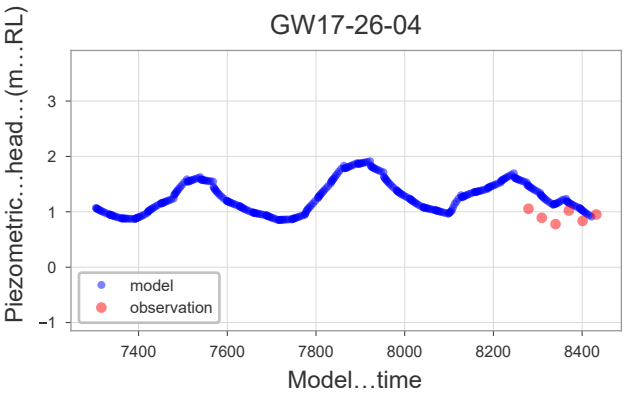
Reference:

Boussinesq, M. J. (1885), "*Application des potentiels a l'etude de l'equilibre et du movement des solides elastiques, principalement au calcul des deformations et des pressions que produisent, dans ces solides, des efforts quelconques exerces sur une petite partie de leur surface ou de leur interieur: Memoire suivi de notes etendues sur divers points de physique mathematique et d'analyse*," GauthierVillars, Paris, pp. 722. [Google title translation: "Application of the potentials to the study of the equilibrium and the movement of elastic solids, mainly to the computation of the deformations and the pressures that produce in these solids, any efforts exerces on a small part of their surface or their interior: Memory followed by extended notes on various points of mathematical physics and analysis"]

APPENDIX B

CALIBRATION HYDROGRAPHS


GW17-26-03
Piezometric…head…(m…RL)
Model…time
model
observation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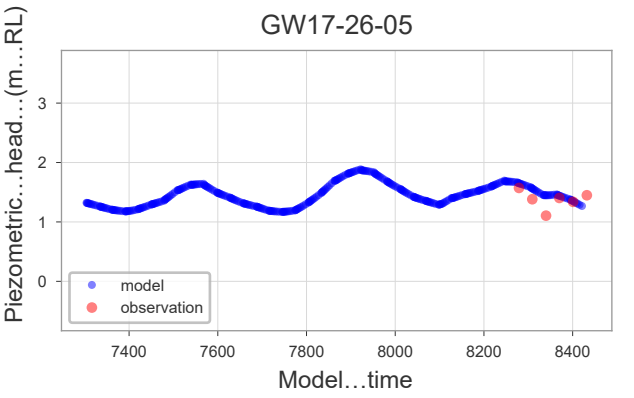
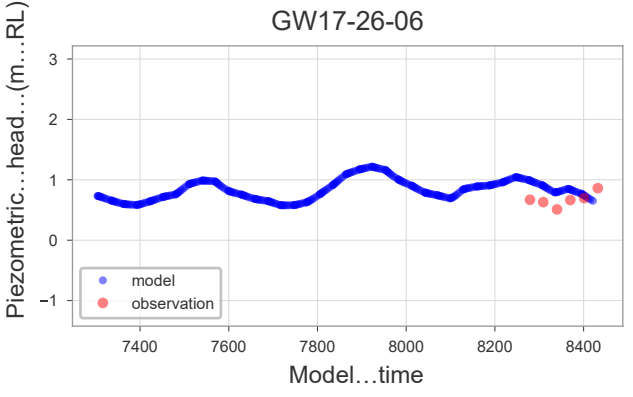
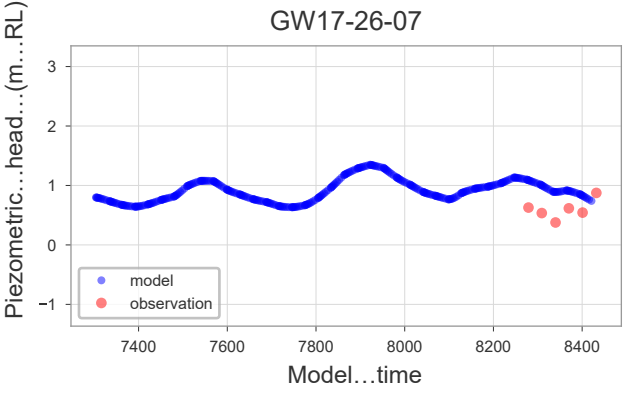
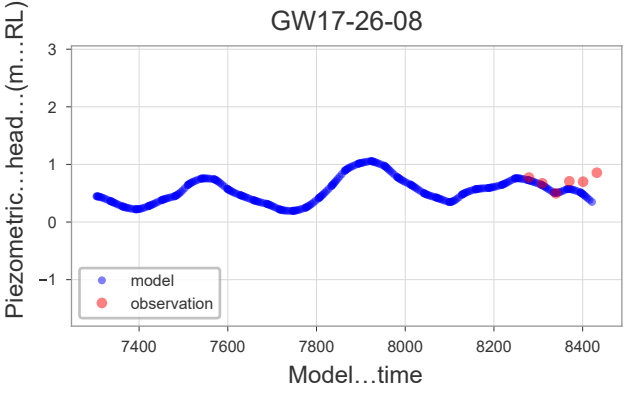
Piezometric…head…(m…RL)
Model…time
model
observation


GW17-26-05
Piezometric…head…(m…RL)
Model…time
model
observation


GW17-26-06
Piezometric…head…(m…RL)
Model…time
model
observation


GW17-26-07
Piezometric…head…(m…RL)
Model…time
model
observation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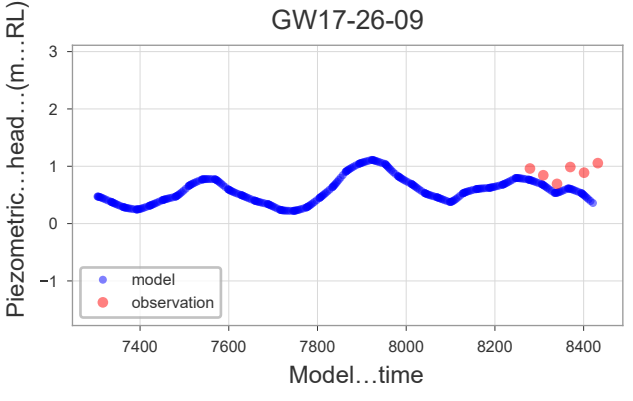
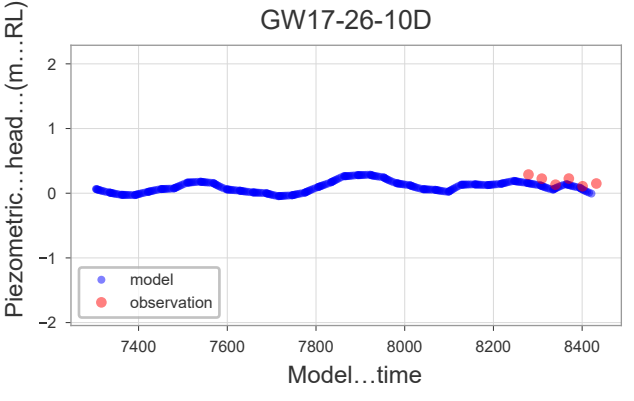
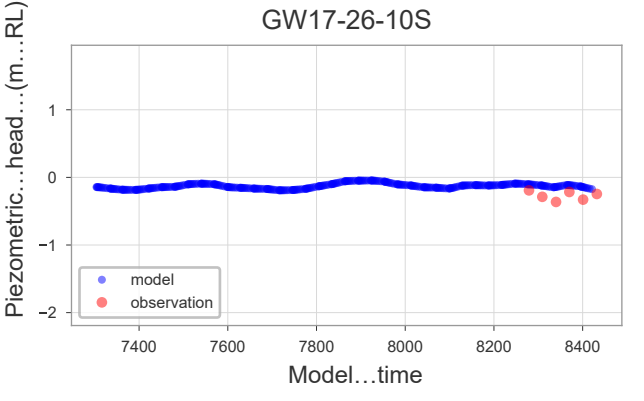
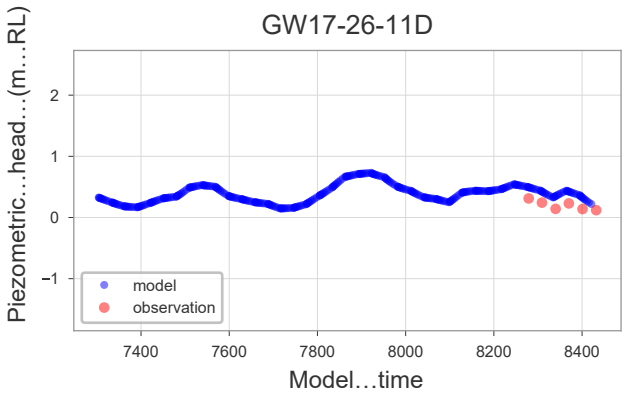
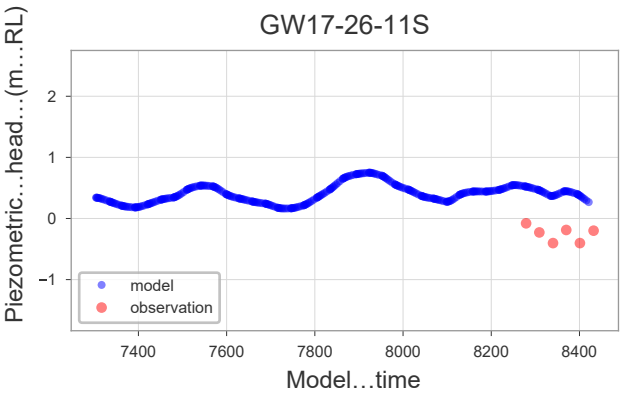
Piezometric…head…(m…RL)
Model…time
model
observation

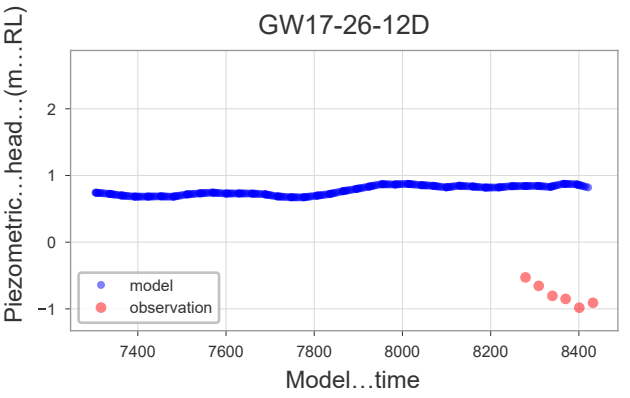

GW17-26-09
Piezometric…head…(m…RL)
Model…time
model
observation

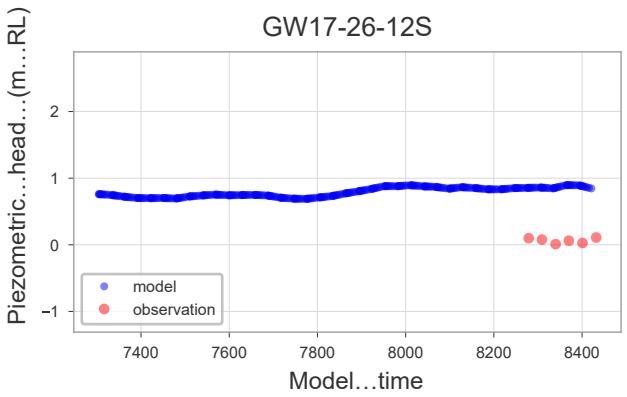

GW17-26-10D
Piezometric…head…(m…RL)
Model…time
model
observation

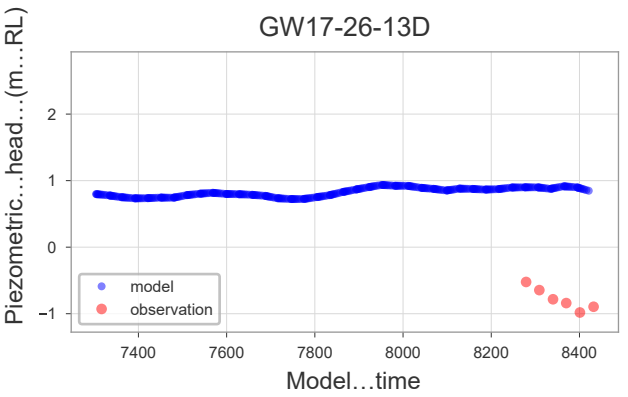

GW17-26-10S
Piezometric…head…(m…RL)
Model…time
model
observation


GW17-26-11D
Piezometric…head…(m…RL)
Model…time
model
observation


GW17-26-11S
Piezometric…head…(m…RL)
Model…time
model
observation


GW17-26-12D
Piezometric…head…(m…RL)
Model…time
model
observation


GW17-26-12S
Piezometric…head…(m…RL)
Model…time
model
observation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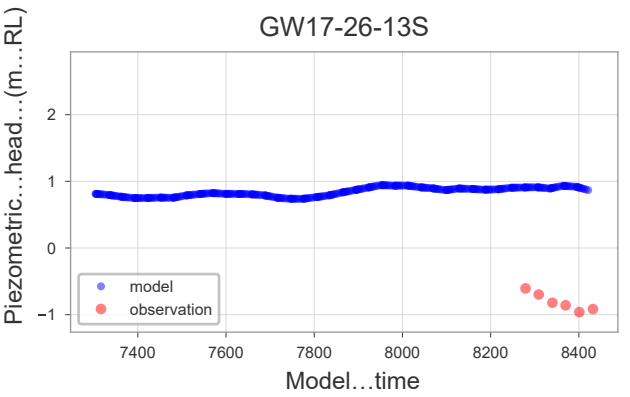
Piezometric…head…(m…RL)
Model…time
model
observation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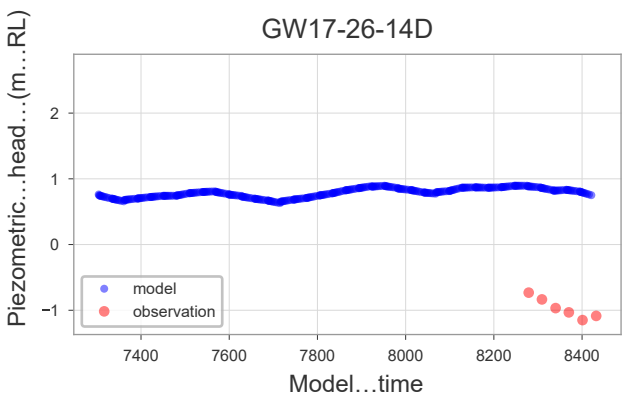
Piezometric…head…(m…RL)
Model…time
model
observation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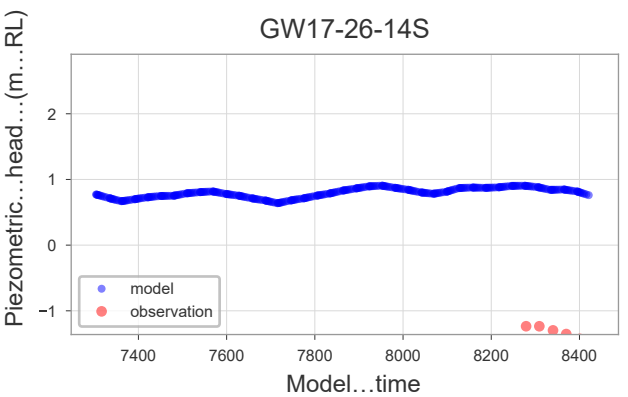
Piezometric…head…(m…RL)
Model…time
model
observation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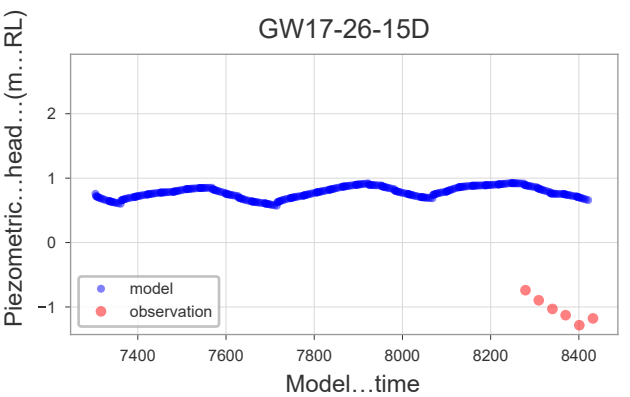
Piezometric…head…(m…RL)
Model…time
model
observation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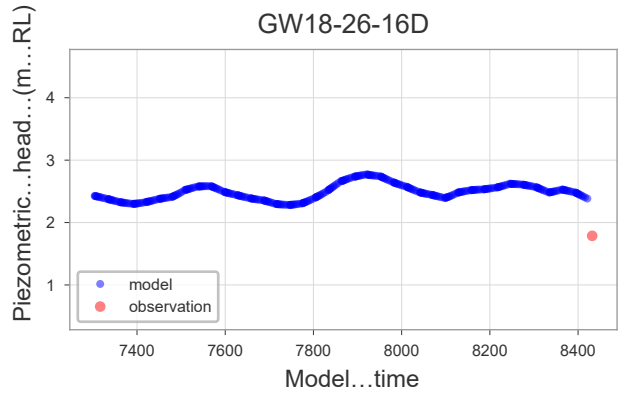
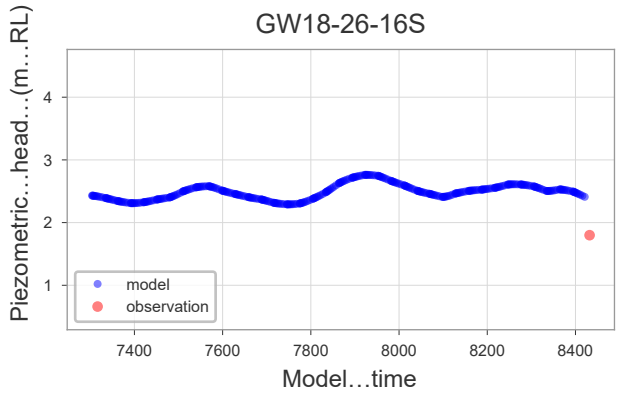
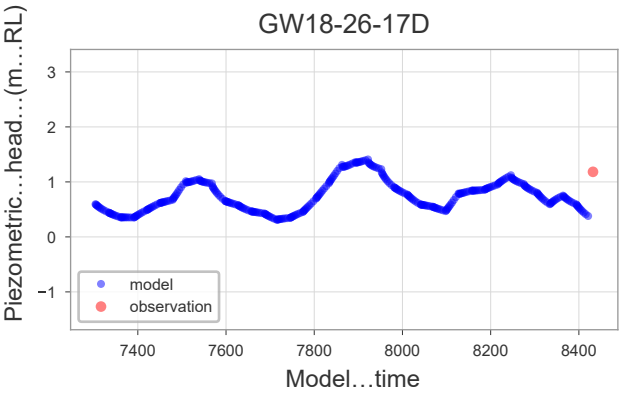
Piezometric…head…(m…RL)
Model…time
model
observation


GW18-26-16D
Piezometric…head…(m…RL)
Model…time
model
observation


GW18-26-16S
Piezometric…head…(m…RL)
Model…time
model
observation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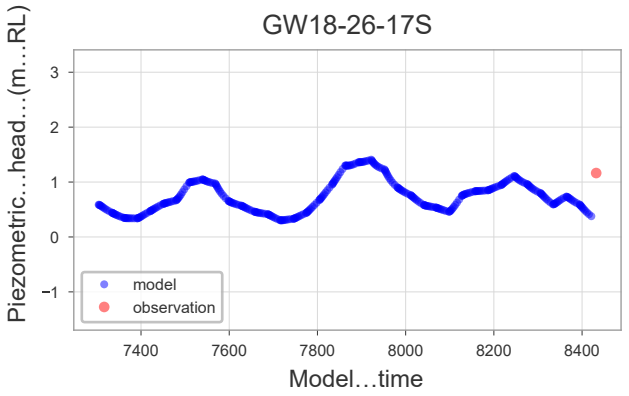
Model…time
model
observation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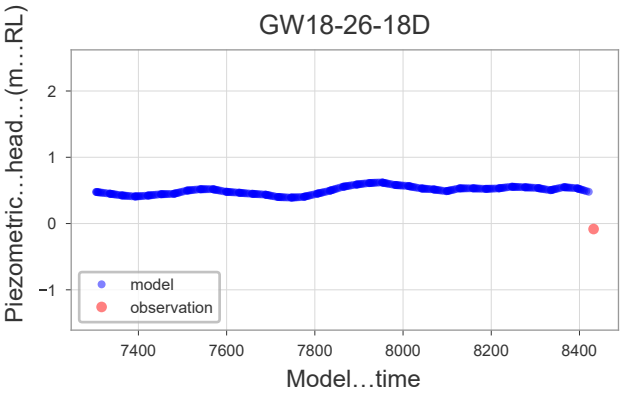
Model…time
model
observation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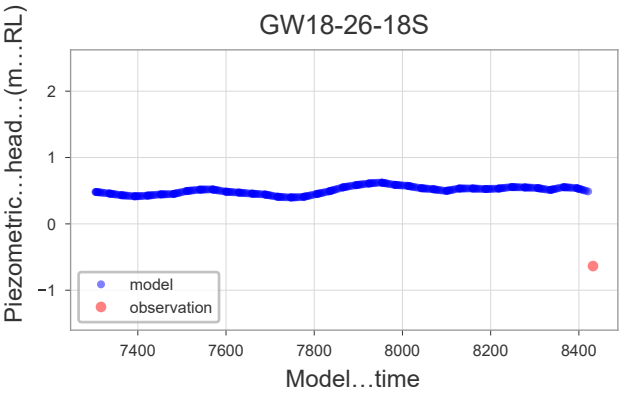
Model…time
model
observation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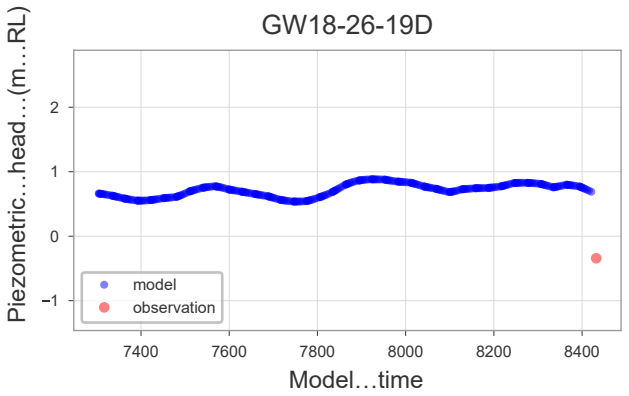
Model…time
model
observation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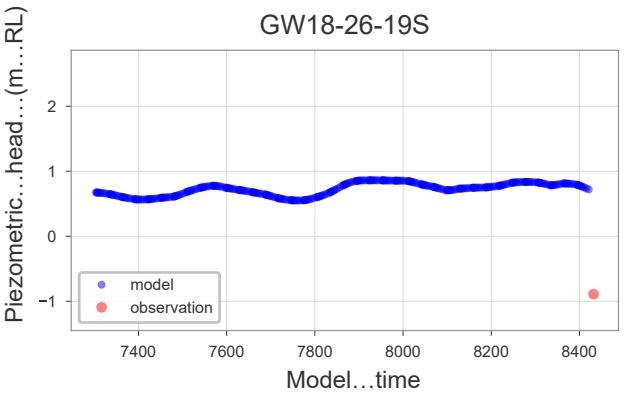
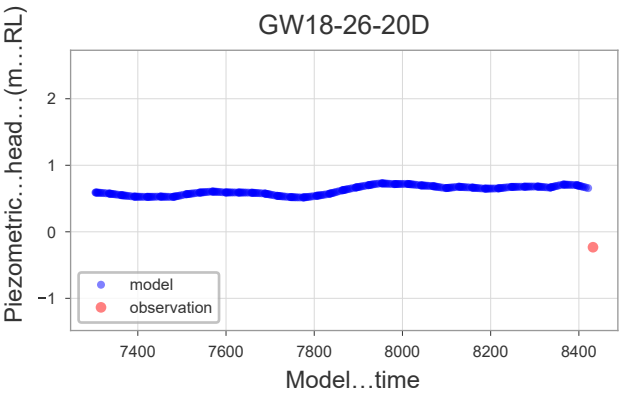
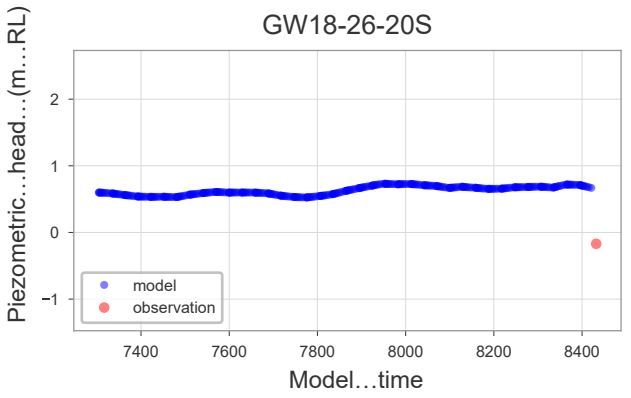
Piezometric…head…(m…RL)
Model…time
model
observation


GW18-26-19S
Piezometric…head…(m…RL)
Model…time
model
observation


GW18-26-20D
Piezometric…head…(m…RL)
Model…time
model
observation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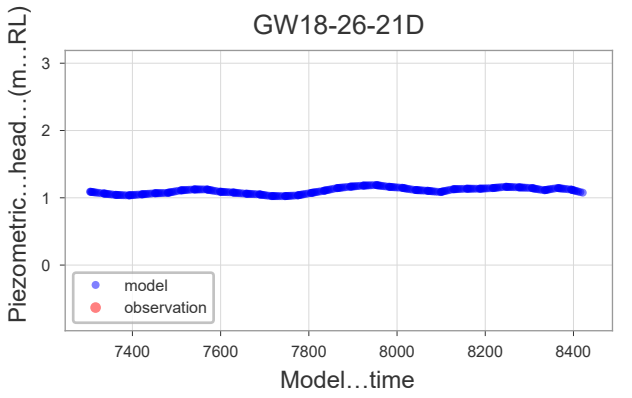
Model…time
model
observation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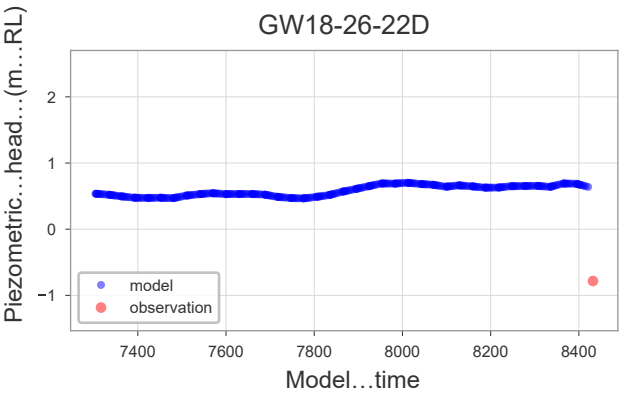
Model…time
model
observation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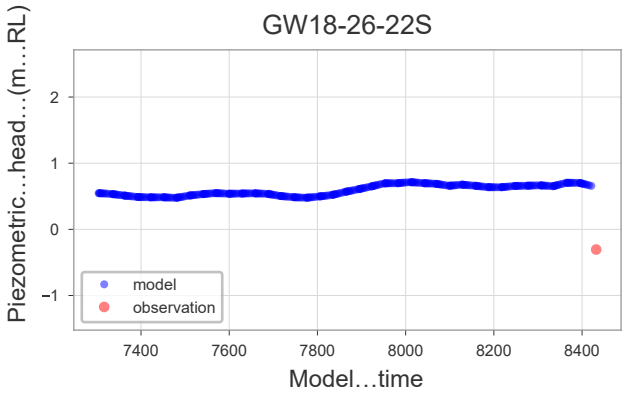
Model…time
model
observation


GW18-26-22S
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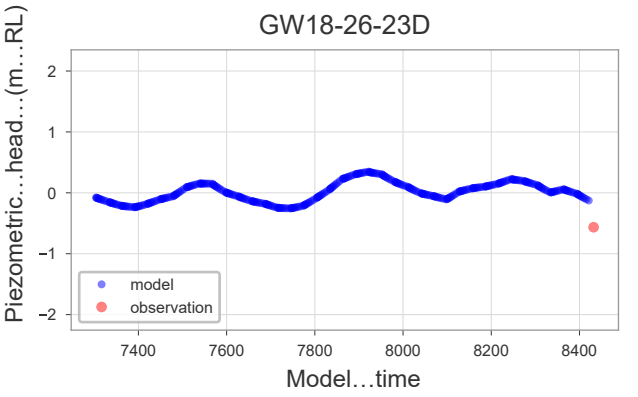
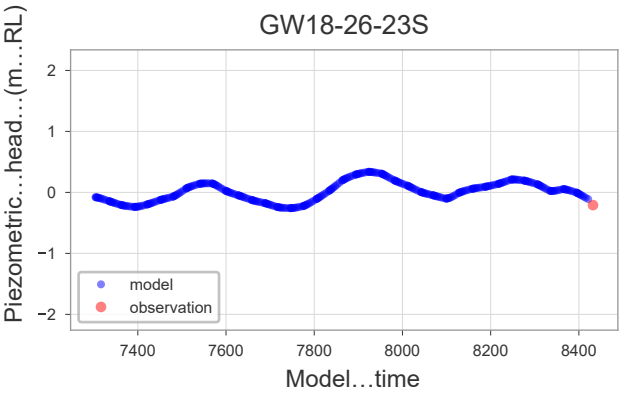
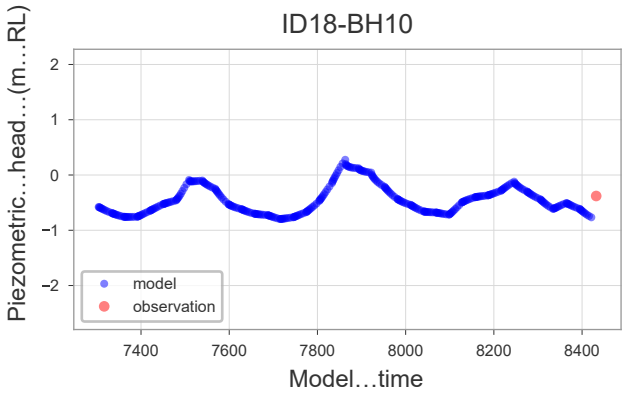
Model…time
model
observation


GW18-26-23D
Piezometric…head…(m…RL)
Model…time
model
observation


GW18-26-23S
Piezometric…head…(m…RL)
Model…time
model
observation


ID18-BH10
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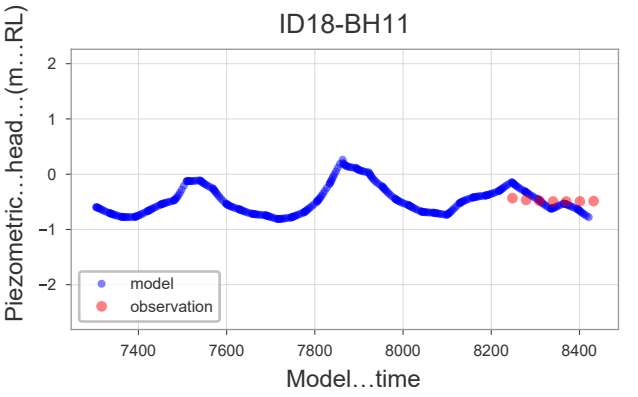
Model…time
model
observation


ID18-BH11
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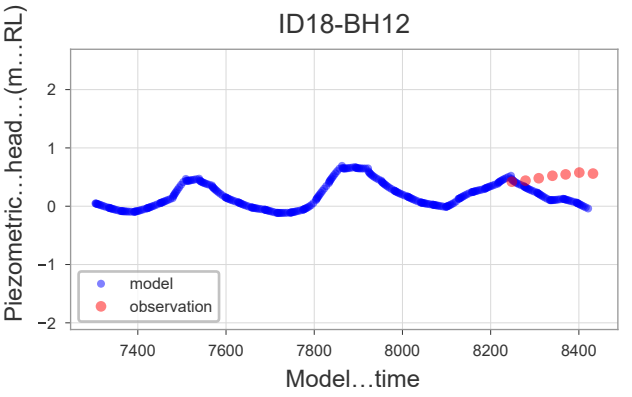
Model…time
model
observation


ID18-BH12
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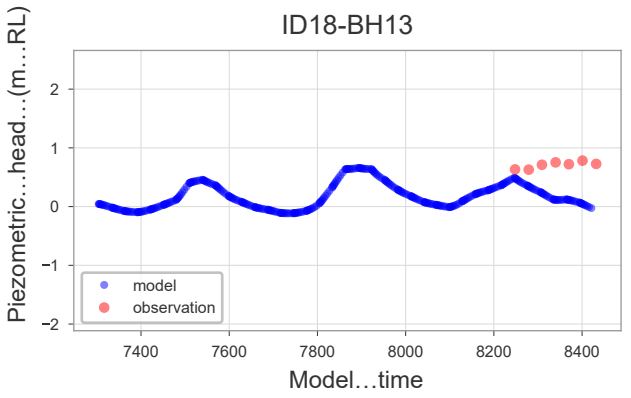
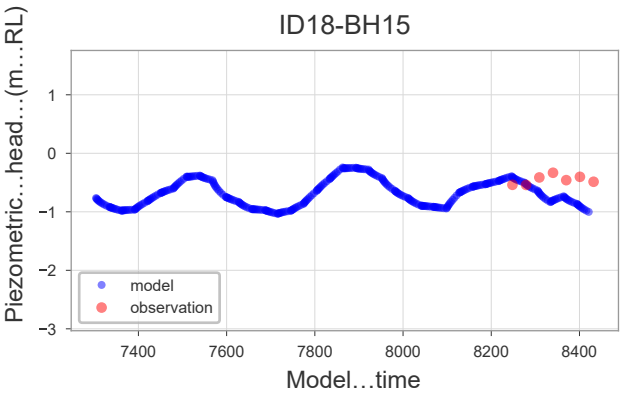
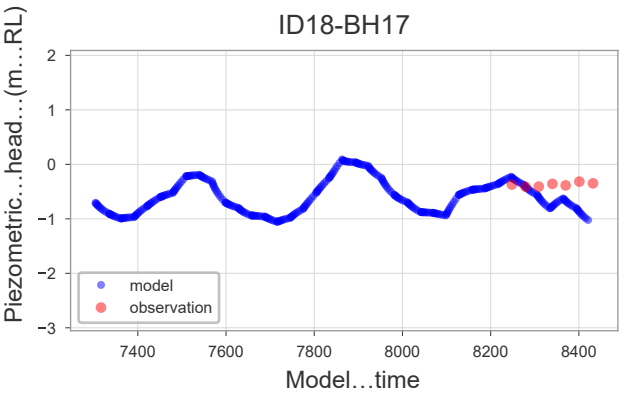
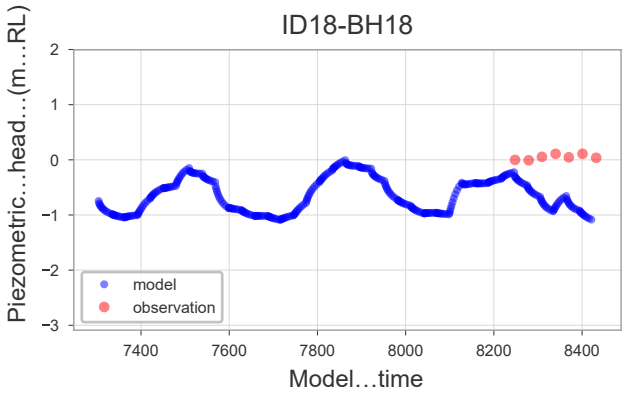
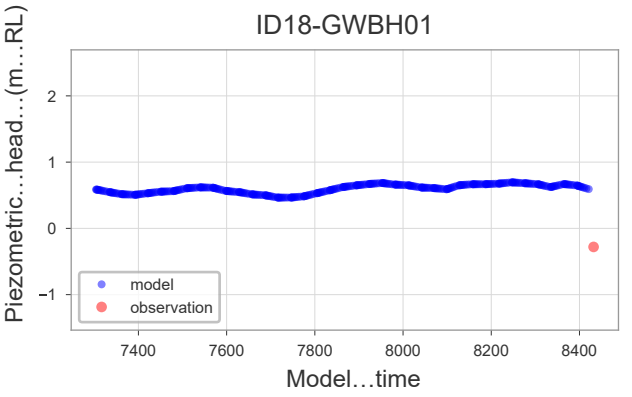
Model…time
model
observation

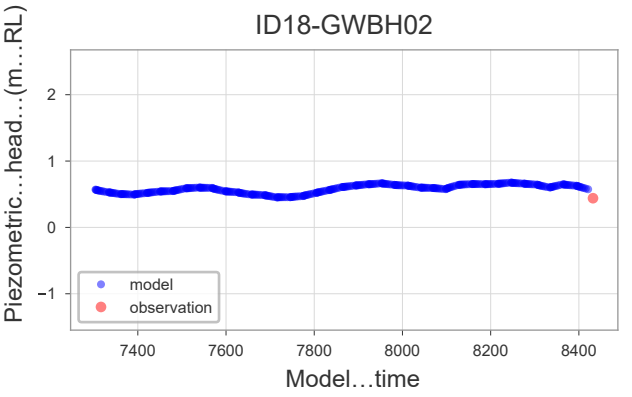

ID18-BH13
Piezometric…head…(m…RL)
Model…time
model
observation

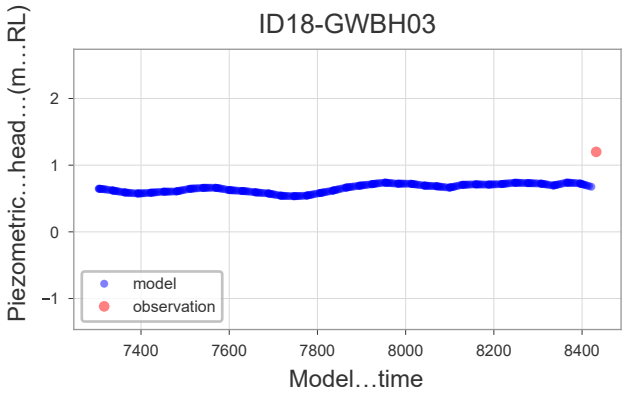

ID18-BH15
Piezometric…head…(m…RL)
Model…time
model
observation

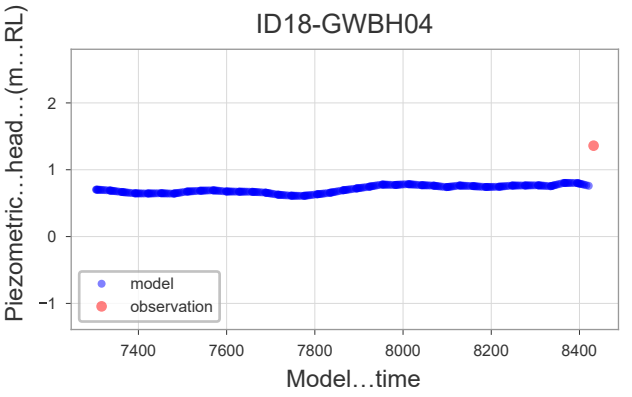

ID18-BH17
Piezometric…head…(m…RL)
Model…time
model
observation

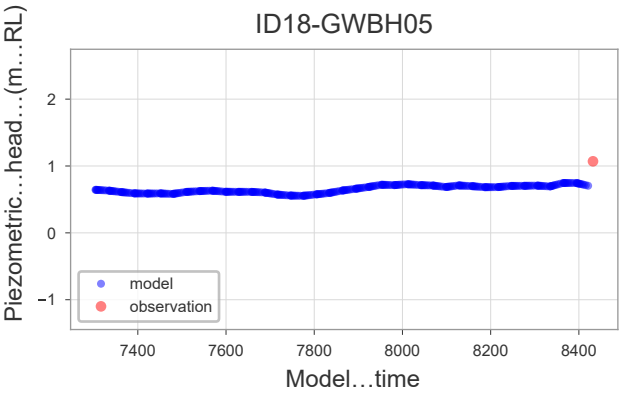

ID18-BH18
Piezometric…head…(m…RL)
Model…time
model
observation


ID18-GWBH01
Piezometric…head…(m…RL)
Model…time
model
observation


ID18-GWBH02
Piezometric…head…(m…RL)
Model…time
model
observation


ID18-GWBH03
Piezometric…head…(m…RL)
Model…time
model
observation


ID18-GWBH04
Piezometric…head…(m…RL)
Model…time
model
observation


ID18-GWBH05
Piezometric…head…(m…RL)
Model…time
model
observation

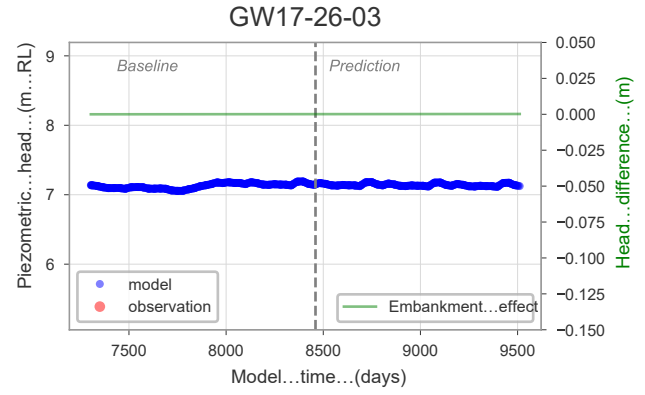
APPENDIX C

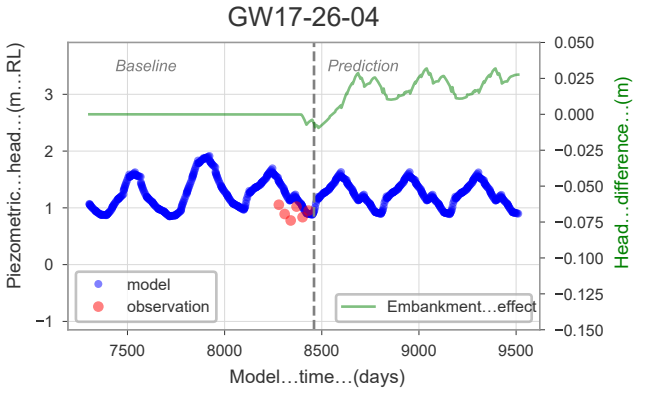
CALCULATED PERMEABILITY REDUCTION FACTORS

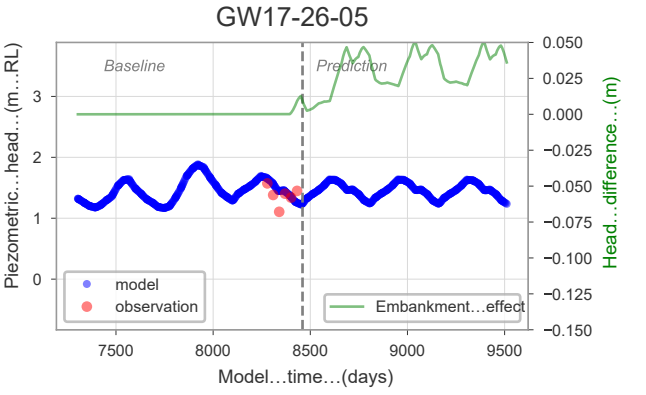
HSU	MODEL LAYER	K REDUCTION FACTOR	HSU	MODEL LAYER	K REDUCTION FACTOR
601	1	0.786	701	2	0.917
602	1	0.749	702	2	0.879
603	1	0.691	703	2	0.840
604	1	0.643	704	2	0.801
605	1	0.581	705	2	0.756
606	1	0.517	706	2	0.709
607	1	0.468	707	2	0.669
608	1	0.468	708	2	0.669
609	1	0.517	709	2	0.709
610	1	0.581	710	2	0.756
611	1	0.629	711	2	0.795
612	1	0.677	712	2	0.835
613	1	0.726	713	2	0.874
614	1	0.774	714	2	0.914
615	1	0.760	715	2	0.909
616	1	0.711	716	2	0.869
617	1	0.677	717	2	0.835
618	1	0.565	718	2	0.749
619	1	0.597	719	2	0.782
620	1	0.527	720	2	0.733
621	1	0.577	721	2	0.775
622	1	0.626	722	2	0.816
623	1	0.675	723	2	0.858
624	1	0.702	724	2	0.893
625	1	0.653	725	2	0.851
626	1	0.603	726	2	0.809
627	1	0.553	727	2	0.767
628	1	0.504	728	2	0.725
629	1	0.454	729	2	0.683
630	1	0.377	730	2	0.629
631	1	0.294	731	2	0.573
632	1	0.342	732	2	0.617

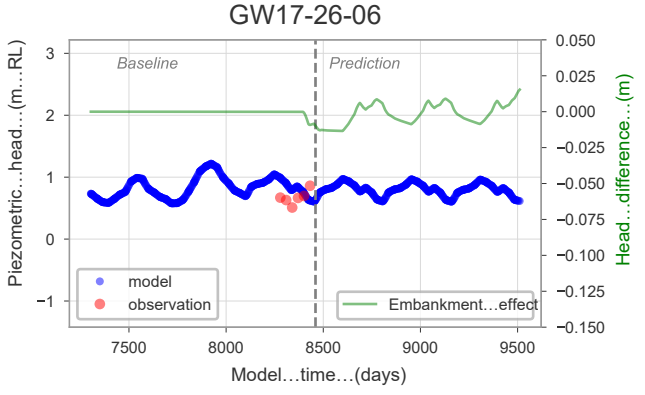
APPENDIX D

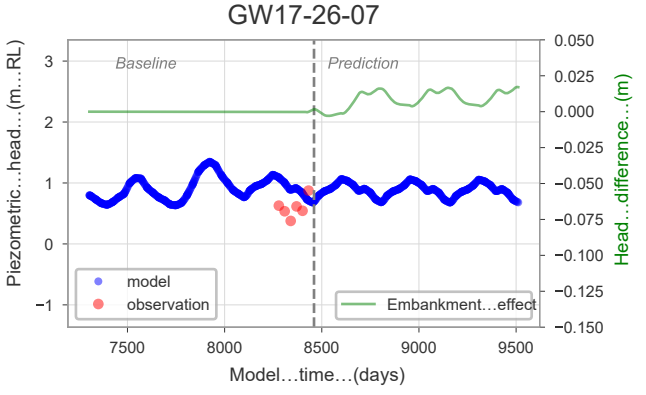
PREDICTION HYDROGRAPHS

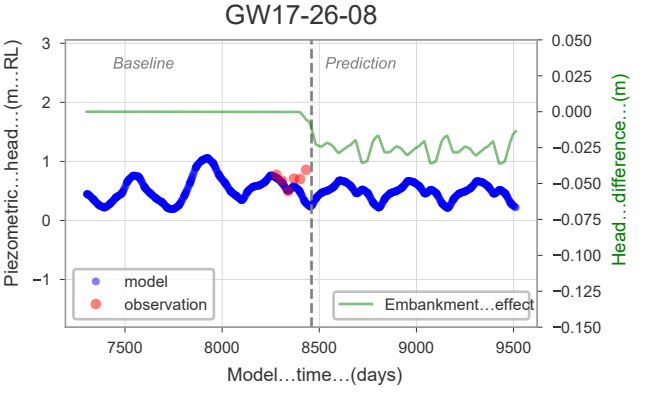

GW17-26-03
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

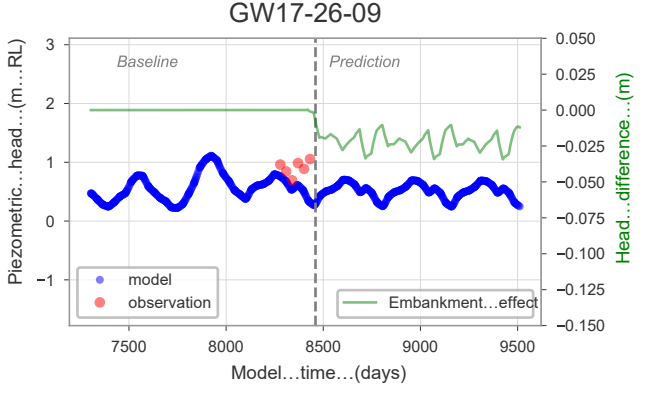

GW17-26-04
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

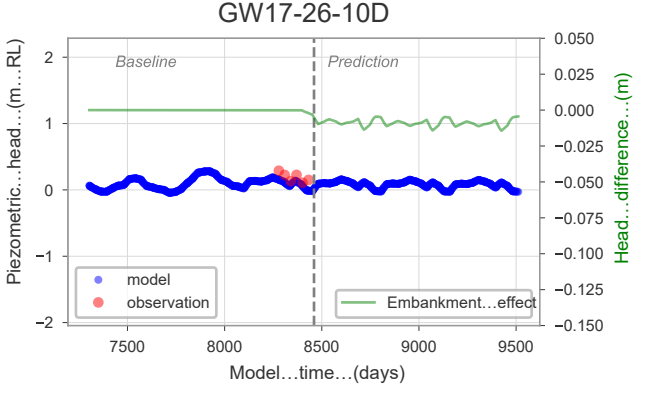

GW17-26-05
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

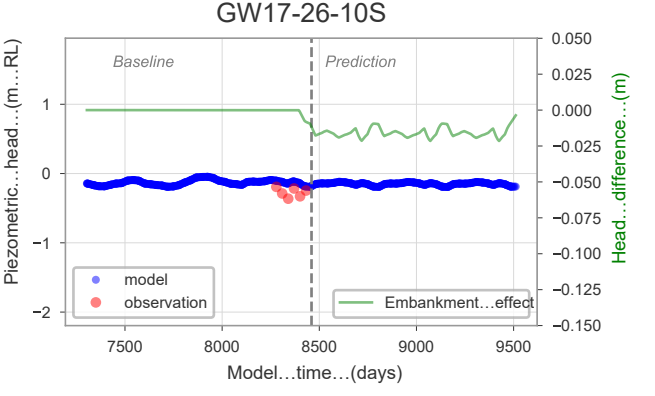

GW17-26-06
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

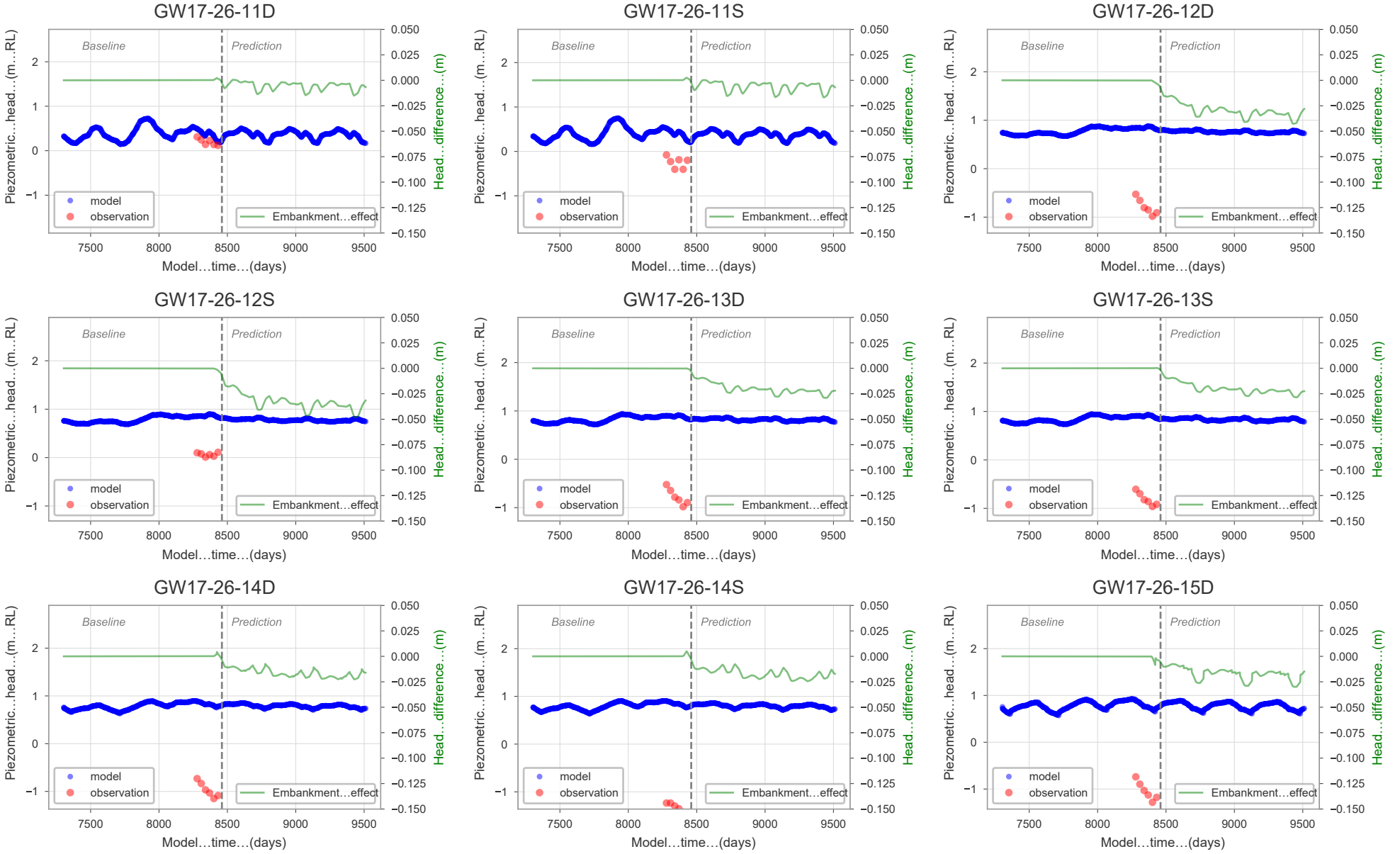

GW17-26-07
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

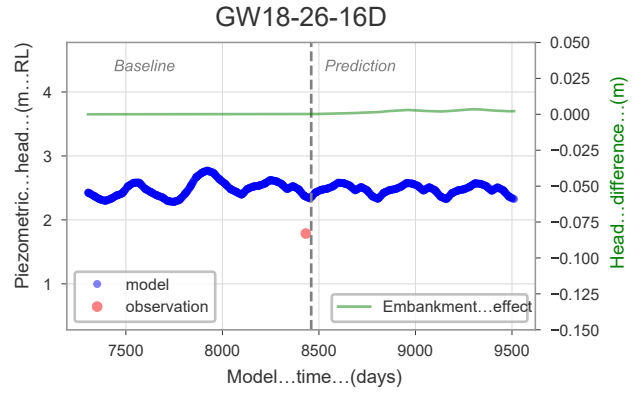

GW17-26-08
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

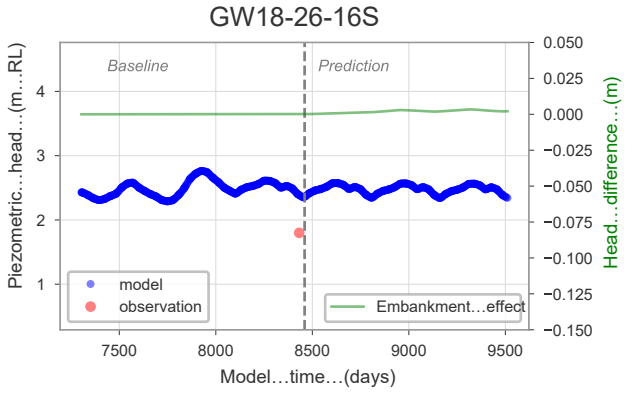

GW17-26-09
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

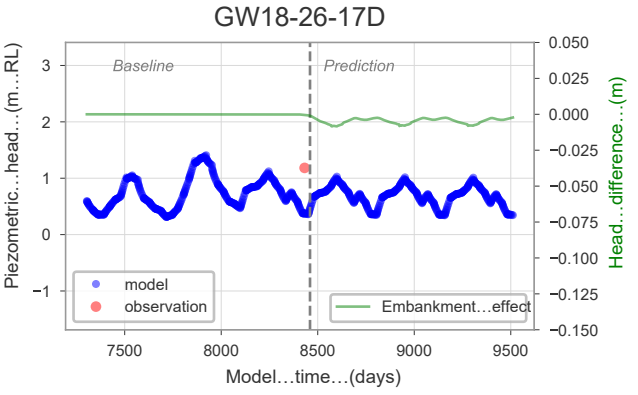

GW17-26-10D
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

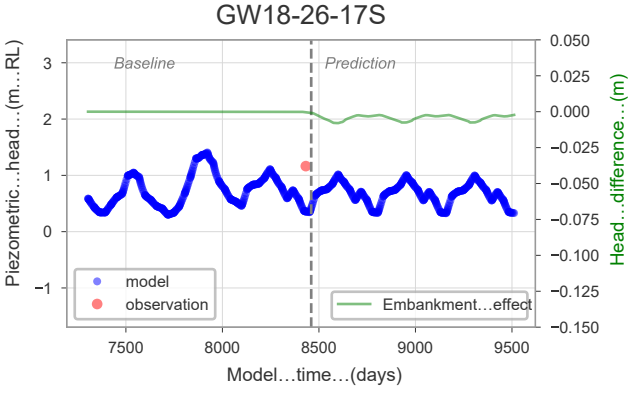

GW17-26-10S
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

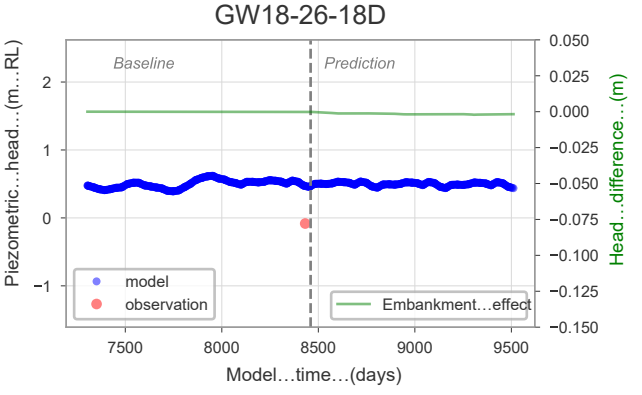

GW17-26-11D
GW17-26-11S
GW17-26-12D
GW17-26-12S
GW17-26-13D
GW17-26-13S
GW17-26-14D
GW17-26-14S
GW17-26-15D
Baseline
Prediction
model
observation
Embankment…effect
Piezometric…head…(m…RL)
Head…difference…(m)
Model…time…(days)

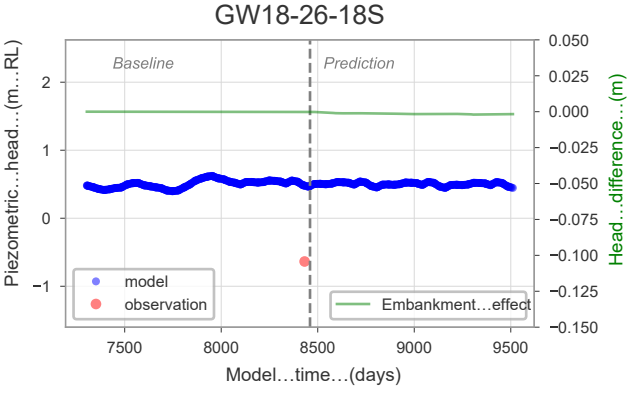

GW18-26-16D
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

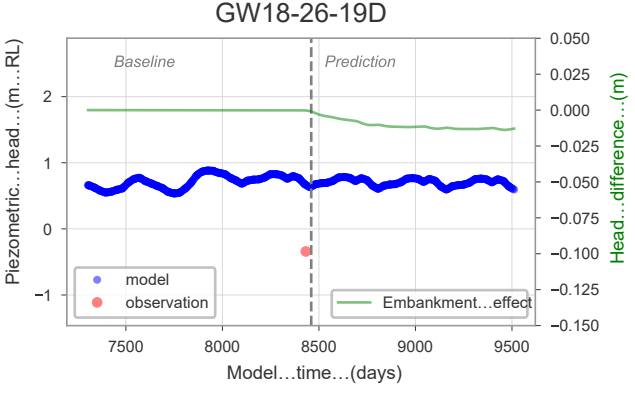

GW18-26-16S
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

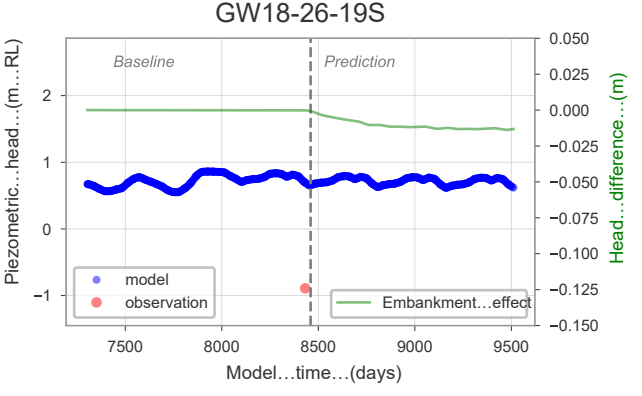

GW18-26-17D
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

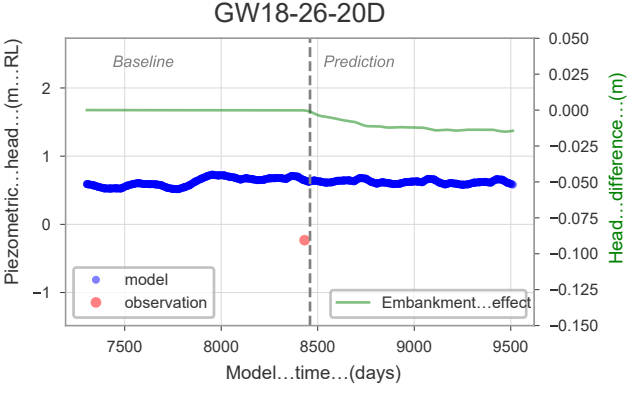

GW18-26-17S
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

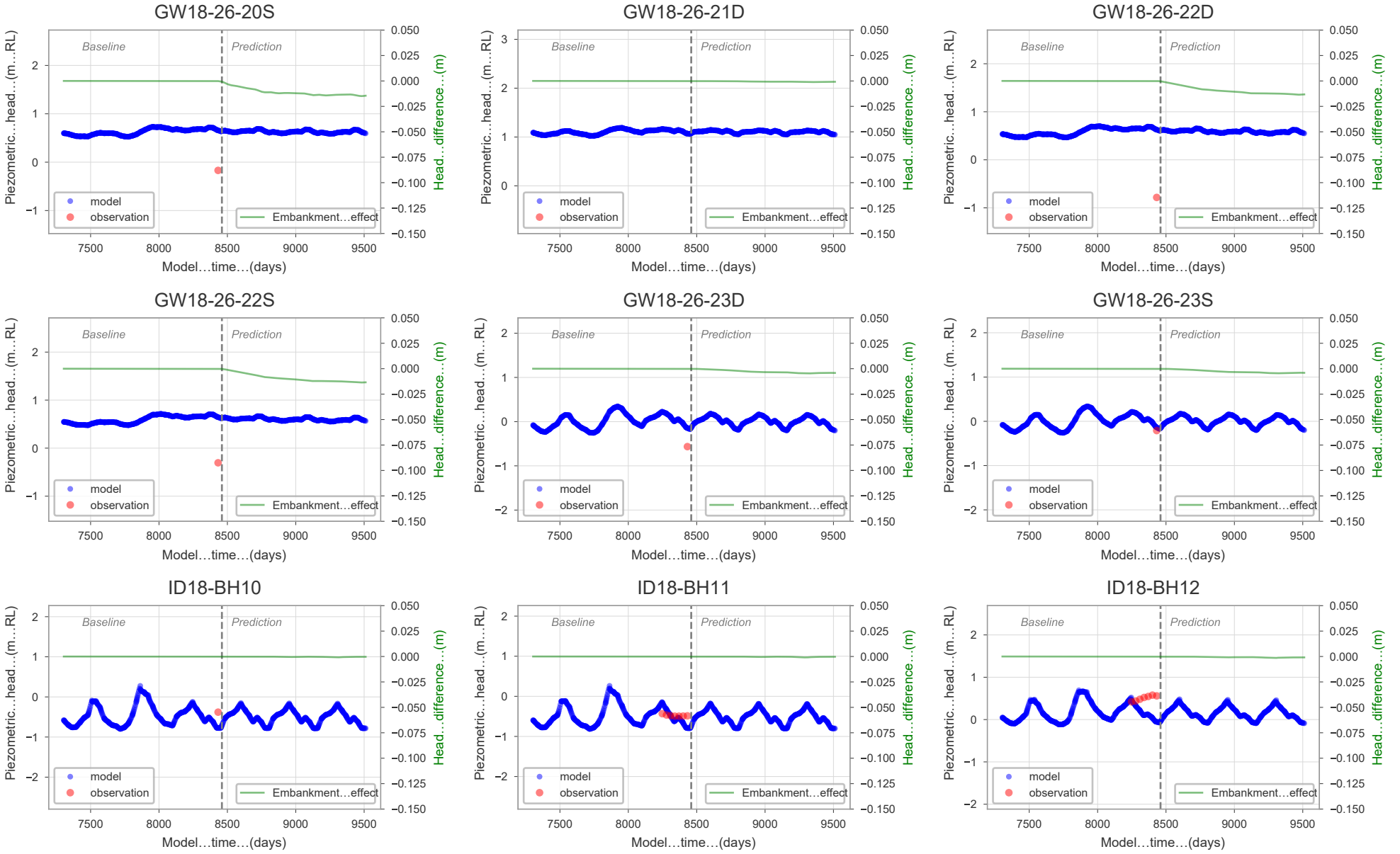

GW18-26-18D
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

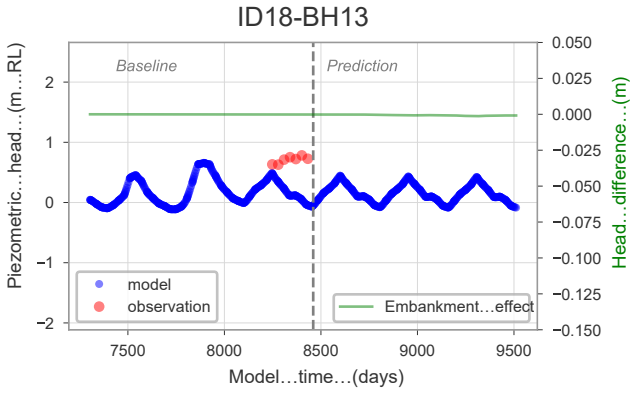

GW18-26-18S
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

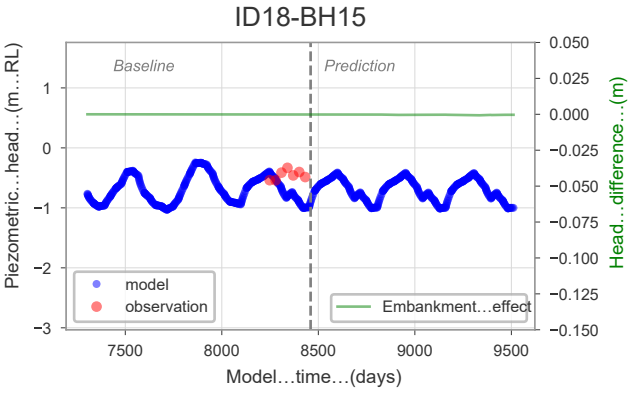

GW18-26-19D
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

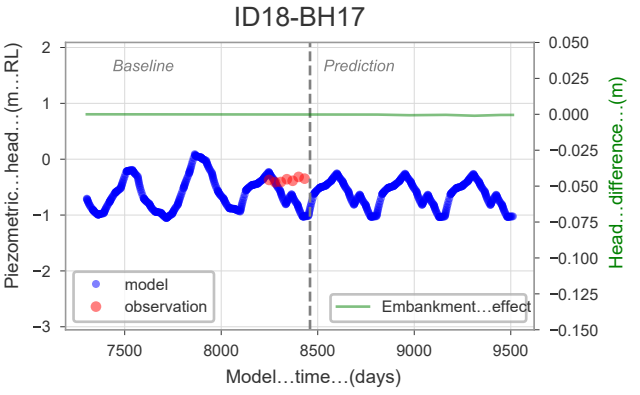

GW18-26-19S
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

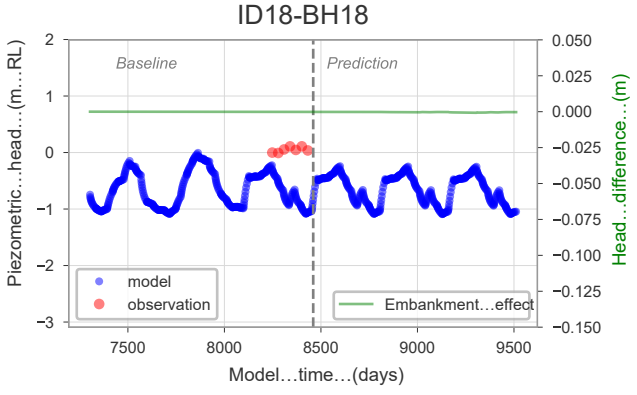

GW18-26-20D
Baseline
Prediction
Piezometric…head…(m…RL)
Head…difference…(m)
model
observation
Embankment…effect
Model…time…(days)

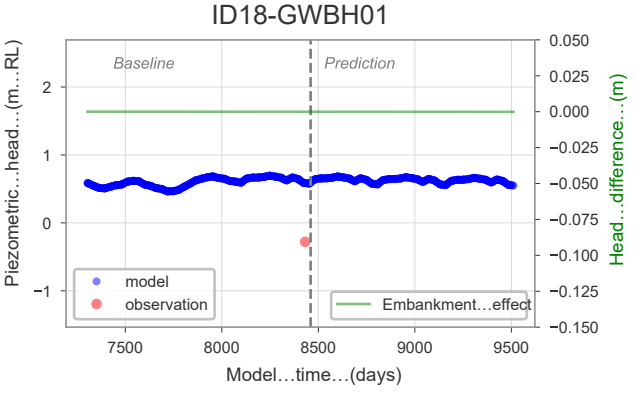

GW18-26-20S
GW18-26-21D
GW18-26-22D
GW18-26-22S
GW18-26-23D
GW18-26-23S
ID18-BH10
ID18-BH11
ID18-BH12
Baseline
Prediction
model
observation
Embankment…effect
Piezometric…head…(m…RL)
Head…difference…(m)
Model…time…(days)

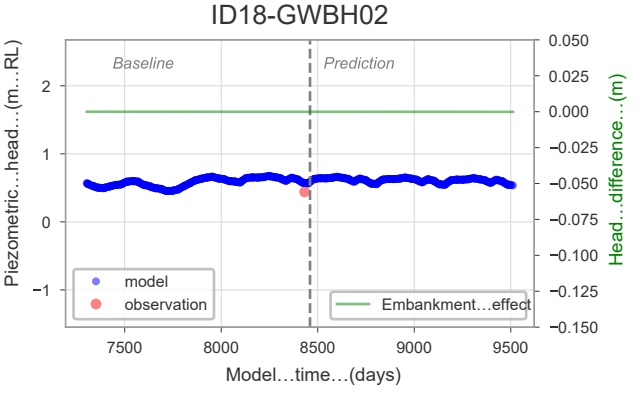

ID18-BH13
Baseline
Prediction
model
observation
Embankment…effect
Piezometric…head…(m…RL)
Head…difference…(m)
Model…time…(days)

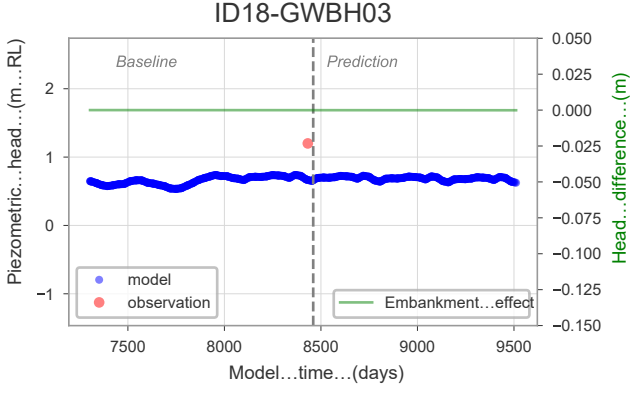

ID18-BH15
Baseline
Prediction
model
observation
Embankment…effect
Piezometric…head…(m…RL)
Head…difference…(m)
Model…time…(days)

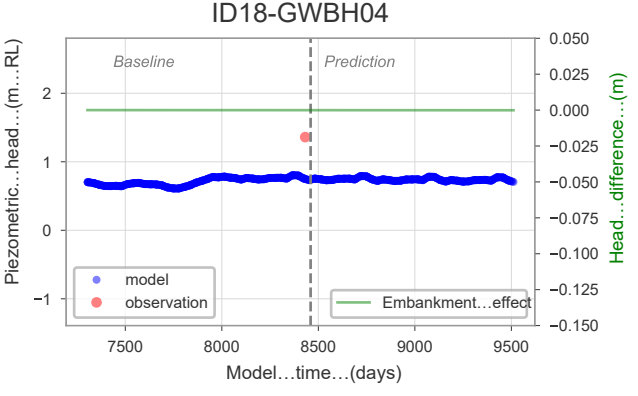

ID18-BH17
Baseline
Prediction
model
observation
Embankment…effect
Piezometric…head…(m…RL)
Head…difference…(m)
Model…time…(days)

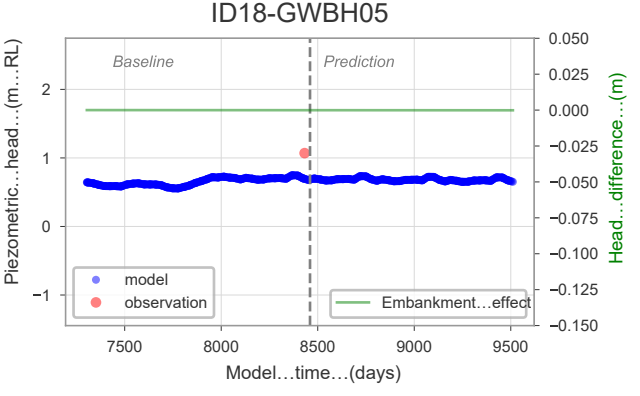

ID18-BH18
Baseline
Prediction
model
observation
Embankment…effect
Piezometric…head…(m…RL)
Head…difference…(m)
Model…time…(days)


ID18-GWBH01
Baseline
Prediction
model
observation
Embankment…effect
Piezometric…head…(m…RL)
Head…difference…(m)
Model…time…(days)


ID18-GWBH02
Baseline
Prediction
model
observation
Embankment…effect
Piezometric…head…(m…RL)
Head…difference…(m)
Model…time…(days)


ID18-GWBH03
Baseline
Prediction
model
observation
Embankment…effect
Piezometric…head…(m…RL)
Head…difference…(m)
Model…time…(days)


ID18-GWBH04
Baseline
Prediction
model
observation
Embankment…effect
Piezometric…head…(m…RL)
Head…difference…(m)
Model…time…(days)


ID18-GWBH05
Baseline
Prediction
model
observation
Embankment…effect
Piezometric…head…(m…RL)
Head…difference…(m)
Model…time…(days)

APPENDIX E

ADDITIONAL MODELLING SCENARIO: TECHNICAL MEMO

MEMO

TO:	Jay Knight, Adam Greenberger
FROM:	Ellen Kwantes, Ray Hatley
SUBJECT:	**Additional groundwater modelling scenario to simulate a greater decrease in permeability under a wider embankment area**
OUR REF:	PS101340-RES-MEM-001 RevA.docx
DATE:	**23 August 2018**

1. GENERAL

The purpose of this memorandum is to test an additional road design scenario that could include increasing the embankment height above and beyond that modelled for the EES Groundwater Impact Assessment Report (2018)

To undertake this assessment, an additional sensitivity model scenario was run to estimate the effect of increasing the embankment height to 15 metres above that modelled for the EES. The premise is that the additional loading and compaction of the shallow aquifer sediments caused by the embankment construction penetrates deeper and causes a greater decrease in hydraulic conductivity (K) beneath the higher embankment. This reduction on K would, in turn, impact on the shallow groundwater flow beneath.

Note: This model scenario should be read in conjunction with the Groundwater Impact Assessment and Groundwater Modelling Report (Appendix E of the main EES groundwater report). The predictions made in this additional modelling has not been third party reviewed and is separate from the impact assessment of the EES modelling.

2. METHODOLOGY & RESULTS

To simulate the higher embankment height, the steady state groundwater model was re-run with a reduced hydraulic conductivity, by a factor of 100 in model layer 1 (QA) and 2 (UTAF) compared, to the host aquifer material in the area shown on Figure 1:

- A hydraulic conductivity of 0.01 (K_h) /0.001 (K_v) m/day was used for the area under the embankment for model layer 1. The previous model assumed a hydraulic conductivity of 1 m/day for alluvium aquifer and a reduced hydraulic conductivity under the embankment of 0.294-0.786 m/day.
- For model layer 2, a hydraulic conductivity of 0.007 (K_h)/0.0007 (K_v) m/day was used under the embankment, which is also a reduction of 100 times. 0.01 (K_h) /0.001 (K_v) m/day was used for the area under the embankment for model layer 1. The previous model assumed a hydraulic conductivity of 0.7 m/day for UTAF and a reduced hydraulic conductivity under the embankment of 0.401-0.642 m/day. The previous model assumed an embankment height varying from 2 to a maximum of 9 m above nominal ground

Level 27, 680 George Street
Sydney NSW 2000
GPO Box 5394
Sydney NSW 2001

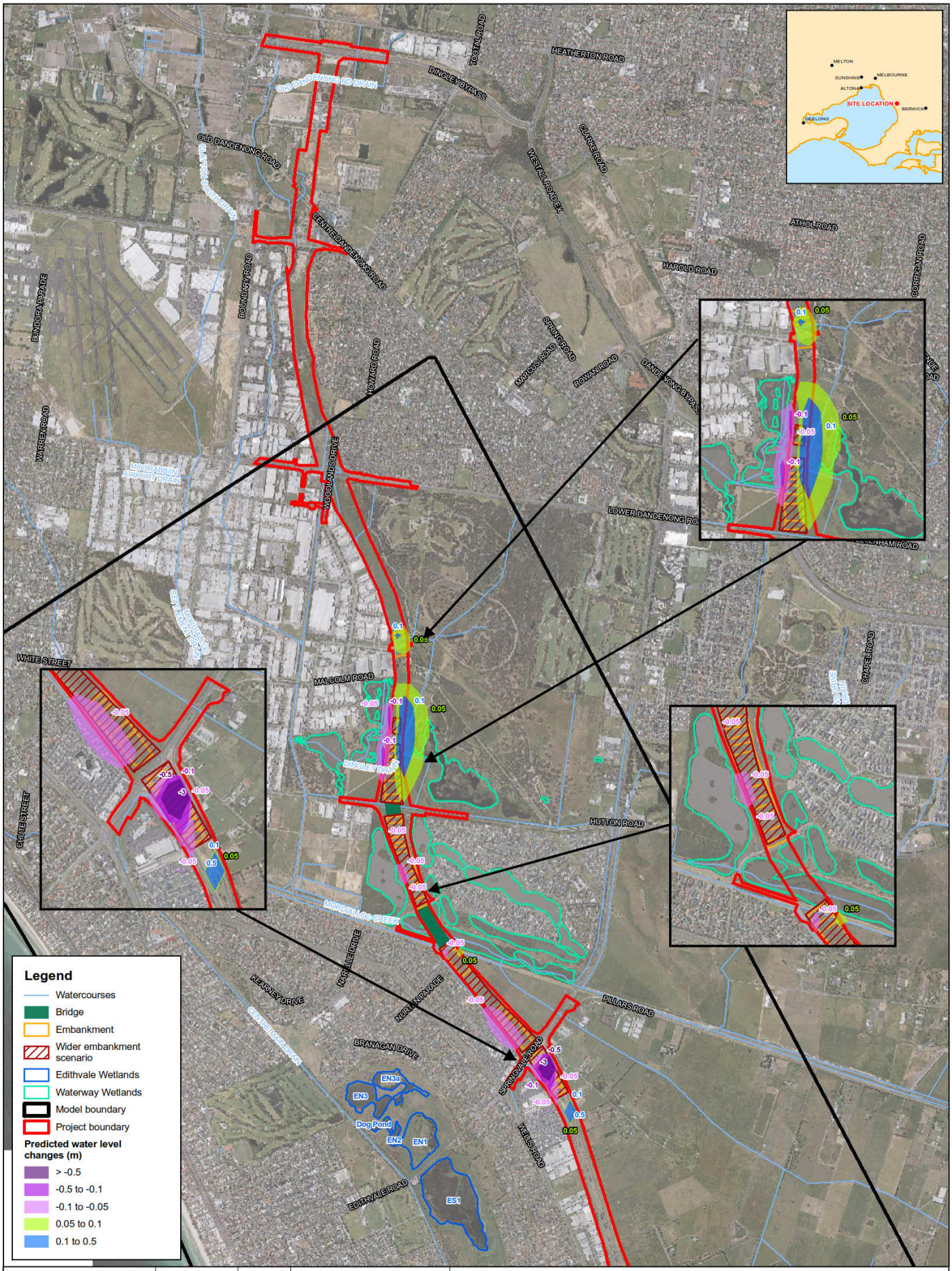
Tel: +61 2 9272 5100
Fax: +61 2 9272 5101
www.wsp.com

level. The sensitivity run described in this memorandum simulates the embankment height to a maximum height of 15 m agl.

The area was slightly larger than the embankment area that was originally modelled for the EES on Figure 1 ('wider embankment scenario'). As such, the zero recharge zone and zero evaporation zones were extended slightly to include the entire 'wider embankment area'.

As the hydraulic conductivity decreases, there is an increased impact to groundwater levels as expected, however, these impacts are still well within the natural variation and are predominantly contained within the footprint of the proposed road. Greater drawdown (of 3 m) occurs at the pumping bore in the southern embankment, but does not extend beyond the embankment footprint.

This approach to assessing the inclusion of the additional embankment height (9 to 15 m) is assumed satisfactory in its conservatism and the results from the steady state model adequately demonstrate "no meaningful increased impact" on the Edithvale Wetlands. It should be noted that when dealing with 5 cm level predictions of impact the outcome is indicative at best, considering natural variations/fluctuations are far in excess of these scales of magnitude.



Map: 2135645A_GIS_1413_A	Author: AS		
Date: 3/09/2018	Approved by: AS		

0 250 500 m

1:25,000

Coordinate system: GDA 1994 MGA Zone 55

Scale ratio correct when printed at A3

Data source: VicRoads. Copyright © The State of Victoria, Department of Environment, Land, Water & Planning 2018

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MAJOR ROAD PROJECTS AUTHORITY

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Figure 1

Predicted groundwater table changes (Steady state scenario) for model scenario with greater hydraulic conductivity reduction under a larger embankment area

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