REPORT

Environmental Evaluation - Kelsey Creek Landfill

Response to Notice STAT1235 - Kelsey Creek Landfill

Submitted to:

Whitsunday Regional Council
83-85 Main Street
Proserpine
QLD 4800

Submitted by:

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1790603-002-R-Rev0 Kelsey Creek Landfill Environmental Evaluation STAT1075

21 August 2018



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1.0 INTRODUCTION

Golder Associates Pty Ltd (Golder) were engaged by Whitsunday Regional Council (WRC) to provide support in responding to a Department of Environment and Science (DES) Statutory Notice STAT1235 "Notice to conduct or commission another environmental evaluation" dated 2 November 2017, and the agreed terms of reference documented in Golder Associates proposal P1790603-002-L-Rev1 dated 12 December 2017. These documents are presented in Appendix A.

Collection and laboratory analysis of additional soil, groundwater, surface water samples to support this report was undertaken by WRC. WRC also compiled the investigation and monitoring data sets that were used by Golder for the preparation of this report.

2.0 DESCRIPTION OF SITE & SURROUNDING ENVIRONMENT

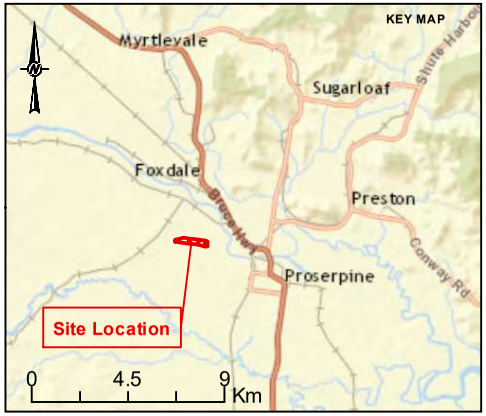
2.1 Site Identification

The site is identified in Table 1, the site setting shown in Figure 1.

Table 1: Site Identification – Kelsey Creek Landfill

Item	Description
Address	Kelsey Creek Road, Proserpine QLD 4800
Lot and Plan	Land parcel descriptions, as shown in the EA, and on Figure 1. ■ Lot 160 Plan SP171910 ■ Lot 277 Plan SP113325 ■ Lot 299 Plan SP113325
Area	The total land parcel area is approximately 32.1 hectares
Local Government Area	Whitsunday Regional Council
Tenure	Reserve
Zoning	Community facilities





LEGEND

Watercourses

Road Type

Main Road

Local Road

Railway

Site Boundary

Coordinate System:
GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

0 100 200 300 400 500
1:10,000 @ A3 METRES

NOTE(S)

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)

Watercourse, Roads, Railway: © State of Queensland (Department of Natural Resources and Mines), 2017
Site Boundary © State of Queensland (Department of Natural Resources, Mines and Energy), 2018

CLIENT
WHITSUNDAY REGIONAL COUNCIL

PROJECT
KELSEY CREEK LANDFILL - ENVIRONMENTAL EVALUATION

TITLE
SITE LOCATION AND SURROUNDING ENVIRONMENT

CONSULTANT
GOLDER

DD/MM/YYYY	19/08/2018
DESIGNED	DC
PREPARED	DC
REVIEWED	KC
APPROVED	KC

PROJECT NO.	CONTROL	REV.	FIGURE
1790603	002-R	0	1

2.2 Surrounding Land use

The site is located approximately 1.5 km north-west from the outskirts of the township of Proserpine. Land use surrounding the site is summarised in Table 2, and shown in Figure 1.

Table 2: Kelsey Creek Landfill - Surrounding Land use and Nearby Sensitive Receptors

Direction	Land Use	Description	Nearest Sensitive Receptor(s)	Direction and Distance to sensitive receptor
Onsite	Commercial / industrial	Pump station – separate land parcel	N/A	N/A
North	Commercial / industrial - Agriculture	Irrigated land	Residential / Agricultural	~ 670m N
	Waterway	Tributary of Lagoon Creek	Onsite	Crosses eastern end of site and discharges offsite to the south
	Waterway	Proserpine River	Proserpine River	~ 1.5- 2.5km N
East	Recreational Open space	Sports fields	Clubhouse facilities	~50 m E
	Residential	Rural Residential / Farmhouse Kelsey Creek Rd & Crystal Brook Rd	Residential	~500 m E
	Commercial / Industrial	Council works depot & WWTP Pound Yard Road	Council buildings	600m E
	Commercial / Industrial – Agriculture	Sugar cane	N/A	N/A
	Waterway	Proserpine River	River	~930 m E
South	Commercial / Industrial – Agriculture	Sugar cane	N/A	N/A
	Commercial / Industrial	Waste stabilisation lagoons or other similar water treatment ponds	N/A	~1.5km S
	Waterway	Lagoon Creek Tributary transits eastern end of site in a north south orientation and converges with main body and travels S-SE	Lagoon Creek	~300 m S of site 300-1.5km S-SE
West	Onsite Recreational open space	Pony Club – land leased by Council to Pony Club forms part of EA	Pony club buildings in west of site	Onsite
	Waterway	Lagoon Creek	Lagoon Creek	Lagoon Creek

Direction	Land Use	Description	Nearest Sensitive Receptor(s)	Direction and Distance to sensitive receptor
				Tributary transits western end of site in a north south orientation and converges with main body and travels S-SE
	Commercial / Industrial	Power – Substation & buildings	Buildings	~350km W
	Commercial Industrial – Agriculture	Grazing lands	N/A	> 3km W

2.3 Historical Aerial Photograph Review

Historical Aerial Photographs of the site and surrounds are presented in Appendix B.

Landfilling activities appear to have been contained within the site footprint, with waste disposal observed to be limited to the known landfill cells (i.e. original waste mound and lined landfill cells).

- **1945 (MAP01204911)**
  - Site – undeveloped and there is no evidence of land disturbance.
  - Site surrounds – generally undeveloped except for the area to the north of the site which is subject to intensive agriculture, as are areas to the south west and adjacent to the Proserpine River.
- **1960 (QAP1145126)**
  - Site - Minor evidence of landfilling / quarrying in the central portion of the site and on the eastern part of the site adjacent to Lagoon Creek Tributary (East) on its western side. The remainder of the site is generally undeveloped with no indications of land disturbance.
  - Site surrounds - Evidence of land disturbance is present to the east of the site and Lon the eastern side of Lagoon Creek tributary (East). Intensive agricultural activity to the north of the site.
- **1970 (QAP2215073)**
  - Site – landfilling activity clearly identifiable and expanded, within the eastern portion of the site adjacent to the Lagoon Creek tributary (East).
  - Site surrounds – intensive agriculture to the north, Council depot developed to the east, township development visible to the southeast, undeveloped to the south, agricultural development to the west / southwest.
- **1975 (QAP2971010)** – consistent with earlier photography
- **1988 (QAP3722338)**
  - Site – consistent with above, footprint of landfilling has expanded in situ. Some areas east of the landfill footprint (central northern portion of the site) may have been disturbed, as vegetation cover (trees) has reduced.
  - Surrounds - Generally consistent with previous except for more intensive agricultural development to the south and southwest. Significant modification of surface drainage systems by development of irrigation canals evident throughout agricultural areas in all directions.

- **1993 (QAP5367110)**
  - Site – landfill footprint at the eastern end of the site expanded to cover most the available area between the northern and southern boundaries. Footprint also expanded to the west. Land disturbance evidence to the west of the landfill footprint, most likely for sourcing soil material for cover soil placement at the landfill. Development of the water pump station west of the borrow area is visible. Various vehicle tracks around the site.
  - Surrounds- intensity of agricultural activity increasing, remainder consistent with previous.
- 2018 – Google Earth
  - Site – landfill mound occupies majority of eastern portion of the site (approximately 35% of total site area) and extends close to northern and southern boundaries. Water storage pond visible adjacent to eastern boundary and Lagoon Creek Tributary (East). Well vegetated mounds (3) located to the south of the water storage pond. Landfill operations (transfer station and resource recovery) occupy approximately 20% of site area west of the landfill mound. Remainder of the west of the site is occupied by Pony Club (under least from Council and not under Councils' operational control) and a water retention dam adjacent to western boundary.
  - Surrounds – Intensive agricultural development to the north and south of the site. Community open space use visible to the east of the site (sports fields, cemetery), beyond which lies commercial industrial land use (Council Depot) and agricultural land use. Remainder generally consistent with previous imagery.

2.4 Site Infrastructure

A summary of the site infrastructure is presented in Table 3, and shown on Figure 2.

Information gathered which shows leachate and stormwater infrastructure is presented in Figure 3, Appendix C.

Table 3: Kelsey Creek Landfill - Infrastructure Summary

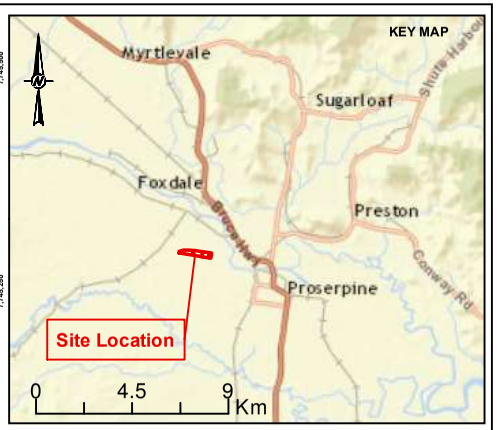
Infrastructure	Description	Approx. Area
Access & Weighbridge Operations	■ The site is enclosed by a chainmesh fence. ■ Public access to the site is controlled by lockable gates. ■ Weighbridge present at site entrance.	Weighbridge 0.01 ha Access 0.2 ha Total 0.233698 ha
Historical Cell / Waste Mound	■ Potential unlined waste burial trenches and raised waste mound located across eastern portion of site. ■ No known landfill gas collection system ■ Leachate collection system – subsurface leachate collection trenches understood to be installed (Maunsell Aecom , 2008). Historically connected to sewer for leachate disposal but disconnected in 2011 (Whitsunday Regional Council , Undated.). ■ WRC indicated that the non-engineered waste mound has been covered by final capping understood to comprise low permeability clay. ■ Identified as a source of potential contaminants through subsurface seepage.	5.7 ha

Infrastructure	Description	Approx. Area
Engineered Waste Cells (1-4)	■ Four engineered cells constructed within central portion of the site directly adjacent to the unlined waste mound. ■ Cell 1 & Cell 2 understood to be filled to capacity and no longer accepting waste. WRC indicated that this area has been covered by interim capping soils. ■ Cell3 has been mostly filled but is understood to have some remaining airspace capacity. ■ Active waste disposal activities currently limited to Cell 4. ■ No landfill gas collection / flaring system installed within the engineered cells. ■ Leachate collection system installed in each cell (refer below). ■ Stormwater management structures installed (refer below). ■ Identified as a source of potential contaminants through subsurface seepage.	Cell 1 & 2 3.8 ha Cell 3 1.2 ha Cell 4 1.2 ha Total Cell 1-4 6.2 ha
Future Cells 5 & 6	■ Footprint of future waste cell development currently occupied by resource recovery stockpiles and daily cover stockpiles.	2.7 ha
Leachate Management	■ Leachate collection drains (subsurface) understood to be installed around the perimeter of the historical cells / waste mound. ■ Engineered waste cells gravity drain to two leachate pump stations serving Cell 1 & Cell 3 (northern boundary) and Cell 2 & Cell 4 (southern boundary). ■ Leachate Management Strategy / Plan for the site not available. ■ General layout of leachate pumping, storage and irrigation system shown on Figure 3 and presented in Appendix C. ■ Leachate pumped by submersible pumps from sumps to a 22kL leachate holding tank on top of the waste mound / Cell 2. ■ One pump runs at a time to fill the holding tank, based on sensors that operate at 5% and 90% to pump and fill or irrigate and empty. ■ Understood that tank does not have a high-level alarm, is un-bunded, and has high-level overflow point. ■ Leachate disposal occurs through irrigation across top of the older waste mound area. Irrigation area is bunded to contain potential run-off. ■ Information on the irrigation capacity of mound / soils not provided. ■ Leachate collection drains (subsurface) understood to be installed around the perimeter of the historical cells / waste mound, and cells, to leachate collection sumps. Leachate sump 1/3 at intersection of cells 1 & 3 on north side landfill – collects leachate from cells 1 &3 Leachate sump 2/4 on southern side landfill – collects leachate from cells 2 & 4 Leachate pumped by submersible pumps from sumps (Sump 1/3 & Sump 2/4) to a 22kL leachate holding tank on top of the waste mound / Cell 2One pump runs at a time to fill the holding tanks, based on sensors that operate at 5% and 90% to pump and fill or irrigate and empty. Understood that tank does not have a high-level alarm, and is un-bunded, and that there is a high-level overflow point. Irrigation of leachate is over top of the consolidated waste mound (■ Evidence of leachate seepage was observed near the pump station and leachate sump services Cell 1/Cell 3. Ground conditions were soft adjacent to northern boundary and Kelsey Creek Rd.	1.85 ha

Infrastructure	Description	Approx. Area
	■ Identified as a source of potential contaminants through subsurface seepage and stormwater run-off.	
Stormwater Management	■ Refer to Figure 3 and Appendix C – F001 Current Stormwater Management Structures, from (Golder Associates , August 2012) for locations of ponds and swales. ■ Water storage pond – SED1 – north-eastern corner of site. ▪ Discharges to Lagoon Creek tributary east. ▪ Receives runoff from – Northern swale (northern side of Cell 3, Cell 1 & Historical cells / mound) – Northern access track drain, – Southern access track drain, – Southern swale-east, – Cell 1 swale – Cell 2 swale ■ Water storage pond – SED 2 – located within transfer station area. ▪ Discharge flows west along the site boundary before discharging off site to Lagoon Creek West (upgradient of monitoring point SW6). ▪ Receives runoff from – Waste transfer station area. – Green waste hardstand area – Domestic receival area. – Western swale (Green waste, and site access road) – Hardstand swale – drains hardstand – Southern Swale – drains • Cell 3 & Cell 4 • Concrete stockpile area, • Daily cover soil stockpile area, • Hardstand area ■ SED1 and SED 2 identified as sources of potential contaminants through direct discharges into Lagoon Creek.	
Domestic Receival Area	■ Tipping point for domestic waste from trailers etc (into back of a tipper truck). ■ Avoids access by the public into the waste disposal cells area, and interaction with heavy plant and equipment.	0.2 ha
Contractors Sheds	■ Site office / amenities. ■ Minor maintenance activities.	
Resource Recovery & Regulated Waste	■ Located east of site access road on hardstand. ■ Collection area for ▪ Minor volumes of hydrocarbons / chemicals stored in this area – Oils, fuels, – Drum muster – Batteries – Fire extinguishers, – Gas cylinders, – e-waste storage, ▪ Recyclables storage – cans & bottles – carboard & paper	0.1 ha

Infrastructure	Description	Approx. Area
	▪ Regulated waste – Grease trap waste separation & processing – Tyres ■ Identified as potential source of contaminants through run-off to hardstand swale, and then to southern swale.	
Scrap metal	■ Materials recycling – stockpiling of scrap metal for processing. ■ Metal sources checked before acceptance (e.g. fridges degassed, fuel/oils removed from vehicles, etc.) ■ Stormwater runoff to the southern swale ■ Identified as source of potential contaminants through subsurface seepage and surface water flows	0.1 ha
Green waste Stockpile Area	■ Hardstand area used to stockpile and process green waste ■ Identified as source of potential contaminants (nutrients, sediment) though stormwater run-off.	0.4 ha
Concrete/ Construction & Demolition Waste Stockpile Area	■ Hardstand area used for the stockpiling and processing of construction & demolition wastes for resource recovery. ■ Non-engineered hardstand with no formal leachate / stormwater runoff management system. ■ Mobile plant used for concrete crushing, etc.	0.3 ha
Day cover soil stockpiles	■ Day cover is trucked to site and stockpiled for use. ■ Identified as potential source of sediment runoff, stormwater discharges to new cell swale and southern swale.	0.3ha
Fuel and Oil Storage/Use	■ No bulk fuel or oil storage occurs on site. ■ Minor quantities of waste oils for recycling (refer above). ■ Refuelling of plant and equipment generally occurs via mobile service truck on the waste mound.	
Underground assets / service trenches	Dial Before You Dig Services Search results indicated: ■ Power – no underground services or pits on site, or immediately adjacent to site boundary. Above ground assets (poles) present. ■ Water ▪ Water main at western end of operations area, adjacent to western boundary of waste transfer station (Mackay Regional Council) and discharging offsite. Unlikely to be impacted by site operations due to distance from landfill mounds. ▪ Water main – on southern side of Kelsey Creek Road, in the road reserve, outside the site boundary. Up-gradient from site. ■ Communications / OFC – no underground services on site. ■ Sewer – main located on northern side of Kelsey Creek Road, in the road reserve, outside the site boundary (likely remnant historical sewer main for leachate transfer to wastewater treatment plant). ■ Some underground services trenches present on site that have potential to act as preferential contaminant migration pathways for leachate, or leachate impacted media. However, these trenches are well removed from the main leachate sources on site (pipes, sumps, pumps, and the cells), and are therefore considered to be low risk for conveyance of leachate off-site.	





LEGEND

Road Type
- Watercourses
- Main Road
- Local Road
- Railway
- Site Boundary
- MSES Regulated Vegetation Category R

Site Layout
- Leachate Holding Tank
- Leachate Sump 1
- Leachate Sump 2
- Leachate Irrigation Area
- Leachate Irrigation Area
- Mackay Regional Council water treatment
- Mackay Regional Council Water Main Below ground
- Sediment Pond SED2
- Sedimentation water storage Pond
- Domestic Receival
- Historic unlined Cell mound
- Greenwaste
- ScrapMetal
- Construction and Demolition
- Day Cover Stockpiles
- Resource Recovery Hardstand
- Unknown Waste Mounds
- Site access weighbridge
- Weighbridge
- Pony Club

Coordinate System:
GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

0 50 100 150 200 250
1:6,000 @ A3 METRES

NOTE(S)
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)
Watercourse, Roads, Railway: © State of Queensland (Department of Natural Resources and Mines), 2017
Site Boundary © State of Queensland (Department of Natural Resources, Mines and Energy), 2018
MSES Regulated Vegetation Category R Department of Natural Resources and Mines MSES: Department of Environment and Heritage Protection.

CLIENT
WHITSUNDAY REGIONAL COUNCIL

PROJECT
KELSEY CREEK LANDFILL - ENVIRONMENTAL EVALUATION

TITLE
KELSEY CREEK LANDFILL - SITE LAYOUT PLAN

CONSULTANT
GOLDER

DD/MM/YYYY	19/08/2018
DESIGNED	DC
PREPARED	DC
REVIEWED	KC
APPROVED	KC

PROJECT NO.	CONTROL	REV.	FIGURE
1790603	002-R	0	2

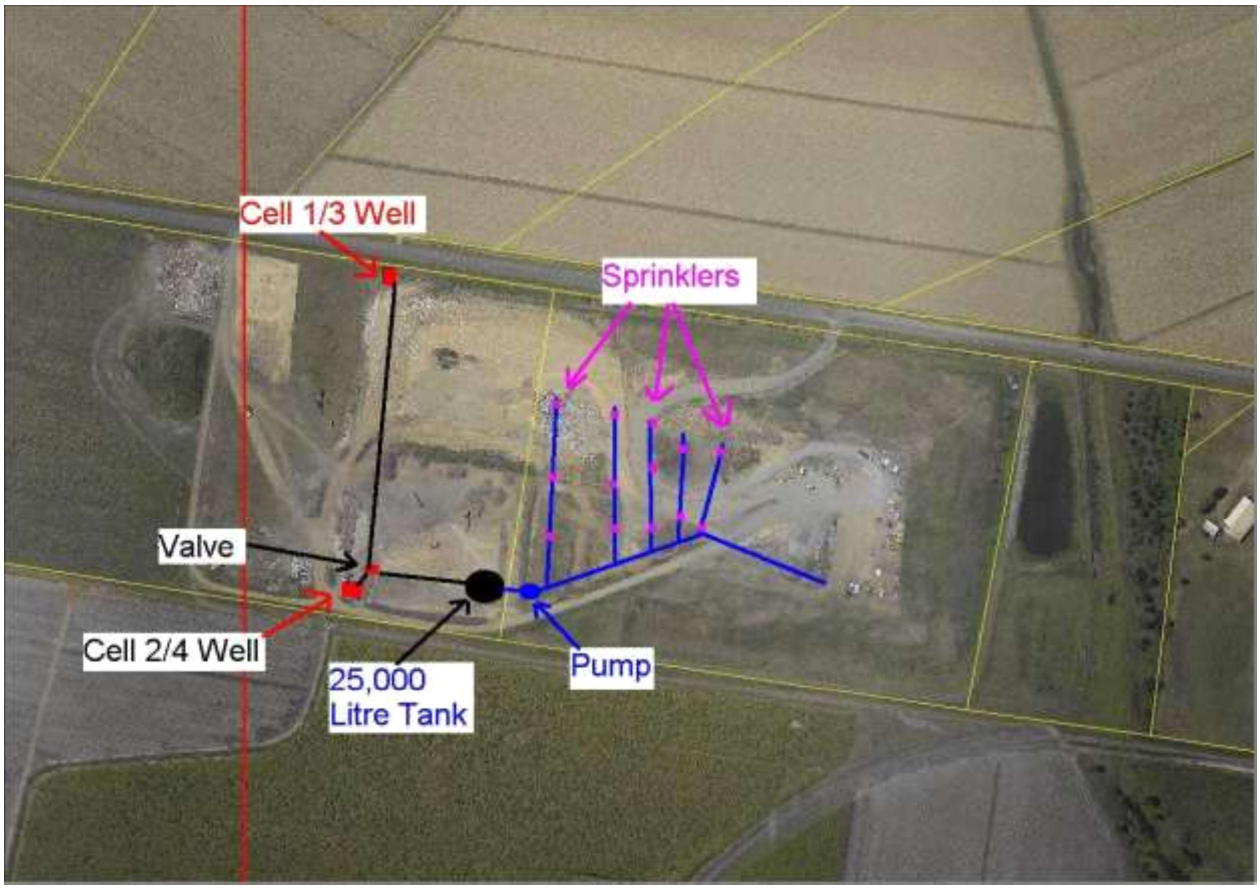


Figure 3: Kelsey Creek Landfill - Leachate Irrigation System (Whitsunday Regional Council , 2017)

2.5 Climate Conditions

Proserpine and the surrounding area are within Australia's monsoon zone, dominated by a prolonged 'cooler' dry season from March/April to November/December, and a 'hotter' wet season from December/January to February/March. The Proserpine Region is located within a 'wet' tropics region, with annual rainfall typically higher than that of the surrounding 'dry' tropics regions located to the north around Townsville and Bowen.

Key monthly rainfall and pan evaporation data available for the Proserpine area in the period from 1871 to 2018, has been summarised, and is presented graphically in Figure 4.

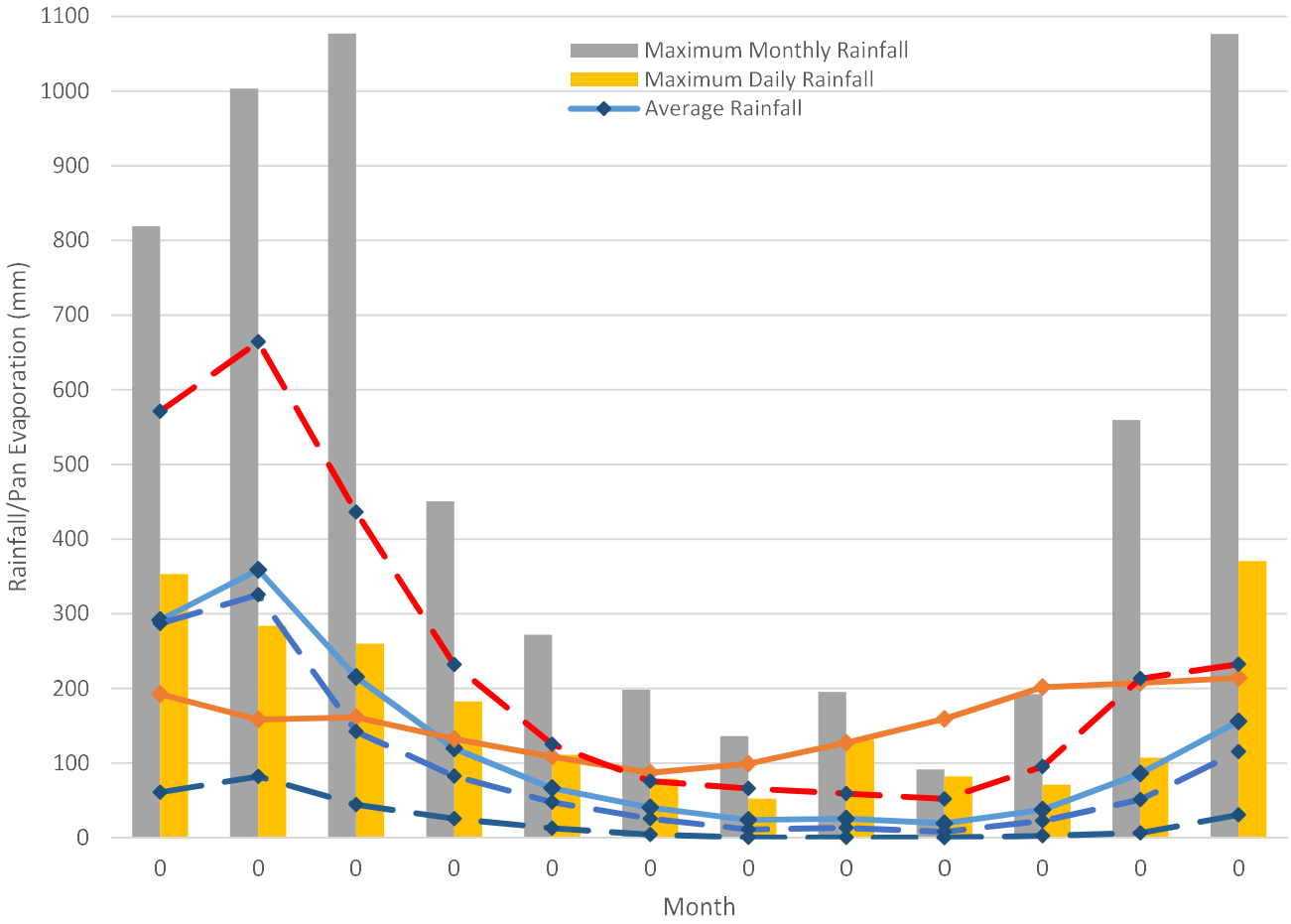


Figure 4: Monthly Climate Data Summary

Annual rainfall conditions taken for the Proserpine area, and pan evaporation for the closest site (Bowen) in the period from 1871 to 2015. A summary is presented in Table 4.

Table 4: Annual Climate Data Summary

Description	Average	50th Percentile	90th Percentile	Maximum
Annual Rainfall	1, 429.2 mm	1,386.8 mm	2,048 mm	2,572.8 mm (2010)
Annual Pan Evaporation	1,819 mm	1,813 mm	1,981 mm	2,402 mm (1975)

In summary:

- Maximum monthly rainfall can be greater than four times the monthly average rainfall.
- Maximum daily rainfall can be greater than double the average monthly rainfall.
- The 90th percentile monthly rainfall is typically double the average monthly rainfall and double the median (50th percentile) of monthly rainfall.
- Monthly pan evaporation exceeds monthly rainfall as follows:
  - Average monthly rainfall in all months except January, February and March.
  - Median (50th percentile) monthly rainfall in all months except January and February.
  - 90th percentile monthly rainfall is exceeded by pan evaporation between June and October.

- Average annual pan evaporation is approximately 400 mm greater than average annual rainfall.

The site is expected to have net evaporation except in January, February and March, when net rainfall exceeds evaporation, and monthly average rainfall volumes are up to four times that of the annual average.

The "wet-season" months of January, February and March, and those following it, are expected to have the highest potential for stormwater releases from site, and for leachate breakthrough to occur (due to incident rainfall).

2.6 Topography and Drainage (Surface Water)

The site is located within the relatively flat alluvial floodplain of the Proserpine River as shown on Figure 1.

Although the Proserpine River is located between 1 km to 1.5 km from the eastern and northern boundaries of the site respectively. Kelsey Creek Landfill is mapped by Queensland Globe as the Kelsey Creek, Lethe Brook (B) sub-catchment area of the Whitsunday Water Plan.

Two surface water courses, which are tributaries of Lagoon Creek, flow through the site, at its eastern and western ends, hereafter referred to as:

- Lagoon Creek Tributary (east)

  Drains an intensive agricultural land use area, starting approximately 700m north of the site, passes adjacent to the eastern site boundary, joins with another tributary draining agricultural land and the sports fields, approximately 400 m south of the site, before a confluence with Lagoon Creek a further 1km downstream. The catchment area is all intensive agricultural land use (primarily cane land) throughout the additional 6km to the confluence of Lagoon Creek with the Lethe Brooke.

- Lagoon Creek Tributary (west)

  Drains intensive agricultural land use area, starting approximately 1.7km to the north of the western end of the site, passes adjacent to the western site boundary, and joins with Lagoon Creek approximately 250m downstream of the southern boundary of the site. Lagoon Creek joins with the eastern tributary approximately 1.8km downstream of the confluence of the western tributary with Lagoon Creek.

It is noted that historical reports and plans for the site have variously identified these two tributaries to Lagoon Creek variously as Dyke Gully, Pig Creek, and Tailing Gully Creek. Adopted naming conventions were based on currently available Queensland Globe mapping information. It is noted that Queensland Globe identifies Tailing Gully Creek is to the west of site, discharging directly to Lethe Brook, and Pig Creek to the south-east of the site, close to the convergence of Lagoon Creek with the Lethe Brook.

Site elevation is less than 20m AHD. Contour elevation to the south of the around Lagoon Creek is approximately 10 m to 15m AHD.

Lagoon Creek flows in a generally south-easterly direction to the south of Proserpine, in sympathy with decreasing elevation to the south-east. The water course then becomes Lethe Brook, approximately 6km downstream of the confluence of the western and eastern tributaries with Lagoon Creek, before flowing eastwards and discharging into the Proserpine River delta at the coastline (straight line distance of approximately 12.5 km).

Drainage surrounding the site generally occurs as sheet flow within cane land that discharges into either the western or eastern tributaries of Lagoon Creek. There is no active diversion of the upstream catchment stormwater around the site, however, based upon a brief review of aerial photography and a site inspection, external stormwater run-off would generally not flow into operational areas of the site as a result of the following conditions:

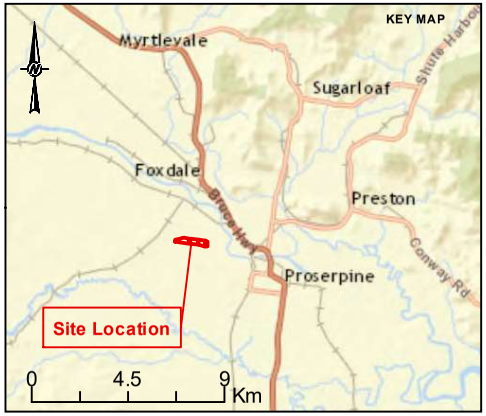
- Northern Boundary: Upgradient sheet flow is intercepted by the Kelsey Creek Road table drains that discharge into either eastward into or westwards into respective tributaries of Lagoon Creek.
- Eastern Boundary: Proximity of Lagoon Creek tributary (east)
- Western Boundary: Proximity of Lagoon Creek tributary (east)
- Southern Boundary: Topography of the floodplain appears to slope southwards away from the site.

Review of the council planning scheme flood hazard overlay issued in 2014 indicated that the land within Lot 299 on SP113325 that the Lagoon Creek tributary (east) creek passes through is located within a flood hazard area. There is potential for stormwater ingress to or flooding impact to the water storage pond SED1 in the east of the site.

The Lagoon Creek tributaries, and Lagoon Creek are understood to be ephemeral watercourses, however at the time of the site inspection it was noted that the western tributary was highly modified, with barrages constructed to retain water flow up-gradient of the confluence with the eastern tributary.

It is not clear when the current surface water monitoring program was designed, however the monitoring locations are identified in (Woodward-Clyde, May 1999), with the same naming, and as such it is concluded that these surface water monitoring points have existed at least since that time.





LEGEND

Proserpine

Locality

- Mount Julian
- Proserpine
- 5m Contours
- Railway

Road Type

- Main Road
- Local Road

Hydrologic Features

- Watercourses
- Lakes
- Reservior
- Site Boundary

Coordinate System:
GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

0 500 1,000 1,500 2,000
1:40,000 @ A3 METRES

NOTE(S)

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)

Watercourse, Roads, Railway: © State of Queensland (Department of Natural Resources and Mines), 2017; **Site Boundary, Locality** © State of Queensland (Department of Natural Resources, Mines and Energy), 2018; **Reservoirs** © State of Queensland (Department of Natural Resources and Mines) 2016; **Lakes** Geoscience Australia

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PROJECT
KELSEY CREEK LANDFILL - ENVIRONMENTAL EVALUATION

TITLE
SITE AND REGIONAL TOPOGRAPHY & DRAINAGE

CONSULTANT
GOLDER

DD/MM/YYYY	19/08/2018
DESIGNED	DC
PREPARED	DC
REVIEWED	KC
APPROVED	KC

PROJECT NO.	CONTROL	REV.	FIGURE
1790603	002-R	0	5

2.7 Geology & Soils

Regional mapping of surface geology of the site documented by Queensland Globe, detailed surface geology layer indicates that:

- Site soils are mapped as Alluvium (TQr-QLD), comprising clay, silt, sand and gravel and flood-plain alluvium.
- Acid sulfate soils are not present at the site based on risk mapping.
- Whitsunday Coast Area (1:100,000 scale) soil and land suitability mapping identified site soil types as Koolachu generally comprising sand or loam over sodic clay. This soil is described as 15 cm to 40 cm coarse textured A horizon over acid grey medium heavy clay B horizon. Sandstone may occur below 110 cm.

(GeoSquare, July 2017) described the soil setting of the site as follows:

> *"The Kelsey Creek landfill is situated in sodosol soil setting (Hardy, 2003). Main soil types are Slater (Sk), Koolachu (Ko) and Foxdale (Fo) that surround or underlay the landfill (Figure 2). Slater soil type is located to the east, north, and south, with a small corridor on the eastern flank of the landfill site overlying it. The Koolachu soil type is overlain by the main landfill structure and extends to the west where it abuts the Slater soil type. The Foxdale soil type is located east of the landfill site and extends nearly to the river where alluvium deposits are dominating the soils types.*
>
> *Soil characteristics were (Hardy, 2003)*
>
> - *Slater - Moderate to deep, sodic duplex soil, with a sandy loam to sandy clay loam topsoil, bleached over an acid to neutral, pale grey, clay subsoil (Subnatric, grey sodosol, Dy3.33).*
> - *Koolachu - Moderately deep, duplex soil with a bleached, sandy loam topsoil, over an acid, grey, clay subsoil (Mesonatric, grey sodosol, Dy3.31).*
> - *Foxdale - Deep duplex to gradational soil with a clay loam topsoil over an acid to neutral, grey to dark grey, light medium to medium heavy clay subsoil (Grey chromosol, Dy3.12, Gn4)*
> - *Classification of soil depths are: moderate depth 0.5 to <1 m and deep 1 to <1.5m Sodosols have abrupt clay increase down the profile and high sodium content and can result in seasonally perched water table where these soil types are dominant. Sodosols are found in poorly drained sites with rainfall between 50 mm and 1100 mm. It has very low agricultural potential with high sodicity leading to high erodibility, poor structure, and low permeability. These soils have low to moderate chemical fertility and can be associated with soil salinity.*
>
> *Chromosols have a strong contrasting texture and are not strongly acidic or sodic in the upper B horizon. These soils are found in imperfectly drained sites (yellow and grey chromosol) where rainfall is between 250 mm and 900 mm. They are also found in well-drained sites (brown and red chromosol) with rainfall between 350 mm and 1400 mm. Interestingly, the Foxdale soil type grey to dark grey with a light medium to medium heavy clay subsoil indicating it will be imperfectly drained site material. These soils have moderate agricultural potential with moderate chemical fertility and water-holding capacity. They can be susceptible to soil acidification and soil structure decline."*

It is understood that the original groundwater monitoring bores were installed on site in 1999 by Woodward Clyde (Woodward-Clyde, May 1999),however, the full report and borehole logs could not be located by WRC for review as part of the current investigation. As such, detailed summary of the sub-surface stratigraphy on the site could not be completed. The lack of regional and site-specific subsurface stratigraphy information is a key data gap for the assessment.

An internal WRC memorandum, dated 14 September 2004, is understood to provide a summary of data from the original borehole logs, and is presented in Appendix D. Whilst this is not a primary source document, for the purposes of this report it has been used as a source of information on actual subsurface site conditions, comprising:

- Clay and sand materials in shallow soils overlying sandstone. There is insufficient information available to infer stratigraphy depths.

2.8 Groundwater

2.8.1 DNRM Groundwater Database Review

A review of publicly available DNRM groundwater database information was undertaken initially within a 500m radius of the site and returned one registered borehole, RN12200038, located on the northern boundary of the site. The search area was expanded to a 1km radius from the site, one additional monitoring bore was identified south of the site, RN162615 (drilled 2016, abandoned and destroyed), as outlined in in the figure shown in Appendix E.

Beyond the 1km radius, there are large numbers of registered monitoring bores to the north-north east of the site, associated with the Proserpine River, and hydraulically upgradient from the site. There are also many registered groundwater bores to the south west of the site, associated with the township of Proserpine, and generally hydraulically down gradient of the site that may represent potential sensitive receptors to groundwater migration from the site.

DNRM data (Appendix E) for the two identified bores located within 1 km of the site is summarised in Table 5

2.8.2 Existing Site Monitoring Bores

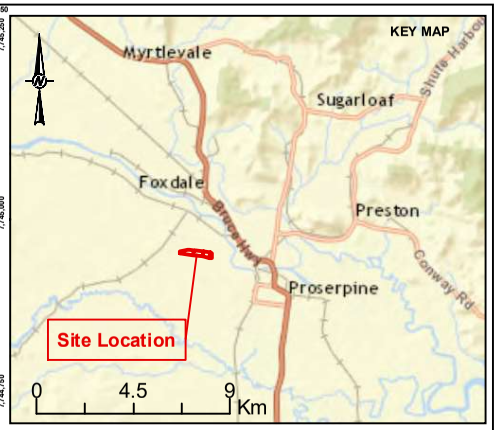
On-site Groundwater Monitoring Locations are shown in Figure 6.

Available site data (WRC memorandum 2004, refer Appendix D) for each location is summarised in Table 5.

Table 5: Groundwater Database Review - Regional Groundwater Conditions & Users

Bore ID	Status	Aquifers	Screen	Geology	Location	Purpose for assessment
DNRM Monitoring Bores – Current & Historical						
RN12200038	Current	6.0-7.0	Not recorded	Alluvium	~15m N, N side Kelsey Creek Road	Upgradient / Background
RN162615	Historical	Not recorded	6. 0-20.0 (screen)	Alluvium	Approx. 0.9km S	Background
On-site Monitoring Bores						
MW1	Current	Not available	7-10 (screen) 5.2-10 (gravel pack)	Sandstone	NW corner of site	Downgradient
MW2D	Current	Not available	11.8-14.8 (screen) 8.5-14.8 (gravel pack)	Sandstone	SE corner of site	Downgradient
MW2S	Current	Not available	3-6 (screen) 2.3-6 (gravel pack)	Alluvium	SE corner of site	Downgradient
MW3	Current	Not available	7-10 (screen) 5.5-10 (gravel pack)	Sandstone	S of site	Downgradient
MW4	Current	Not available	5.5-8.5 (screen) 4.5-8.5 (gravel pack)	Alluvium	NE corner of site	Downgradient
MW5	Current	Not available	9-12 (screen) 5.7-12 (gravel pack)	Alluvium and Sandstone	S of site	Downgradient
MW6		Not available	8-11 (screen) 5.5-11 (gravel pack)	Alluvium and Sandstone	W of site	
MW7	Current	Not available	5-8 (screen) 3.9-8 (gravel pack)	Sandstone	W of MW6	Potentially Background
MW8	Current		7-10 (screen) 6.4-10 (gravel pack)	Sandstone	W of MW7	BACKGROUND





LEGEND

Monitoring Locations

- Groundwater Monitoring Bore (MB)
- Water Storage / Sediment Pond (SED)
- Surface Water (SW)
- Leachate Sump (L)
- Watercourses

Road Type

- Main Road
- Local Road
- Railway
- Site Boundary
- Sediment Pond SED2
- Sedimentation water storage Pond

Coordinate System:
GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

0 50 100 150 200 250
1:7,500 @ A3 METRES

NOTE(S)

Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

REFERENCE(S)

Watercourse, Roads, Railway: © State of Queensland (Department of Natural Resources and Mines), 2017
Site Boundary © State of Queensland (Department of Natural Resources, Mines and Energy), 2018

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PROJECT
KELSEY CREEK LANDFILL - ENVIRONMENTAL EVALUATION

TITLE
MONITORING LOCATIONS

CONSULTANT
GOLDER

DD/MM/YYYY	20/08/2018
DESIGNED	DC
PREPARED	DC
REVIEWED	KC
APPROVED	KC

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2.8.3 Groundwater Levels

Groundwater levels have been monitored regionally in RN12200038 since 1974. The DNRM water level monitoring plot for this bore is presented in Appendix E.

Review of the long-term time-series plot for RN12200038 indicates that:

- Seasonal fluctuation in groundwater levels has been reducing in magnitude over time, with seasonal lows in groundwater level increasing, indicating an overall rise in groundwater levels over time. It appears that the groundwater table elevation has increased by approximately 7m AHD over a period of some 40 years.
- Peak groundwater elevations have remained relatively stable over time;
- Groundwater levels have generally fluctuated between 12 m to 14m AHD since 1996.

Monitoring data has been compiled for on-site groundwater monitoring bores over time at Kelsey Creek and is presented in Figure 7.

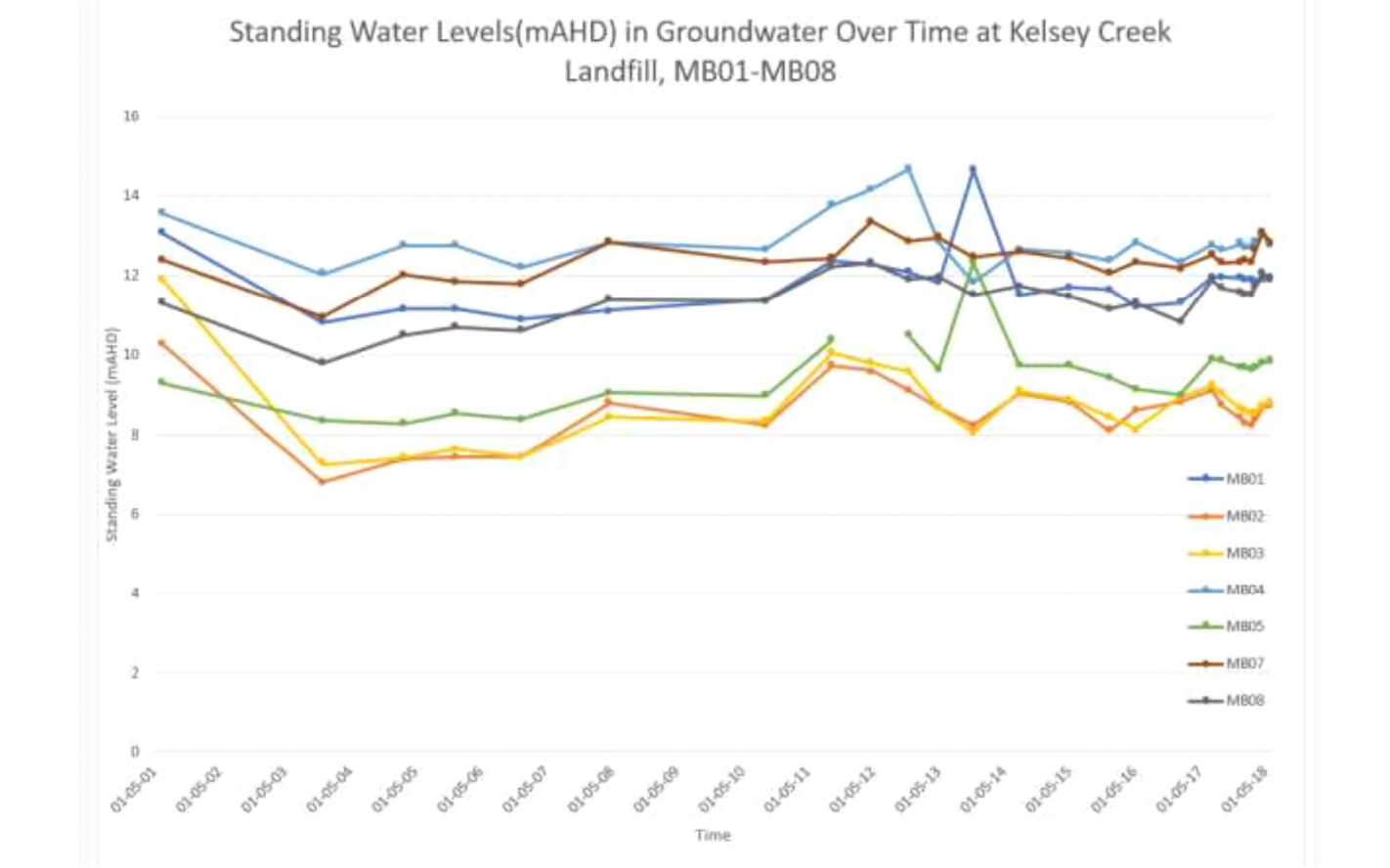


Figure 7: Kelsey Creek Landfill – Groundwater Elevations over Time – Site Monitoring Network

2.8.4 Regional Groundwater Quality

Water quality monitoring results for RN12200038 are presented in Appendix E, with key analysis parameters considered directly relevant to waste disposal activities summarised in Table 6.

Table 6: Summary of Regional Groundwater Quality – Regional DNRM Monitoring Bore

Bore NuMWer RN	Aquifer	Location	Purpose for Assessment	Monitoring Period	pH	Electrical Conductivity (µS/cm)	Nitrate (mg/L)	Zinc (mg/L)	Copper (mg/L)
RN12200038	Not available	~15 m north of site, across road	Upgradient	1988 to 2000	6.4-7.3	285 - 432	3.3 to 4.2	0.08	0.09

The review of available regional groundwater quality data for DNRM monitoring bores indicates:

- Low electrical conductivity.
- Slightly acidic to neutral pH.
- Elevated historical nitrate concentrations (note: the most recent result was approximately 18 years ago).
- Presence of copper and zinc at concentrations above the laboratory limit of reporting (note: the most recent result was approximately 18 years ago).

2.8.5 Groundwater Movement

Groundwater levels, corrected to mAHD were reviewed to infer groundwater flow direction, as shown in Figure 8, indicating that:

- Groundwater is generally flowing to the south-east, based on the higher elevations in MW8 & MW7 compared to the elevations in MW2, MW3 & MW5.
- MW8 is considered to represent background (upgradient) conditions. MW7 may also represent background conditions.

(GeoSquare, July 2017) reported that:

> *"The upper limit of the saturated hydraulic conductivity (K_{sat}) of the soils with potential contact with the landfill area is Sodosol K_{sat} 0.5 - 0.05 m/day and Chromosol 1-0.5 m/day."*

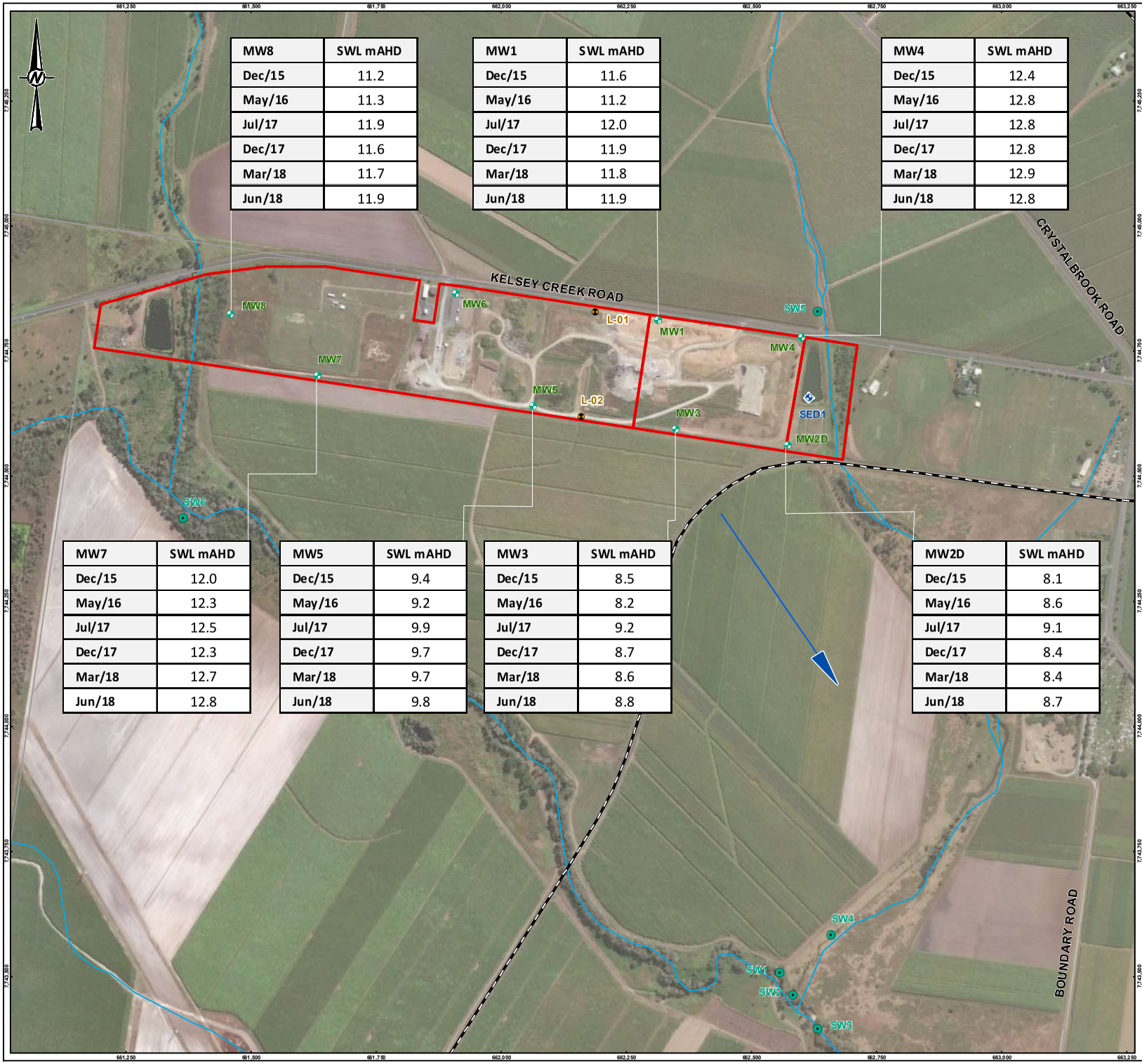
(GeoSquare, July 2017) also constructed a geological block model for the site, based on available drill regional drill data, and inferred that based on the constructed block model:

> *"the landfill site is underlain by a sandy layer, most probably Ko [Koolachu] soil type from soil mapping, and to the east a more dominant clay soil which is associated with Sk [Slater] soil type. Deeper sand formations are associated with competent sandstone layers that could occur as shallow as two metres below the landfill. For this assessment, this layer could have a permeability ranging from 0.01 - 8 m/d and was assigned a permeability of 1 m/d which is overly conservative due to the expected interbedded structure of semi-consolidated material with sandstone layers.*
>
> *Coarse weathered rock is reported, and for this analysis, it was assumed to be a weathered granite which is commonly called Grus. The grus is typically associated with clay like interfill such as illite or kaolinite. No smectitic or montmorillonite is present within this subsurface layer. The hydraulic permeability within this zone is limited and hydraulic conductivity of 1.2 m/day (Hutchison and Hicks, 1985)"*
>
> *Permeability testing in-situ, or in the laboratory, and/or aquifer testing on site was not completed as part of the current assessment.*

2.8.6 Regional Aquifer Descriptions

Kelsey Creek Landfill is located with the Whitsunday Groundwater Management Area (Department of Natural Resources, Mines and Energy, 2018). Due to the limited availability of suitable data it has not been possible to reliably describe regional aquifer conditions. Based on the limited information that is available, the on-site aquifer system is considered to comprise:

- A single semi-confined or unconfined alluvial aquifer system present within alluvial soils and potentially underlying sandstone.
- Groundwater elevations in the local area have risen in the order of 7 m over the past 40 years, based on DNRM regional groundwater monitoring information. This is considered most likely to be related to the intensity of agricultural activity, particularly irrigation and flood mitigation works in the region;
- Groundwater elevations generally ranging from 12 m to 14m AHD have been measured at the DNRM monitoring bore located adjacent to the site. This range of groundwater elevations is consistent with on-site upgradient monitoring bores, with downgradient locations typicaly ranging between 7 m to 10 m AHD.
- Groundwater flow is anticipated to be to the south east in sympathy with regional topography, potentially discharging to Lethe Brook, and/or the Proserpine River.



MW8	SWL mAHD
Dec/15	11.2
May/16	11.3
Jul/17	11.9
Dec/17	11.6
Mar/18	11.7
Jun/18	11.9

MW1	SWL mAHD
Dec/15	11.6
May/16	11.2
Jul/17	12.0
Dec/17	11.9
Mar/18	11.8
Jun/18	11.9

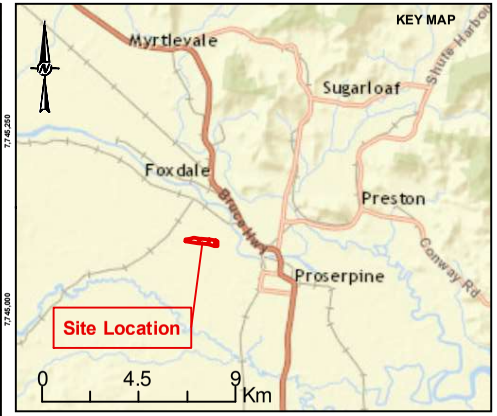
MW4	SWL mAHD
Dec/15	12.4
May/16	12.8
Jul/17	12.8
Dec/17	12.8
Mar/18	12.9
Jun/18	12.8

MW7	SWL mAHD
Dec/15	12.0
May/16	12.3
Jul/17	12.5
Dec/17	12.3
Mar/18	12.7
Jun/18	12.8

MW5	SWL mAHD
Dec/15	9.4
May/16	9.2
Jul/17	9.9
Dec/17	9.7
Mar/18	9.7
Jun/18	9.8

MW3	SWL mAHD
Dec/15	8.5
May/16	8.2
Jul/17	9.2
Dec/17	8.7
Mar/18	8.6
Jun/18	8.8

MW2D	SWL mAHD
Dec/15	8.1
May/16	8.6
Jul/17	9.1
Dec/17	8.4
Mar/18	8.4
Jun/18	8.7



LEGEND

Monitoring Locations
- Groundwater Monitoring Bore (MW)
- Water Storage / Sediment Pond (SED)
- Surface Water (SW)
- Leachate Sump (L)
- Watercourses

Road Type
- Main Road
- Local Road
- Railway
- Site Boundary
- Direction of Groundwater flow

Coordinate System:
GDA 1994 MGA Zone 55
Projection: Transverse Mercator
Datum: GDA 1994

0 50 100 150 200 250
1:7,500 @ A3
METRES

NOTE(S)
Service Layer Credits: Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
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REFERENCE(S)
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Site Boundary © State of Queensland (Department of Natural Resources, Mines and Energy), 2018

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PROJECT
KELSEY CREEK LANDFILL - ENVIRONMENTAL EVALUATION

TITLE
GROUNDWATER ELEVATION & FLOW DIRECTION

CONSULTANT
GOLDER

DD/MM/YYYY	20/08/2018
DESIGNED	DC
PREPARED	DC
REVIEWED	KC
APPROVED	KC

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2.9 Environmentally Sensitive Areas

2.9.1 Information Sources

Environmentally Sensitive Areas were reviewed by using the Queensland Government Environmental reports online tool searching as follows:

- Onsite – lot and plan number.
- Offsite – coordinates for the site to identify regional ecological receptors within a 2 km radius of the site.

These on-line searches identify:

- Matters of State Environmental Significance
- Regional Ecosystems
- Terrestrial Biodiversity and Aquatic Conservation Values.

The results of the searches address Notice Requirement 8 (i), and are presented in full in Appendix F.

Key information obtained by the searches is presented in Table 7 to Table 12 (inclusive). Key search results are also shown in **Figure 2.**

2.9.2 On-site

Potentially sensitive areas are summarised in Table 7, Table 8 and Table 9.

Table 7: Matters of State Environmental Significance Summary – Area of Interest (AOI) – Kelsey Creek Landfill - Onsite

Kelsey Creek Landfill – Onsite Search Results - Matters of State Environmental Significance
Search Results for Lot 160 SP171910 – Matters of State Environmental Significance not present on the subject land parcel
Search Results for Lot 299 SP 113325 – Matters of State Environmental Significance not present on the subject land parcel
Search Results for Lot 277 SP113325 – Matters of State Environmental Significance present as follows:

Kelsey Creek Landfill – Onsite Search Results - Matters of State Environmental Significance
Search Results for Lot 160 SP171910 – Matters of State Environmental Significance not present on the subject land parcel
Search Results for Lot 299 SP 113325 – Matters of State Environmental Significance not present on the subject land parcel

1a Protected Areas- estates	0.0 ha	0.0 %
1b Protected Areas- nature refuges	0.0 ha	0.0 %
2 State Marine Parks- highly protected zones	0.0 ha	0.0 %
3 Fish habitat areas (A and B areas)	0.0 ha	0.0 %
4 Strategic Environmental Areas (SEA)	0.0 ha	0.0 %
5 High Ecological Significance wetlands on the map of Referable Wetlands	0.0 ha	0.0 %
6a High Ecological Value (HEV) wetlands	0.0 ha	0.0 %
6b High Ecological Value (HEV) waterways **	0.0 km	Not applicable
7 Threatened species and Iconic species	0.0 ha	0.0 %
8a Regulated Vegetation - Endangered/Of concern in Category B (remnant)	0.0 ha	0.0 %
8b Regulated Vegetation - Endangered/Of concern in Category C (regrowth)	0.0 ha	0.0 %
8c Regulated Vegetation - Category R (GBR riverine regrowth)	1.69 ha	7.6%
8d Regulated Vegetation - Essential habitat	0.0 ha	0.0 %
8e Regulated Vegetation - intersecting a watercourse **	0.2 km	Not applicable
8f Regulated Vegetation - within 100m of a Vegetation Management Wetland	0.0 ha	0.0 %
9a Legally secured offset areas- offset register areas	0.0 ha	0.0 %
9b Legally secured offset areas- vegetation offsets through a Property Map of Assessable Vegetation	0.0 ha	0.0 %

Table 8: Regional Ecosystem Mapping – Area of Interest (AOI) - Kelsey Creek Landfill – On-site

Kelsey Creek Landfill Regional Ecosystem Mapping

Search Results for Lot 160 SP171910

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	0.0	0.0
No concern at present	0.0	0.0
Total remnant vegetation	0.0	0.0

Search Results for Lot 299 SP 113325

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	0.0	0.0
No concern at present	0.0	0.0
Total remnant vegetation	0.0	0.0

Search Results for Lot 277 SP113325

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	0.0	0.0
No concern at present	0.0	0.0
Total remnant vegetation	0.0	0.0

Table 9: Biodiversity & Conservation Assessment Summary – Area of Interest (AOI) – Kelsey Creek Landfill – On-site

Kelsey Creek Landfill

Biodiversity Conservation Significance - Search Results for Lot 160 Plan 171910

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	0.0	0.0
No concern at present	0.0	0.0
Total remnant vegetation	0.0	0.0

Aquatic Conservation Significance – Search Results for Lot 160 Plan 171910

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0
High	7.14	100.0
Medium	0.0	0.0
Low	0.0	0.0
Very Low	0.0	0.0

Biodiversity Conservation Significance - Search Results for Lot 299 Plan SP113325

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	0.0	0.0
No concern at present	0.0	0.0
Total remnant vegetation	0.0	0.0

Aquatic Conservation Significance - Search Results for Lot 299 Plan SP113325

Kelsey Creek Landfill

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0
High	2.56	100.0
Medium	0.0	0.0
Low	0.0	0.0
Very Low	0.0	0.0

Biodiversity Conservation Significance - Search Results for Lot 277 Plan SP113325

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	0.0	0.0
No concern at present	0.0	0.0
Total remnant vegetation	0.0	0.0

Aquatic Conservation Significance - Search Results for Lot 277 Plan SP113325

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0
High	22.23	100.0
Medium	0.0	0.0
Low	0.0	0.0
Very Low	0.0	0.0

Review of the search results, and the current configuration of the site indicates the following:

- An area of approximately 1.7 hectares in the western portion of the site, adjacent to and contiguous with the western tributary to Lagoon Creek, contains riparian vegetation (intersecting a watercourse), that is relatively intact, or regrowth, and is classed as a matter of state environmental significance. The remainder of the site is highly modified and cleared.
- Terrestrial vegetation values are associated with the site; however, it is located upgradient of the current landfill operations, and separated by the pony club area.
- Terrestrial ecosystem values and aquatic ecosystem values exist in association with riparian vegetation, and drainage lines, which may be of regional conservation significance, however this area is not likely to be subject to influence by site operations and will not be further considered during the current investigation.
- No wetlands, or high ecological value (HEV) surface water or groundwater systems were identified.

- The remainder of lot 277 Plan 113325 is cleared, and no species of conservation significance were identified in association with it. The surrounding area is highly modified (cleared extensively, agricultural land use, irrigation channels, dams, barrages and extensively modified drainage systems) and as such it is considered that the main value associated with this area is in relation to connectivity, which is not affected by the site operations at present.

2.9.3 Surrounding Area

Potentially sensitive areas are summarised in Table 10, Table 11, and Table 12 (on the following pages).

Table 10: Matters of State Environmental Significance Summary – Area of Interest (AOI) – Kelsey Creek Landfill – 2km radius

Search Results for Longitude: 148.55308 Latitude: -20.388652

1a Protected Areas- estates	0.0 ha	0.0 %
1b Protected Areas- nature refuges	0.0 ha	0.0 %
2 State Marine Parks- highly protected zones	0.0 ha	0.0 %
3 Fish habitat areas (A and B areas)	0.0 ha	0.0 %
4 Strategic Environmental Areas (SEA)	0.0 ha	0.0 %
5 High Ecological Significance wetlands on the map of Referable Wetlands	0.0 ha	0.0 %
6a High Ecological Value (HEV) wetlands	0.0 ha	0.0 %
6b High Ecological Value (HEV) waterways **	0.0 km	Not applicable
7 Threatened species and Iconic species	0.0 ha	0.0 %
8a Regulated Vegetation - Endangered/Of concern in Category B (remnant)	19.43 ha	1.5%
8b Regulated Vegetation - Endangered/Of concern in Category C (regrowth)	0.0 ha	0.0 %
8c Regulated Vegetation - Category R (GBR riverine regrowth)	90.22 ha	7.2%
8d Regulated Vegetation - Essential habitat	0.0 ha	0.0 %
8e Regulated Vegetation - intersecting a watercourse **	13.3 km	Not applicable
8f Regulated Vegetation - within 100m of a Vegetation Management Wetland	0.0 ha	0.0 %
9a Legally secured offset areas- offset register areas	0.0 ha	0.0 %
9b Legally secured offset areas- vegetation offsets through a Property Map of Assessable Vegetation	0.0 ha	0.0 %

Table 11: Regional Ecosystem Mapping – Area of Interest (AOI) – Kelsey Creek Landfill– 2 km radius

Search Results for Longitude: 148.55308 Latitude: -20.388652

Biodiversity Status	Area (Ha)	% of AOI
Endangered	17.4	1.4
Of concern	2.0	0.2
No concern at present	0.0	0.0
Total remnant vegetation	19.4	1.5

Table 12: Biodiversity & Conservation Assessment Summary – Area of Interest (AOI) – Kelsey Creek Landfill – 2km radius

Search Results for Longitude: 148.55308 Latitude: -20.388652

Biodiversity Significance	Area (Ha)	% of AOI
State	0.0	0.0%
Regional	33.1	2.6%
Local or Other Values	0.0	0.0%

Search Results for Longitude: 148.55308 Latitude: -20.388652

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	48.7	3.9%
High	1183.0	94.1%
Medium	24.9	2.0%
Low	0.0	0.0%
Very Low	0.0	0.0%

Conclusions are similar to those for the on-site areas, in that:

- Terrestrial ecosystem values exist in association with the Lagoon Creek Tributary (West) riparian vegetation, which is of regional conservation significance, and in relation to Great Barrier Reef Riverine Regrowth, and remnant vegetation.
- Lagoon Creek Tributary (West) riparian associated riparian vegetation are of high aquatic conservation significance in relation to riverine wetland values.
- No wetlands, or high ecological value surface water or groundwater systems were identified surrounding the site
- Very high & high aquatic conservation value was ascribed to the receiving environment (Lagoon Creek & Lethe Brook) due to:

- Threatened species – We note that these were not detected in the surrounding environment by the rest of the searches;
- Connectivity;
- Naturalness of the catchment – We note that the catchment has been extensively modified by agricultural activity, flood mitigation works, and irrigation and drainage modification work;
- Priority species and ecosystems – We note that these were not identified in the receiving environment.

Based on this information it is concluded that the Lagoon Creek & Lethe Brook have aquatic ecosystem values but are not "High Ecological Value" (HEV) receiving environments.

2.10 Groundwater Dependent Ecosystems - GDE

The National Groundwater Dependent Ecosystem Atlas[1] was searched using with a 1km radius around Kelsey Creek landfill. The following results were returned:

- Aquatic GDE: Two "wetlands" were identified. The shape and location of these features correlated with Lagoon Creek to the west of the site and the Proserpine River to the north and east.
- Subterranean GDE: No results returned
- Terrestrial GDE: Vegetation located 700 m west of the site.

Based on the information outlined in Section 3.8, and the information outlined above, it is considered that riparian vegetation associated with the Lagoon Creek system downgradient of Kelsey Creek Landfill is potentially a groundwater dependent ecosystem.

3.0 ENVIRONMENTAL VALUES

3.1 Background

Notice Requirement 8(II) references identification of environmental values, in the context of the *Environmental Protection Policy (EPP) Water 2009.* Review of the Department of Environment and Science Environmental Protection Policy (Water) Scheduled Data – surface water online search tool[2] , using the site address (Kelsey Creek Road, Crystal Brook, 9800). indicates that:

- Environmental values (EV's) and Water Quality Objectives (WQO's) for surface water are scheduled for the site under schedule map identifier WQ1221, and the document:
  - *"Environmental Protection (Water) Policy 2009, Proserpine River, Whitsunday Island, and O'Connell River Basins Environmental Values & Water Quality Objectives: Basins 122 … 123 and … 124…"* (EHP (Department of Environment & Heritage Protection, Environmental Policy & Planning Division, August 2013). This document identifies that:
    - The site is within the Lethe Brook sub-catchment and is classed as "moderately disturbed" (MD);
    - The site water quality is fresh waters (Proserpine & O'Connell River fresh waters).
- There are currently no separately legislatively scheduled EV's or WQO for groundwater on-site, or off-site. However (EHP, 2013) states that:

  "This document applies to fresh and estuarine surface waters and groundwaters draining the basins of the Proserpine River, Whitsunday Island, and O'Connell River (basins 122, 123 and 124), and coastal waters as indicated in the accompanying plans (WQ1221—surface waters, WQ1222—coastal waters)".

[1] http://www.bom.gov.au/water/groundwater/gde/map.shtml

[2] https://environment.ehp.qld.gov.au/protection-policy-water/

3.2 Surface Water Environmental Values

The scheduled guidelines outlined above been adopted for the current assessment, in recognition of the Queensland Water Quality Guidelines 2009 and ANZECC 2000 recommendation that regional guidelines should take precedence over national guideline values in assessment of water quality.

Draft Environmental Values for surface water are summarised in the Table 13.

Table 13: Lethe Brook Freshwater - Environmental Values (EHP, 2013)

Environmental Values	Lethe Brook Fresh Waters
Aquatic Ecosystem protection	X
Irrigation	X
Farm supply / use	X
Stock Water	X
Aquaculture	
Human Consumers (aquatic foods)	X
Primary Recreation	X
Secondary Recreation	
Visual Recreation	X
Drinking Water	X
Industrial Use	
Cultural & Spiritual Values	X

3.3 Groundwater Environmental Values

Environmental values (EVs) or water quality objectives (WQOs) scheduled for groundwater for the site under the EPP (EHP, 2013) are summarised in Table 14

WQO's for groundwaters are not provided in (EHP, 2013) which instead notes that:

> *"Where groundwaters interact with surface waters, groundwater quality should not compromise identified EVs and WQOs for those waters.*
>
> *There is insufficient information available to establish WQOs for this water type[3].*

3

The values for these indicators are based on the QWQG Mackay Whitsunday sub-regional water quality guidelines, which are derived from values in the Mackay Whitsunday Water Quality Improvement Plan (WQIP). These include objectives for both ambient/baseflow conditions and high flow ('event') conditions. The event quality objectives are expressed as end of system (e.g. subcatchment) event mean concentrations (EMC). Further details are provided in source documents (refer below).

Table 14: Environmental Values – Groundwaters – (EHP, 2013)

Environmental Values	Groundwaters
Aquatic Ecosystem protection	X
Irrigation	X
Farm supply / use	X
Stock Water	X
Aquaculture	
Human Consumers (aquatic foods)	
Primary Recreation	
Secondary Recreation	
Visual Recreation	
Drinking Water	X
Industrial Use	X
Cultural & Spiritual Values	X

Surface water assessment criteria may also be also adopted for groundwater assessment if there is evidence of groundwater and surface water connection (for example site derived groundwater expressing in surface water onsite or nearby offsite), or in the absence of dedicated groundwater criteria.

This is the approach taken by the NEPM ASC 2013 Groundwater Investigation Levels (GILs) which uses the ANZECCC 2000 surface water criteria to assess toxicant concentrations as a first-tier risk assessment screening tool.

4.0 CONCEPTUAL SITE MODEL

4.1 Developing the Conceptual Site Model (CSM)

In accordance with Schedule B2 of the NEPM 2013, a CSM has been developed for the site to assess identified sources of potential human health and environmental risk in relation to the current condition of the site. The essential elements of the CSM have been identified as follows:

- Known and potential sources of risk and hazards including the mechanism(s) of potential impact (i.e. nature of the source release into the environment).
- Potentially affected media (soil, sediment, groundwater, surface water).
- Human and ecological receptors.
- Potential and complete exposure pathways.

The above elements have been addressed in the following sections.

4.2 Source & Hazards

Notice Requirement 6 focuses the scope of the investigation on the nature and extent of potential groundwater and surface water contamination. As such, the key potential source and hazards considered for the Bowen Landfill has excluded landfill gas. The potential sources and hazards for the Kelsey Creek Landfill are presented in Table 15

Table 15: Potential Sources of Concern & Hazards

Potential Sources of Concern	Potential Hazards	
Waste	Putrescible material Biological agents Chemical agents – organic & inorganic Contaminated soils	Asbestos Nutrients Physical hazards – stability of containment Physical hazards – contact with waste
Leachate	Nutrients Chemical agents – organic & inorganic Contaminated materials	Biological agents Metals Physical hazards – stability of containment
Sediment	Export of waste / leachate associated hazards in association with sediment	Reduced light penetration in surface water bodies Smothering of certain aquatic plants

Site-specific source areas at the Kelsey Creek landfill are summarised in Table 16 along with contaminants of potential concern (COPC).

Table 16: Site Specific Source Areas

Potential Source of Concern	Site Specific Source Areas	Contaminants of Potential Concern (COPC)	
Waste	■ Unlined landfill cell / waste mound ■ Lined landfill cells – Cells 1 to 4 inclusive (and overlying mounds)	Key contaminants of potential concern derived from landfilled waste comprise:	
		■ pH & electrical conductivity ■ Heavy metals ■ Nutrients	■ Pesticides ■ Solvents ■ Hydrocarbons ■ Asbestos
Leachate	■ Lined & Unlined landfill cells & associated mounds ■ Leachate collection and transfer pipes ■ Leachate collection sumps ■ Runoff & spray drift from leachate irrigation areas	As for waste excluding asbestos.	
Stormwater runoff	■ Stormwater runoff from Waste Mounds (uncapped) ■ Stormwater runoff from leachate irrigation areas ■ Stormwater runoff from transfer station areas	■ As for leachate ■ Sediment – Total suspended sediments / turbidity	
	■ Stormwater runoff from operational areas (disturbed) – including interim capped & final capped	■ Sediment – Total suspended sediments / turbidity	
	■ Greenwaste Pad	■ Nutrients & sediment	
Sediment	■ Sediment laden stormwater runoff from waste infrastructure	■ Sediment – Total suspended sediments / turbidity	

4.3 Pathways

The potentially active pathways for each Source Area on site are summarised in Table 17.

Table 17: Kelsey Creek Landfill – Potentially Active Pathways

	Pathways								
Potential Sources of Concern	**Direct contact** **Ecological –** plant growth, animals (ingestion, direct contact).	**Humans –** dermal contact, inhalation (dust / vapour), ingestion (onsite / offsite)	Surface Seepage onsite / offsite) Migration to surface water via overland flow or in stormwater runoff / irrigation spray drift (onsite / offsite)	Migration to groundwater (onsite / offsite)	Migration of impacted groundwater	Extraction and use of impacted groundwater	Impacted groundwater discharge to surface water (onsite / offsite)	Excavation into landfill & direct contact	Containment Failure Erosion Liner failure Overtopping
Waste Material	Yes	Yes	No	No	No	No	No	Yes	Yes
Leachate & leachate impacted stormwater	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sediment	Yes	Yes	Yes	No	No	No	No	No	Yes

4.4 Receptors

Environmental and human health receptors and mechanisms for exposure are summarised in Table 18

Table 18: Bowen Landfill - Potential Receptors

Potential Sources of Concern	Potential Receptors						
	Environment				Human Health		
	Aquatic Ecosystems – Lagoon Creek	Terrestrial Ecosystems (riparian vegetation, animals)	Groundwater Ecosystems	Groundwater – Irrigation & Stock water	General Public (On-site) Council Staff (On-site)	Adjacent land users (commercial/community including drinking water use and farm supply)	Workers completing intrusive / excavation works (On-site)
Waste Material		■ Direct contact ■ Containment failure			■ Direct contact		■ Excavation into landfill & direct contact
Leachate & **Leachate impacted stormwater**	■ Leachate migration to surface water (overland flow/irrigation spray drift) / uncontained breakout ■ Containment failure – overtopping ponds ■ Impacted groundwater discharge to surface water ■ Leachate Impacted stormwater discharge to surface water	■ Direct contact ■ Migration to groundwater onsite ■ Migration of impacted groundwater offsite ■ Containment failure – overtopping (onsite / offsite) ■ Migration to surface water via overland flow or surface runoff (onsite / offsite)	■ Migration to groundwater onsite ■ Migration of impacted groundwater offsite	■ Extraction and use of impacted groundwater	■ Direct contact ■ Containment failure	■ Extraction & use of impacted groundwater ■ Migration of leachate impacted stormwater to surface water	■ Excavation into landfill & direct contact with leachate
Sediment	■ Migration to surface water in stormwater runoff ■ Containment failure	■ Direct contact (smothering) ■ Migration to surface water in stormwater runoff ■ Containment failure					

4.5 Conceptual Site Model

The conceptual site model for the Kelsey Creek Landfill is presented in Table 20 below.

Table 19: Kelsey Creek Landfill - Conceptual Site Model

Potential Sources of Concern	Potential Pathways	Potential Receptors	Comments
Waste	■ Direct Contact ■ Containment failure	■ Terrestrial ecosystems ■ General Public (onsite) ■ Council Staff (onsite)	■ Risk typically addressed via operational management plans and Landfill Remediation and Aftercare Plan following closure.
Leachate	■ Leachate migration to surface water (overland flow, spray drift from irrigation areas) / uncontained breakout	■ Aquatic ecosystems ■ Terrestrial ecosystems ■ General Public (onsite) ■ Council Staff (onsite)	■ Stormwater controls on the site are currently inadequate to contain all potentially leachate-affected stormwater on-site. (Maunsell Aecom , 2008) and (Golder Associates , August 2012) have recommended development of additional stormwater retention and controls on site ■ Irrigation of leachate onto the waste mound is a pathway for leachate migration to stormwater – additional stormwater controls required to mitigate this risk, or updated leachate management strategy. ■ Irrigation of leachate onto final capping areas of the waste mound is a potential source for soil contamination and subsequent contaminant migration to stormwater. ■ No assessment of leachate generation rates from lined cells and capacity of existing irrigation area identified. A comprehensive leachate management strategy for the entire site that takes into account planned future waste cells would assist in reducing potential for this risk to impact on receptors. ■ Irrigation of leachate over no active landfill areas with interim/final capping may not be permitted under Condition WA8 of the Environmental Authority.
	■ Containment failure – overtopping ponds	■ Aquatic ecosystems ■ Terrestrial ecosystems ■ General Public (onsite) ■ Council Staff (onsite)	
	■ Migration to groundwater	■ Groundwater ecosystems	■ Primary risk most likely to be associated with older unlined waste disposal areas. ■ Newer engineered waste cells should represent a lower risk.
	■ Migration of impacted groundwater offsite	■ Groundwater ecosystems ■ Groundwater – irrigation & stock watering ■ Extraction and use of impacted groundwater (including drinking water)	
	■ Impacted groundwater discharge to surface water	■ Aquatic ecosystems ■ Adjacent land users (offsite)	No current evidence of groundwater discharge to surface water receptors within or adjacent to the site. Groundwater discharge to surface water may occur in downgradient waterways some distance from the site.
	■ Leachate impacted stormwater discharge to surface water	■ Aquatic ecosystems ■ Terrestrial ecosystems ■ Adjacent land users	Stormwater and irrigation management comments as above
Sediment	■ Migration to surface water in stormwater runoff ■ Direct contact (smothering) ■ Containment failure	■ Aquatic ecosystems ■ Terrestrial ecosystems	Stormwater and irrigation management comments as above Capacity of current site stormwater system to contain stormwater runoff and detain sediment is an information gap.

5.0 LEACHATE ANALYSIS

Requirement 10 of the investigation notice states:

"Provide information on the leachate analysis of contaminants identified in the surface and subsurface soil directly beneath the site, under the areas (cells) where waste is buried and actively deposited"

No drilling into the soils underlying the landfill cells was undertaken based on the following:

- For both lined and unlined landfills this could provide a direct and preferential contaminant migration pathway for leachate into soils underlying the landfill cells and represent unacceptable high risk of direct discharge to underlying groundwater.
- High risk of explosion, or landfill fire, due to ignition of landfill gas within cells by sparks or heat generated during drilling through waste.
- Soils beneath the cells will not disturbed in the future due to the waste interred above.
- The quality of soils underlying the landfill cells presents low risk to the environment and human health compared to the risks posed by leachate, as outlined in Section 4.0, Conceptual Site Model.
- Leachate signature analysis has been completed using data from samples directly collection from leachate management systems.

6.0 WATER QUALITY MONITORING

6.1 Data Collection & Quality

Compiled Data used for this report was provided to Golder in MS Excel format by WRC. It is assumed that the data set supplied for interpretation was complete and validated WRC. No independent verification of the data set was completed by Golder.

WRC completed all water quality sampling tasks during the notice period internally, with Golder auditing WRC fieldwork at one of the two landfill sites subject to investigation.

6.2 Monitoring Program Design and Non-compliances

6.2.1 Notice Period

The design of the environmental evaluation investigation is outlined in Golder Proposal Number P1790603-002-L-Rev2-EHP_Non-commercial dated 24th November 2017 (Appendix A) and was based on the Bowen Leachate Detection Monitoring Program (Golder Associates , 2014) (Appendix G) for groundwater and leachate.

Identified departures from the proposed monitoring program conducted during the Environmental Evaluation notice period are summarised as follows:

- **Leachate Sumps (L1 & L2)**
  - TRH/BTEX not analysed for one round.
  - Metals (total and dissolved) not analysed for one round.
  - Total alkalinity not analysed for one round.
  - Filterable Reactive Phosphorous (FRP) not analysed.
  - Anions & cations not analysed for one round.
- **Surface Water (SW1, SW2, SW3, SW4, SW5, SW6)**
  - TRH/BTEX not analysed for one round.
  - Metals (total and dissolved) not analysed for one round during the notice period in surface water, and not analysed for dissolved metals for one round during the notice period in groundwater (i.e. only total metals analysed)

- Total alkalinity not analysed for one round.
- Filterable Reactive Phosphorous (FRP) not analysed.
- Anions & cations not analysed for one round.

- **Groundwater**
  - The sampling program did not include two proposed regional / background bore locations.
  - TRH/BTEX not analysed for one round.
  - Metals (dissolved) not analysed for one round.

6.2.2 General Monitoring Program Implementation

Review of the Environmental Authority (IPDE00656507) indicates that monitoring is required as follows:

- Surface water – required by Condition WA9 as follows:

  "Surface water monitoring must be carried out generally in accordance with the Sampling Quality Plan – Kelsey Creek Road Landfill Environmental Management Program dated 27 October 1998) refer Appendix K, Volume 2 of the Document entitled "Kelsey Creek Road Landfill Extension Proserpine, Draft Impact Assessment Study dated May 1999. (Appendix G)"

Condition WA 13 states that

"Groundwater water monitoring must be carried out generally in accordance with the Sampling Quality Plan – Kelsey Creek Road Landfill Environmental Management Program dated 27 October 1998) refer Appendix K, Volume 2 of the Document entitled "Kelsey Creek Road Landfill Extension Proserpine, Draft Impact Assessment Study dated May 1999. (Appendix G)"

A review of the implementation of the Monitoring Program (Woodward-Clyde, May 1999) over time was observed to have some gaps including:

- Gaps in the quarterly monitoring program as outlined in (Woodward-Clyde, May 1999).
- Water storage ponds (SED1, SED2) and Leachate Sumps (L1, L2) and discharge from the southern swale not included in the monitoring program.
- Off-site discharges from site (SED1, SED2, southern swale) are not monitored.
- Gaps in the laboratory analytical suite outlined in (Woodward-Clyde, May 1999) during monitoring rounds since 2016 including:
  - Major Anions & Cations and ionic balance not routinely analysed in both groundwater and surface water;
  - Heavy Metals not routinely analysed both groundwater and surface water,
  - TRH/ BTEX not routinely analysed.
- Leachate Monitoring - not required by the EA;
  - Not included in Woodward Clyde 1998 Monitoring Program scope;
  - Leachate analysis has not routinely been conducted, however, data is available for monitoring rounds from 2017 onwards.
  - Analysis for anions and cations has been limited, with a total of 2 data points from 5 monitoring events.

- Sediment / Water Storage Pond Monitoring - not required by the EA;
  - Not included in Woodward Clyde 1998 Monitoring Program scope;
  - Analysis has not routinely been conducted, however, data is available for monitoring rounds from 2010 for Sediment Pond 1, and from 2017 onwards for Sediment Pond 2.
  - Analysis for anions and cations has been limited.

It is also noted that the Woodward Clyde 1999 monitoring program has not been updated over time to reflect changes in the site operations and to ensure that all potential contaminant sources are appropriately monitored. This is an opportunity for improvement.

6.2.3 Sample Collection Methods & Field QA/QC – Field Audit

WRC advised that sampling methods employed are as recommended in Woodward Clyde 1999, Bowen Leachate Detection Monitoring Program (Golder Associates , 2014) and (AS 5667.11:1998). Golder audited collection of groundwater and surface water samples by WRC in the field in May 2018. Identified issues of concern that Golder recommends are reviewed for improvements included:

- Structuring the sampling program to minimise potential for cross-contamination between sampling locations. This could include the use of dedicated sampling equipment;
- Adopting recommended minimum bore purging volumes and monitoring for stabilised field parameters (+/- 10%),;
- Use of correct laboratory supplied sampling bottles for specific analytes (e.g. TRH/BTEX);
- Use of dedicated nitrile gloves for sample collection.

7.0 ASSESSMENT CRITERIA

7.1 Surface Water Assessment Criteria

Water quality assessment criteria for the Surface Water Risk Assessment summarised in Table 20 were selected based on the following:

- There are no surface water release limits or other compliance criteria specified in the EA.
- Assessment criteria to protect key EV's and WQO's scheduled for the site under the EPP Water were adopted as follows:
  - Ecosystem protection - ANZECC 2000 guidelines for freshwater at the 95% level of protection adopted for toxicants (Volume 1, Section 3.4.2, Table 3.4.1).
  - Drinking water - Assessment criteria were adopted from the Australian Drinking Water Quality Guidelines 2011, Rev 3.4 Oct, (ADWG,2011). The criteria are for raw / priority drinking water supply near off-takes before treatment (includes) groundwater, before treatment.
  - Irrigation - long-term and short-term trigger values have been adopted from ANZECC 2000, Volume 1, Section 4.2.6, Table 4.2.10.
  - Stock watering - trigger values for TDS (total dissolved solids), heavy metals and metalloids in livestock drinking water have been adopted from ANZECC 2000 Volume 1, Section 4.3.3.5, Table 4.3.1 (TDS) and Volume 1, Section 4.3.4, Table 4.3.2 (metals).

Water Quality Objectives for EV's are presented in Appendix H.

Table 20: Surface Water Assessment Criteria

Group	Parameter	Units	Surface Water Contaminant Alert Trigger Value
Field characteristics	pH	pH units	7.5 - 7.8 [1] 6.5 - 8.0 [2]
	Electrical conductivity (EC)	µS/cm	463 [1]
General Chemistry	Total Dissolved Salts (TDS)	mg/L	2000-5000[3]
	Sodium	mg/L	180[5]
Heavy Metals (Totals / Dissolved)	Arsenic(V)	mg/L	0.013[4]
	Cadmium	mg/L	0.0002[4]
	Chromium (VI)	mg/L	0.001[4]
	Copper	mg/L	0.0014[4]
	Lead	mg/L	0.034[4,]
	Manganese	mg/L	1.9[1]
	Mercury	mg/L	0.0006[4]
	Nickel	mg/L	0.011[4]
	Zinc	mg/L	0.008[4,]
Nutrients	Ammonia (NH_3) – toxicant	mg/L	0.900[4]
	Ammonia (NH3) (*physico-chemical indicator*[6])	mg/L	0.0202
	Nitrate (NO3) – toxicant	mg/L	0.700[4]
	Dissolved Inorganic Nitrogen (DIN) – sum of NH3+NOx (*physico-chemical indicator*[6])	mg/L	0.064[1]
	Total Nitrogen (*physico-chemical indicator*[6])	mg/L	0.500[2]
	Total Phosphorous (*physico-chemical indicator)*	mg/L	0.050[2]
	Filterable Reactive Phosphorous (FRP) – *(physico chemical indicator)*	mg/L	0.008[1]
Organics	Organochlorine Pesticides (OCP)	µg/L	Not detected in raw water[5]
	Total Recoverable Hydrocarbons	µg/L	No criteria

Group	Parameter	Units	Surface Water Contaminant Alert Trigger Value
	Benzene, Toluene, Ethyl Benzene, Total Xylenes (BTEX)	µg/L	0.950[4,7]
	Polycyclic Aromatic Hydrocarbons (PAH)	µg/L	Naphthalene -0.016[4]
	Volatile Organic Compound (VOC)	µg/L	6.5[4]

1) EHP (2013) Proserpine River, Whitsunday Island, and O'Connell River Basins Environmental Values & Water Quality Objectives
2) Queensland Water Quality Guidelines, 2009
3) ANZECC 2000- Stock Watering Low Risk Trigger Values
4) ANZECC 2000 95th percentile for toxicants in freshwater
5) ADWG 2011
6) Physico-chemical indicator –potential for nuisance growth of aquatic plants
7) Benzene
8) 1,1,2-trichloroethane

7.2 Groundwater Assessment Criteria

Water quality assessment criteria for the Tier 1 Hydrogeological Risk Assessment summarised in Table 21 have been selected based on the following:

- There are no groundwater release limits or other compliance criteria specified in the EA.
- Assessment criteria to protect key EV's and WQO's scheduled for the site under the EPP Water were adopted as follows:
  - **Ecosystem protection -** ANZECC 2000 guidelines for freshwater at the 95% level of protection adopted for toxicants (Volume 1, Section 3.4.2, Table 3.4.1).
  - **Drinking water -** Assessment criteria were adopted from the Australian Drinking Water Quality Guidelines 2011, Rev 3.4 Oct, (ADWG,2011). The criteria are for raw / priority drinking water supply near off-takes before treatment (including groundwater).
  - **Irrigation -** long-term and short-term trigger values have been adopted from ANZECC 2000, Volume 1, Section 4.2.6, Table 4.2.10.
  - **Stock watering -** trigger values for TDS (total dissolved solids), heavy metals and metalloids in livestock drinking water have been adopted from ANZECC 2000 Volume 1, Section 4.3.3.5, Table 4.3.1 (TDS) and Volume 1, Section 4.3.4, Table 4.3.2 (metals).

In relation to drinking water as an EV we note:

- ADWG notes that 20 mg/L sodium should not be exceeded for 'at-risk' groups;
- 50 mg/L sodium is a 'typical value' in reticulated supplies;
- 180 mg/L of sodium should not be exceeded due to taste considerations;
- Sodium salts cannot readily be removed from drinking water supplies.
- ADWG stipulates that pesticides should not be detected in raw water.

It is also important to note that:

- ANZECC 95% aquatic ecosystem guidelines identify concentrations that should not be exceeded in *surface receiving waters*. Although these guidelines have also been adopted as trigger values for groundwater assessment (per the approach of the NEPM ASC 2013 Groundwater Investigation Levels) it must be recognised that issues such as dilution, natural attenuation, advection, adsorption and contaminant flux must be considered to assess potential risks to down gradient aquatic ecosystems. Criteria for physico-chemical indicators in surface water have not been adopted for groundwater assessment.

Water Quality Objectives for all EV's are presented in Appendix H.

Table 21: Assessment Criteria - Groundwater

Group	Parameter	Units	Surface Water Contaminant Alert Trigger Value
Field characteristics	pH	pH units	7.5 - 7.8 [1] 6.5 - 8.0 [2]
	Electrical conductivity (EC)	µS/cm	463 [1]
General Chemistry	Total Dissolved Salts (TDS)	mg/L	2000-5000[3]
Heavy Metals (Totals / Dissolved)	Arsenic (V)	mg/L	0.013[4]
	Cadmium	mg/L	0.0002[4]
	Chromium (VI)	mg/L	0.001[4]
	Copper	mg/L	0.0014[4]
	Lead	mg/L	0.034[4,]
	Manganese	mg/L	1.9[1]
	Mercury	mg/L	0.0006[4]
	Nickel	mg/L	0.011[4]
	Zinc	mg/L	0.008[4,]
Nutrients	Ammonia (NH_3) – toxicant	mg/L	0.900[4]
	Ammonia (NH3) (*physico-chemical indicator*[6])	mg/L	0.020[2]
	Nitrate (NO3) – toxicant	mg/L	0.700[4]
	Dissolved Inorganic Nitrogen (DIN) – sum of NH3+NOx (*physico-chemical indicator*[6])	mg/L	0.064[1]
	Total Nitrogen (*physico-chemical indicator*[6])	mg/L	0.500[2]
	Total Phosphorous (*physico-chemical indicator)*	mg/L	0.050[2]

Group	Parameter	Units	Surface Water Contaminant Alert Trigger Value
	Filterable Reactive Phosphorous (FRP) – *(physico chemical indicator)*	mg/L	0.008[1]
	Nitrate (NO3) – toxicant	mg/L	0.700[4]
Organics	Organochlorine Pesticides (OCP)	µg/L	Not detected in raw water[5]
	Total Recoverable Hydrocarbons	µg/L	No criteria
	Benzene, Toluene, Ethyl Benzene, Total Xylenes (BTEX)	µg/L	0.950[4,7]
	Polycyclic Aromatic Hydrocarbons	µg/L	Naphthalene -0.016[4]
	Volatile Organic Compound (VOC)	µg/L	6.5[4]

1) EHP (2013) Proserpine River, Whitsunday Island, and O'Connell River Basins Environmental Values & Water Quality Objectives
2) Queensland Water Quality Guidelines, 2009
3) ANZECC 2000- Stock Watering Low Risk Trigger Values
4) ANZECC 2000 95th percentile for toxicants in freshwater –
5) ADWG 2011
6) Physico-chemical indicator –potential for nuisance growth of aquatic plants
7) Benzene
8) 1,1,2-trichloroethane

8.0 INVESTIGATION RESULTS

Results of the investigation program were compiled in conjunction with available historical data and are presented as follows:

- Summary tables for available and relevant data are presented in Appendix I for leachate, surface water and groundwater, including summary statistics and rolling medians for the last 8 monitoring rounds, where enough data (8 points) was available to calculate statistics.
- Piper Plots for the water storage ponds, surface water, and groundwater are presented in Appendix J. Please note that plots refer to MW rather than MW.
- Time-series graphs against relevant assessment criteria are presented in Appendix K.
- Standing water level data graphs are presented in Appendix L.
- Monitoring locations are shown in Figure 6, and the following is noted:
  - The up-gradient monitoring location for surface water is SW5; and
  - The background (upgradient) well is MW8 for groundwater

9.0 SURFACE WATER QUALITY

9.1 Monitoring Network

A documented monitoring program for Kelsey Creek Landfill was identified (Woodward-Clyde, May 1999), and is presented in Appendix G. More recent documented monitoring programs do not exist for the Kelsey Creek site. Monitoring locations are shown in Figure 6, and summarised in Table 22.

Surface water monitoring locations are not at the site boundary and are generally greater than 1km downstream of the site boundary, receiving diffuse stormwater inputs from a large agricultural catchment area downgradient of the site.

Future monitoring may consider moving surface water monitoring locations to the site boundary to monitor the quality of surface water leaving the site.

Table 22: Kelsey Creek Landfill - Surface Water Monitoring Locations

Sample ID	Location Description
Operational Monitoring	
L1	Leachate Sump – Cell 1/3 (northern side)
L2	Leachate Sump – Cell 2/4 (southern side)
SED1	Sediment Pond 1 – East
SED2	Sediment Pond 2 – West
Receiving Environment Monitoring	
SW1	Confluence of Lagoon Creek with Lagoon Creek Tributary East, approximately 1.4km downstream of site boundary
SW2	Downstream of SW1
SW3	Downstream of SW2
SW4	Upgradient of confluence of Lagoon Creek with Lagoon Creek Tributary East, approximately 1km downstream of site boundary.
SW5	Upstream t of Eastern Lagoon Creek Tributary and Sediment Pond Control point
SW6	Lagoon Creek, approximately 100m downstream of confluence with Lagoon Creek Tributary West, approximately 400m downstream of site boundary.

9.2 Piper Plots – Ionic Balance

9.2.1 Leachate

Review of the piper plots based on available data for the leachate sumps indicated the following water chemistry:

- L1 – limited data set of short duration (2 data points only), robust conclusions not possible, available data set indicates that possibly sodium chloride type.
- L2 – limited data set of short duration (2 data points only), robust conclusions not possible, available data set indicates that possibly sodium bicarbonate type.

9.2.2 Surface Water – SW1-SW6 (inclusive)

Review of the piper plots based on available data for the surface water monitoring locations indicated the following water chemistry:

- SW1, SW2, SW3, SW5, SW6 –
  - Plots not tightly clustered, fluctuation over time, but no clear trend with respect to change over time; and
  - Generally characterised as sodium chloride type, with some variability.
  - Up-gradient (SW5) generally consistent with water chemistry in down-gradient locations (SW1, SW2, SW3, SW6).
- SW4
  - Plot not tightly clustered, fluctuation over time, but no clear trend.
  - Indeterminate water type.

Review of the piper plots for surface water against site leachate data (L2 & L2) indicates that based on available data:

- SW1- SW6 plotting in separate regions to L1 & L2 over time, with little to no overlap in regional plots.

9.2.3 Water Storage Ponds – SED1 & SED2

Review of the piper plots based on available data for the water storage ponds indicated the following water chemistry:

- SED1 – No dominant water type – water chemistry is variable over time (points not tightly clustered and no clear trend).
- SED2 - limited data set of short duration, robust conclusions not possible, available data set does not identify dominant water type.

Review of the piper plots for the water storage ponds against site leachate data (L2 & L2) indicates that based on available data:

- SED1 – plotting in separate regions to L1 & L2 over time, with little to no overlap in regional plots on the chart.
- SED2 - limited data set of short duration (2 data points only), robust conclusions not possible, available data set indicates minimal overlap in regional plots.

9.3 Comparison of Results to Assessment Criteria

A summary of exceedances of the assessment criteria, including achievement of environmental values, and comments is presented in Table 23 (SED1 & SED2) and Table 24 (SW1 - SW6).

Please note that there was insufficient data to calculate rolling medians for any parameters in SED2.

Table 23: Kelsey Creek Landfill - Water Storage Ponds (SED1 & SED2) - Summary of Results in comparison to assessment criteria and environmental values

Water Storage Ponds – SED1 - rolling medians SED 2 – comments only			Environmental Values						Comments
			Aquatic Ecosystem Protection			Irrigation	Stock Watering	Drinking Water	
Contaminant of Concern	Units	Rolling Median Concentration Range	ANZECC 95%toxicants	Lethe Brook WQO	QWQG 2009	ANZECC 2000			
pH	N/A	8.19	N/A	X	X	✓	✓	✓	■ Limited available data for SED2 indicates that quality in SED2 may exceed Lethe brook WQO & QWQG 2009. ■ Further assessment is required
Electrical conductivity (EC)	µS/cm	1,847	N/A	X	N/A	✓	✓	✓	■ Limited available data for SED2 indicates that quality in SED2 may exceed Lethe brook WQO & QWQG 2009 ■ Further assessment is required
Dissolved Oxygen	%Saturation	Insufficient data	N/A	N/A	N/A	N/A	N/A	N/A	■ Limited available data for SED1 & SED2 indicates that quality may exceed Lethe brook WQO & QWQG 2009. Further assessment is required.
Turbidity	Turbidity	Insufficient data	N/A	N/A	N/A	N/A	N/A	N/A	■ Limited available data for SED1 & SED2 indicates that quality may exceed Lethe brook WQO & QWQG 2009 ■ Further assessment is required
Total Dissolved Salts (TDS)	mg/L	1,087	N/A	N/A	N/A	✓	✓	✓	
Heavy Metals									■ Total metals only ■ Insufficient data to calculate rolling median for dissolved metals
Arsenic – total	mg/L	0.005	✓	✓	✓	✓	✓	✓	
Cadmium	mg/L	0.0001	✓	✓	✓	✓	✓	✓	
Chromium – total [Cr(III) +Cr(VI)]	mg/L	0.002	X	X	X	✓	✓	✓	■ Marginal exceedance 0.002 mg/L against a limit of 0.001 mg/L ■ Guideline is for Cr(VI) result is for Cr (III) & Cr(VI) species. ■ Not analysed for hardness so comparison to hardness modified trigger value not able to be completed. ■ Analyse for hardness in future to enable hardness modification of trigger value. ■ Analyse for dissolved in future as this is an indicator of potential bioavailability. ■ Cr(VI) speciation analysis unlikely to be achievable due to regional location of laboratory and 24 hour holding time, to get to a lab NATA accredited for this specialised analysis (likely Brisbane).
Copper	mg/L	0.0020	X	X	X	✓	✓	✓	■ Marginal exceedance (against limit 0.0014 mg/L) ■ Not analysed for hardness so comparison to hardness modified trigger value not able to be completed ■ Analyse for hardness in future to enable hardness modification of trigger value. ■ Analyse for dissolved if hardness modified trigger value is exceeded following statistically valid data set comparison

Water Storage Ponds – SED1 - rolling medians SED 2 – comments only			Environmental Values						Comments
			Aquatic Ecosystem Protection			Irrigation	Stock Watering	Drinking Water	
Contaminant of Concern	Units	Rolling Median Concentration Range	ANZECC 95%toxicants	Lethe Brook WQO	QWQG 2009	ANZECC 2000			
									to assessment criteria, as this is an indicator of potential bioavailability.
Lead	mg/L	0.0008	✓	✓	✓	✓	✓	✓	
Manganese	mg/L	0.355	✓	✓	✓	✓	✓	✓	
Mercury	mg/L	Nod detected	✓	✓	✓	✓	✓	✓	
Nickel	mg/L	0.007	✓	✓	✓	✓	✓	✓	
Zinc	mg/L	0.009	X	X	X	✓	✓	✓	■ Marginal exceedance against limit (0.008 mg/L) ■ Not analysed for hardness so comparison to hardness modified trigger value not able to be completed ■ Analyse for hardness in future to enable hardness modification of trigger value. ■ Analyse for dissolved if hardness modified trigger value is exceeded following statistically valid data set comparison to assessment criteria, as this is an indicator of potential bioavailability.
Ammonia (NH3)	mg/L	Insufficient data to calculate rolling median	N/A	N/A	N/A	✓	✓	✓	■ Range of raw data results ▪ SED1 - 0.01 – 29* mg/L *March 2018 ▪ SED2 - Not detected – 5.1 mg/L ■ Raw results in both water storage ponds are a strong indicator of potential transient leachate impact to storage ponds. ■ Further assessment is required to ▪ verify actual ammonia concentrations in ponds over time ▪ Verify statistically valid rolling median concentrations over time ▪ Verify concentrations discharged to the environment during overflow events
Total Oxidised Nitrogen	mg/L	0.170	✓	N/A	X	N/A	N/A	N/A	■ ANZECC guideline for is for NO3 ■ Exceedance less than one order of magnitude (0.170 against a limit of 0.060 mg/L QWQG 2009 for physico-chemical indicator.
Dissolved Inorganic Nitrogen	mg/L	Insufficient Data	N/A	N/A	N/A	N/A	N/A	N/A	
Total Nitrogen	mg/L	Insufficient Data	Insufficient Data	N/A	N/A	N/A	N/A	N/A	
Total Phosphorous (TP)	mg/L	0.440	N/A	N/A	X	N/A	N/A	N/A	■ Exceedance less than one order of magnitude (0.170 against a limit of 0.060 mg/L QWQG 2009. ■ Not a toxicant indicator.

Water Storage Ponds – SED1 - rolling medians SED 2 – comments only			Environmental Values						Comments
			Aquatic Ecosystem Protection			Irrigation	Stock Watering	Drinking Water	
Contaminant of Concern	Units	Rolling Median Concentration Range	ANZECC 95%toxicants	Lethe Brook WQO	QWQG 2009	ANZECC 2000			
Filterable Reactive Phosphorous (FRP)	Mg/L	No data	Not applicable						
Organochlorine Pesticides (OCP)	mg/L	No data	Not Applicable						
Total Recoverable Hydrocarbons	mg/L	Generally, not detected C15-C28 - 0.115 C29-C36 – 0.053 C10-C40 - 0.180 F3 >C16-C34 – 0.050	✓	✓	✓	✓	✓	✓	■ Minor low level detects in some monitoring rounds ■ Further assessment of transient impacts may be warranted ■ Not indicative of gross widespread pollution ■ Continue monitoring, monitor discharges to receiving environment.
BTEX	mg/L	Not detected	✓	✓	✓	✓	✓	✓	
Polycyclic Aromatic Hydrocarbons	mg/L	Not detected	✓	✓	✓	✓	✓	✓	
Volatile Organic Compounds (VOC)	mg/L	Not detected	✓	✓	✓	✓	✓	✓	

Table 24: Kelsey Creek Landfill - Surface Water - Summary of Results in comparison to assessment criteria and environmental values

Surface Water: SW1- SW6 (inclusive)			Environmental Values						Comments
			Aquatic Ecosystem Protection			Irrigation	Stock Watering	Drinking Water	
Contaminant of Concern	Units	Rolling Median Concentration Range	ANZECC 95%toxicants	Lethe Brook WQO	QWQG 2009	ANZECC 2000			
pH	N/A	7.2 -7.5	N/A	X	✓	✓	✓	✓	■ SW1, SW2, SW3 & SW6 marginally outside Lethe Brook WQO
Electrical conductivity (EC)	µS/cm	265-409	N/A	✓	N/A	✓	✓	✓	
Dissolved Oxygen	%Saturation	74-100	N/A	✓	N/A	N/A	N/A	N/A	■ SW6 insufficient data to calculate rolling median
Turbidity	NTU	3-9	N/A	X	N/A	N/A	N/A	N/A	■ SW2, SW5 & SW6 insufficient data to calculate rolling median ■ SW5 is background – no comparison with background able to be made
Total Dissolved Salts (TDS)	mg/L	Not detected -256	N/A	N/A	N/A	✓	✓	✓	
Sodium	mg/L	29 -39	N/A	N/A	N/A	✓	✓	✓	All rolling medians exceed ADWG 2011 health-based guideline (20mg/L) but not maximum sodium guideline (180 mg/L)
Heavy Metals									■ Dissolved metals only ■ Insufficient data to calculate rolling median for total metals
Arsenic – total	mg/L	Not detected – 0.001	✓	✓	✓	✓	✓	✓	
Cadmium	mg/L	Not detected – 0.0001	✓	✓	✓	✓	✓	✓	
Chromium	mg/L	0.0005 (not detected using half LOR)	✓	✓	✓	✓	✓	✓	
Copper	mg/L	Not detected – 0.003	✓	✓	✓	✓	✓	✓	
Lead	mg/L	Not detected – 0.0045	✓	✓	✓	✓	✓	✓	■ SW2 rolling median marginal exceedance (0.0045 against a limit of 0.0034). Less than one order of magnitude ■ Hardness not sampled – hardness modified trigger value not able to be calculated ■ Samples higher up the catchment and closer to the landfill did not return exceedances so may not be related to landfill. ■ Not sampled since 2016 for dissolved metals ■ Total metals samples since 2016 (3 of 4 were not detected) ■ Further investigation may be warranted to confirm exceedance, however discharge monitoring at site boundary would be more effective to ascertain if the landfill is the source due to the distance (>1km) downstream from the site

Surface Water: SW1- SW6 (inclusive)			Environmental Values						Comments
			Aquatic Ecosystem Protection			Irrigation	Stock Watering	Drinking Water	
Contaminant of Concern	Units	Rolling Median Concentration Range	ANZECC 95%toxicants	Lethe Brook WQO	QWQG 2009	ANZECC 2000			
Manganese	mg/L	0.075 – 0.452	✓	✓	✓	✓	✓	✓	
Mercury	mg/L	Nod detected	✓	✓		✓	✓	✓	
Nickel	mg/L	Not detected -0.001	✓	✓	✓	✓	✓	✓	
Zinc	mg/L	0.006 -0.013	X	X	X	✓	✓	✓	■ Rolling median in SW2(0.013mg/L) SW3 (0.011 mg/L) SW4, SW5, SW6 (0.006 mg/L) and marginally exceeded the assessment criterion (0.008 mg/L). ■ Hardness not sampled – hardness modified trigger value not able to be calculated ■ SW5 is the upgradient location ■ Exceedance could be associated with background conditions or other sources downstream of landfill.
Ammonia (NH3)	mg/L	0.015-0.090	✓	N/A	X	✓	✓	✓	■ Insufficient data to calculate rolling median in SW3 & SW4, SW6 ■ SW1 (0.035mg/L), SW5 (0.090 mg/L) rolling median exceed QWQG 2009 for ammonia (0.02 mg/L) (physico-chemical. ■ SW5 is the upgradient location and was higher than locations downgradient of site that could be calculated. ■ Exceedance could be associated with background conditions or other contaminant sources ■ May reflect regional water due to agricultural activity in the catchment
Total Oxidised Nitrogen	mg/L	00005 -0.010	✓	N/A	✓	N/A	N/A	N/A	■ ANZECC guideline for is for NO3
Dissolved Inorganic Nitrogen	mg/L	0.083 -0.128	N/A	X	N/A	N/A	N/A	N/A	■ Insufficient data to calculate rolling median in SW3 & SW4, &SW6 ■ SW1 (0.083 mg/L), SW2 (0.100 mg/L), SW5 (0.128 mg/L) rolling median exceed Lethe Brook WQO. ■ SW5 is upgradient of landfill ■ Exceedance could be associated with background conditions or other contaminant sources ■ Likely reflects regional water due to agricultural activity in the catchment
Total Nitrogen	mg/L	0.85 -1.40	N/A	N/A	X	N/A	N/A	N/A	■ Insufficient data to calculate rolling median in SW2, SW3, SW4 & SW6. Not sampled since 2016. ■ SW1 (0.85 mg/L) and SW5 (1.40 mg/L) rolling medians exceeded the QWQGL 2009 (0.500 mg/L). ■ SW5 is the upgradient location. ■ Exceedance could be associated with background conditions or other contaminant sources ■ Likely reflects regional water due to agricultural activity in the catchment

Surface Water: SW1- SW6 (inclusive)			Environmental Values						Comments
			Aquatic Ecosystem Protection			Irrigation	Stock Watering	Drinking Water	
Contaminant of Concern	Units	Rolling Median Concentration Range	ANZECC 95%toxicants	Lethe Brook WQO	QWQG 2009	ANZECC 2000			
Total Phosphorous (TP)	mg/L	0.050 – 0.290	N/A	N/A	X	N/A	N/A	N/A	■ Concentrations exceed physico-chemical indicator WQO by up to one order of magnitude, in all locations except SW4 (0.050 mg/L). Not a toxicant indicator. ■ SW5 upgradient of the landfill returned highest concentration (0.290 mg/L) against a limit of 0.050 mg/L. ■ Exceedance could be associated with background conditions or other contaminant sources ■ Likely reflects regional water due to agricultural activity in the catchment
Filterable Reactive Phosphorous (FRP)	Mg/L	No data	Not applicable						
Organochlorine Pesticides (OCP)	mg/L	No data	Not Applicable						
Total Recoverable Hydrocarbons	mg/L	Not detected	✓	✓	✓	✓	✓	✓	Insufficient data to calculate rolling medians in SW3 & SW4
BTEX	mg/L	Not detected	✓	✓	✓	✓	✓	✓	Insufficient data to calculate rolling medians in SW1
Polycyclic Aromatic Hydrocarbons	mg/L	Not detected	✓	✓	✓	✓	✓	✓	Insufficient data to calculate rolling medians in SW2, SW3, SW4 & SW6
Volatile Organic Compounds (VOC)	mg/L	Insufficient data	Not Applicable						

10.0 GROUNDWATER

10.1 Monitoring Network

A documented monitoring program for Kelsey Creek Landfill was identified (Woodward-Clyde, May 1999), and is presented in Appendix G. More recent documented monitoring programs do not exist for the Kelsey Creek site.

Monitoring locations are shown in Figure 1 and described in Table 25.

Table 25: Kelsey Creek Landfill - Groundwater Monitoring Network

Bore	Depth (m bgl)[1]	Description	Coordinates (GDA 94)	
			Easting	Northing
MW1	2001 - 14.885 2018 – 11.33	■ Northern boundary, middle of cells	662300.860	7744807.347
MW2	-	■ Assumed to be MW2D*	-	-
MW2S	2001 - 13.49 2008 - 5.80	■ Assumed destroyed / abandoned	-	-
MW2D	2001 -13.49 2018 -15.58	■ South east corner of historic unlined landfill cells ■ Close to southern site boundary	662567.509	7744556.445
MW3	2001 - 14.087 2018 12.30	■ Southern boundary – middle of landfill cells	662344.531	7744589.538
MW4	2008 6.2 2018-9.76	■ Northeast corner of historic unlined landfill cells	662597.951	7744773.367
MW5	2001 – 13.827 2018 – 12.5	■ Southwest corner of active cells, near southern boundary	662060.360	7744636.607
MW6	20018 – 5.4 2011- 12.0	■ Lost / destroyed	-	-
MW7	2008 – 5.4 2018 – 8.2	■ Southwest of landfill operations, in the central portion of the pony club area ■ Adjacent to southern swale and southern site boundary	661631.288	7744696.870
MW8	2008 – 10.3 2018 – 10.52	■ Background well ■ West of pony club, and west of landfill operations, adjacent to riparian vegetation and western Tributary of Lagoon Creek.	661455.112	7744820.002

1. Assumed from Top of Casing (TOC)

*Installed 2003 – considered likely to be the bore currently identified as MW2

10.2 Groundwater Elevations

The following is noted with respect to groundwater elevations:

- Groundwater is flowing the south-east, based on elevation data over time, in sympathy with site topography and surface water drainage;
- Monitoring wells appear to be installed within a single aquifer system, based on the correlation in elevation changes over time;
- Groundwater elevations are increasing slightly over time in MW1, MW2, MW5, MW7 & MW8; and
- Groundwater elevations are generally stable over time in MW3 & MW4.

10.3 Ionic Balance – Piper Plots

Review of the piper plots for groundwater is described below:

- Background well MW8 – tightly clustered (i.e. limited change) over time – sodium chloride type;
- MW2D, MW3, MW4, MW5, MW7 – tightly clustered (i.e. limited change) over time – sodium chloride type; and
- MW1 – Minor drift over time, but not indicative of changing chemistry – sodium chloride type.
- Based on available data, the site groundwater chemistry type is consistent with a single stable aquifer system, with no notable;

10.4 Comparison of Results to Assessment Criteria & Background Well

A summary of exceedances of the calculated rolling medians against assessment criteria, and comparison to background, including achievement of environmental values, and comments is presented in Table 26.

There was insufficient data to calculate statistically valid rolling medians for historical well MW6, which is assumed to have been destroyed.

Table 26: Kelsey Creek Landfill - Groundwater - Summary of Results in Comparison to assessment criteria and Environmental Values

Groundwater Monitoring Wells – MW1 -MW8 (inclusive)			Environmental Values						Comments
			Aquatic Ecosystem Protection			Irrigation	Stock Watering	Drinking Water	
Contaminant of Concern	Units	Rolling Median Concentration Range	ANZECC 95%toxicants	Lethe Brook WQO	QWQG 2009	ANZECC 2000			
pH	N/A	5.67 – 6.61	N/A	X	X	✓	✓	X	■ Rolling median was less than ecosystem protection EV's in MW1 (6.26), MW2 (6.11), MW3(6.23), MW4 (6.61), MW5 (5.68) MW7 (5.67) and MW8 (5.89). ■ Rolling median was less than human use (drinking water) EV in all wells except MW4 (6.61). ■ Given the results for the background bore (MW8) pH conditions considered representative of regional groundwater quality
Electrical conductivity (EC)	µS/cm	4,525 - 24,582	N/A	X	N/A	✓	✓	✓	■ Rolling median in all wells exceeds Lethe Brook WQO by one order of magnitude ■ Consistent with background in all wells except MW5 (24,582 µS/cm) ■ Given the results for the background bore (MW8) pH conditions considered representative of regional groundwater quality
Total Dissolved Salts (TDS)	mg/L	2,804 – 15,844	N/A	N/A	N/A	✓	X	✓	■ Rolling median in background well MW8 (5,259 mg/L) exceeds Stock Watering EV ■ Rolling median in MW7 (8,218 mg/L) upgradient of landfill operations exceeds Stock Watering EV ■ Consistent with background in all wells except MW5 (15,844 mg/L) which is less than one order of magnitude above background ■ Given the results for the background bore (MW8) pH conditions considered representative of regional groundwater quality
Sodium	mg/L	745-4,210	N/A	N/A	N/A	✓	✓	X	■ Rolling median in background well MW8 (1,460 mg/L) exceeds drinking water EV (180 mg/L) ■ Consistent with background in all wells except MW5 (4,210 mg/L) which is less than one order of magnitude above background ■ Given the results for the background bore (MW8) pH conditions considered representative of regional groundwater quality
Heavy Metals									■ Dissolved metals only ■ Insufficient data to calculate rolling median for total metals
Arsenic – total	mg/L	0.005 – 0.0025	✓	✓	✓	✓	✓	✓	
Cadmium	mg/L	0.0001 – 0.0002	✓	✓	✓	✓	✓	✓	■ Rolling median in MW5 (0.0002 mg/L) exceeded the ecosystem protection EV (0.0001 mg/L) ■ No hardness modification of trigger value was conducted, due to lack of hardness data. ■ Analyse for hardness in future to enable hardness modification of trigger value.

Groundwater Monitoring Wells – MW1 -MW8 (inclusive)			Environmental Values						Comments
			Aquatic Ecosystem Protection			Irrigation	Stock Watering	Drinking Water	
Contaminant of Concern	Units	Rolling Median Concentration Range	ANZECC 95%toxicants	Lethe Brook WQO	QWQG 2009	ANZECC 2000			
Chromium – total [Cr(III) +Cr(VI)]	mg/L	0.0005	✓	✓	✓	✓	✓	✓	
Copper	mg/L	0.0005 – 0.0023	X	N/A	N/A	✓	✓	✓	■ Rolling medians exceeded EV at MW1 (0.0035 mg/L) MW2 (0.0020 mg/L), MW3 (0.0015 mg/L), MW5 (0.0023 mg/L) ■ All concentrations less than reported for regional DNRM bore (0.0800 mg/L) in Section 2.8.3 ■ No hardness modification of trigger value was conducted, due to lack of hardness data ■ Analyse for hardness in future to enable hardness modification of trigger value.
Lead	mg/L	0.0005	✓	✓	✓	✓	✓	✓	
Manganese	mg/L	0.170 – 3.450	✓	✓	✓	✓	✓	✓	■ Rolling median in MW5 (3.450 mg/L) exceeded the ecosystem protection EV (1.900 mg/L) ■ No hardness modification of trigger value was conducted, due to lack of hardness data. ■ Analyse for hardness in future to enable hardness modification of trigger value. ■ Less than one order of magnitude greater than rolling median in background well MW 8 (1.31mg)
Mercury	mg/L	0.00005	✓	✓	✓	✓	✓	✓	
Nickel	mg/L	0.001 – 0.031	✓	✓	✓	✓	✓	✓	■ Rolling median in MW5 (0.031 mg/L) exceeded the ecosystem protection EV (0.011 mg/L) ■ No hardness modification of trigger value was conducted, due to lack of hardness data. ■ Analyse for hardness in future to enable hardness modification of trigger value. ■ Less than one order of magnitude greater than rolling median in background well MW 8 (0.004 mg) and EV
Zinc	mg/L	0.001 – 0.035	X	X	X	✓	✓	✓	■ Rolling medians exceeded the ecosystem protection EV in MW1 (0.0035 mg/L) MW3 (0.009 mg/L), MW4 (0.0012 mg/L), MW5 (0.031 mg/L), MW7 (0.017 mg/L) and was equivalent to the trigger value in MW8 (0.008 mg/L). ■ No hardness modification of trigger value was conducted, due to lack of hardness data. ■ Analyse for hardness in future to enable hardness modification of trigger value. ■ All exceedances less than one order of magnitude above trigger value and consistent with background except for MW5.
Ammonia (NH3)	mg/L	0.010 - 0.540	✓	N/A	X	✓	✓	✓	■ Insufficient data to calculate rolling median in MW1

Groundwater Monitoring Wells – MW1 -MW8 (inclusive)			Environmental Values						Comments
			Aquatic Ecosystem Protection			Irrigation	Stock Watering	Drinking Water	
Contaminant of Concern	Units	Rolling Median Concentration Range	ANZECC 95%toxicants	Lethe Brook WQO	QWQG 2009	ANZECC 2000			
									■ Rolling medians exceeded the ecosystem protection EV for ammonia as a physico-chemical indicator in MW3 (0.035 mg/L) MW4 (0.075 mg/L), MW5 (0.0565 mg/L), MW7 (0.0545 mg/L), MW (0.159 mg/L) . ■ Background exceeds the trigger value ■ All exceedances less than one order of magnitude above surface water guideline, except MW5 & MW7. ■ Concentrations consistent with regional background except MW7 (upgradient of landfill operations) and MW5.
Total Oxidised Nitrogen	mg/L	0.005 – 0.013	✓	✓	✓	N/A	N/A	N/A	■ ANZECC guideline for is for NO3
Dissolved Inorganic Nitrogen	mg/L	0.018 – 0.565	X	N/A	N/A	N/A	N/A	N/A	■ Insufficient data to calculate rolling median in MW1 ■ All exceed Lethe Brook WQO for DIN in surface water ■ Rolling median in background MW8 (0.159 mg/L) ■ All wells less than background except MW5 (0.565 mg/L) & MW7 (0.545 mg/L) ■ Considered representative of regional background
Total Nitrogen	mg/L	0.47 – 0.75	N/A	N/A	X	N/A	N/A	N/A	■ Insufficient data to calculate rolling median in MW1 -MW4 (inclusive) ■ Rolling median exceeds trigger value for TN as a physico-chemical indicator (QWQGL 2009) in MW5 (0.75 mg/L) and MW7 (0.80 mg/L) ■ Exceedances less than one order of magnitude above trigger value (0.500 mg/L) for surface water.
Total Phosphorous (TP)	mg/L	0.440	N/A	N/A	X	N/A	N/A	N/A	■ Rolling median in MW3 (0.095 mg/L) and MW7 (0.295 mg/L) exceed QWQG 2009 trigger value for TP (0.050 mg/L) as a physico-chemical indicator in surface water ■ Exceedances less than one order of magnitude above trigger value for surface water
Filterable Reactive Phosphorous (FRP)	Mg/L	No data	Not applicable						
Organochlorine Pesticides (OCP)	mg/L	No data	Not Applicable						
BTEX	mg/L	Not detected	✓	✓	✓	✓	✓	✓	
Polycyclic Aromatic Hydrocarbons	mg/L	Not detected	✓	✓	✓	✓	✓	✓	
Total Recoverable Hydrocarbons	mg/L	Generally, not detected except MW1, MW3, MW5 ■ C6 -C9- not detected	✓	✓	✓	✓	✓	✓	■ Transient, low level detects in some monitoring rounds, at some wells. ■ No trend in detections

Groundwater Monitoring Wells – MW1 -MW8 (inclusive)			Environmental Values						Comments
			Aquatic Ecosystem Protection			Irrigation	Stock Watering	Drinking Water	
Contaminant of Concern	Units	Rolling Median Concentration Range	ANZECC 95%toxicants	Lethe Brook WQO	QWQG 2009	ANZECC 2000			
		■ C10-C14 – 0.025 – 0.065 ■ C15-C28 – 0.050 - 0.410 ■ C29-C36 – not detected – 0.063 ■ C10-C40 - 0.180 ■ F1 -not detected ■ F2 - not detected – 0.190 ■ F3 - not detected – 0.690 ■ F4 not detected							■ Low-level detect not indicative of gross widespread contamination ■ Continue monitoring
Volatile Organic Compounds (VOC)	mg/L	Not detected	✓	✓	✓	✓	✓	✓	■ Insufficient data to calculate rolling median in MW8

N/A not applicable – no guideline

11.0 DISCUSSION OF RESULTS

11.1 Leachate

The results of the assessment indicate that:

- Available data for leachate characterisation was limited to 2 data points, and robust conclusions are not able to be made;
- Based on available data – leachate is possibly of sodium chloride type in Leachate Sump 1 (L1) and sodium bicarbonate type in Leachate Sump (L2).
- Monitoring for anions and cations (total) in leachate should be conducted during all monitoring rounds (quarterly) to enable robust characterisation of leachate signature for comparison against surface water and groundwater monitoring results.

11.2 Surface Water – Water Storage Ponds & Stormwater

Review of available surface water quality data for the water storage ponds indicates that:

- There are several data gaps that have limited the findings of the assessment, including the following:
  - Water storages are not currently monitored during discharge and as such discharge quality to the receiving environment is not currently known.
  - Discharges are not monitored at the site boundary (southern swale, discharging to Lagoon Creek Tributaries East & West) so stormwater quality discharged into the receiving environment is not currently known;
  - SED2 should be routinely monitored to understand ongoing quality and suitability for discharge.
  - Anions and cations are not routinely monitored and as such characterisation of water chemistry is limited.
- Water chemistry in the water storage ponds is generally of indeterminate type. No clear trends regarding changes in water quality over time were apparent in the Piper Plots, based on available data.
- Some exceedances of the assessment criteria for ammonia were observed during some monitoring rounds, however these could not be assessed further due to a lack of data precluding calculation of statistically valid rolling medians. Spikes in ammonia concentrations could be indicative of leachate impact to the water storage ponds. Potential sources of leachate impact to the water storage ponds include leachate seepage into the ponds, or leachate-impacted surface water runoff from irrigation of leachate on interim or final capped surfaces of the waste mound, or leachate-impacted stormwater runoff from operational areas (such as the Green waste Pad)
- The aquatic ecosystem protection EV (Lethe Brook WQO) will not be maintained for pH, electrical conductivity, dissolved oxygen and turbidity in SED1, and exceedances of the assessment criteria for ammonia were observed during some monitoring rounds for SED2.
- Water quality was generally acceptable to maintain the aquatic ecosystem EV for heavy metals, where rolling medians could be calculated. Minor low-level exceedances were observed for zinc; however, hardness modification of trigger values was not able to be completed. Monitoring for hardness in future and modifying trigger values to conduct assessment is recommended. No indications of gross widespread contamination associated with heavy metals were observed from the available data set.

Development of an appropriate leachate and stormwater management strategy (inclusive of leachate irrigation strategy) for the whole of site as part of the Site Based Management Plan would enable more effective management of these water storages, and reduction of water inventory by active discharge, if within appropriate quality limits for discharge offsite.

11.3 Surface Water – Receiving Environment

The current site monitoring program design may have some gaps including:

- An appropriate background monitoring location is not installed up-gradient of Lagoon Creek Tributary West, which limits ability to make comparison to background for water quality from this waterway.
- Receiving environment monitoring locations are situated approximately 1km downstream of site, in an agricultural catchment. Detecting potential site impacts (e.g. from nutrients) may be difficult due to water quality influences from non-landfill land uses on the receiving environment. Data assessment is further limited by the absence of a site discharge monitoring program.

Review of the piper plots for the receiving environment monitoring locations against site leachate indicates:

- Upgradient and downgradient locations both plotting with variation over time.
- Surface water monitoring locations plotting generally as sodium-chloride to indeterminate type waters over time, whilst leachate is plotting as sodium chloride & sodium-bicarbonate type waters over time. No apparent overlap between leachate and surface water conditions on the piper plot over time.

Comparison of results against the assessment criterion indicated that:

- Data gaps exist which precluded calculation of rolling medians for all monitoring locations, for all contaminants of potential concern.
- Some exceedances of the assessment criteria were observed for rolling medians for some contaminants in some monitoring locations, however these were generally for nutrients, and the rolling median in the upgradient monitoring location was generally above that of those in the down-gradient monitoring locations. As such it is considered that these exceedances (for nutrients and metals) are generally representative of catchment scale influences on water quality rather than site operations.
- Update of the monitoring program, and implementation in full will assist in characterising risk to regional ecological receptors from site operations, and to assess if statistically significant change is occurring over time.
- The data set should be reviewed annually, and rolling medians calculated using the 8 most recent monitoring rounds.

11.4 Groundwater

Review of the piper plots indicates that site groundwater is sodium-chloride type, whilst site leachate could not be reliably characterised but is possibly sodium-chloride & sodium bicarbonate type. Site groundwater is plotting in a different region of the piper plot to both L1 and L2.

Comparison of the available groundwater data against assessment criteria indicates the following trends:

- The regional groundwater quality (pH, salinity, sodium, TDS) in MW8 the background well, generally would not support most environmental values (aquatic ecosystem protection for surface water, stock watering, drinking water), based on available data.
- Review of the current investigation data (pH, salinity, sodium, TDS) indicates that site groundwater generally would not support most environmental values (aquatic ecosystem protection for surface water, stock watering, drinking water).
- Groundwater quality on site is consistent with regional groundwater quality in MW8, except for MW5 located on the southern site boundary, in the south-east of the site.
- MW5 is located close to the landfill footprint adjacent to Cell 4 and some distance from the unlined waste mound that is better represented by MW2D and MW3. This would indicate that potential impacts to water quality may be associated leakages from the waste cells. Further investigation for other potential impact sources is required.
- Ammonia and total oxidised nitrogen rolling median concentrations in groundwater are less than trigger values for to maintain aquatic ecosystem EV's for surface water.

- Rolling median concentrations for toxicants generally do not exceed ANZECC 2000 trigger values for toxicants applied at the 95% level of protection for freshwater. Isolated, marginal exceedances were identified in some locations; for some metals, however hardness data was not collected, and hardness modification of trigger values could not be completed.

  Further assessment is recommended to enable calculation of rolling medians and comparison against hardness modified trigger values (HMTV's). This can be achieved by update of the monitoring program to include hardness, calculation of HMTV's, and comparison of data to HMTV's.

  Rolling median concentrations for nutrients as physico-chemical indicators in surface water indicated that groundwater concentrations also generally exceed the aquatic ecosystem protection EV's, including in the background well, but by less than one order of magnitude. Assuming very conservative discharge & dilution ratio for groundwater discharge to surface water of 1:10, the EV could conservatively be assumed to be maintained. We consider that the observed concentrations are representative of regional background, and that discharge to surface water is a low risk of impacting existing quality, and the EV.

- Site groundwater may be used by regional terrestrial ecosystems on and offsite. Based on the data available for interpretation, water quality is suitable to maintain the Irrigation EV, and ecosystem protection EV for terrestrial ecosystems.

- Site groundwater may be extracted offsite by regional users for stock watering. Based on the data available for interpretation water quality onsite is unsuitable to maintain the stock-watering environmental values due to salinity (Total Dissolved Salts), however this appears to be a regional groundwater quality issue rather than from widespread leachate impact to groundwater from the landfill.

- Site groundwater may be extracted offsite by regional users. Observed salinities of site and regional groundwater, including the background well on site, would preclude use as a drinking water source (sodium concentrations 20mg/L for health reasons, and should not exceed 180 mg/L for drinking water). Regional groundwater quality would not support groundwater use for drinking water due to salinity. Based on available data, there appears to be a low risk that the landfill is impacting regional groundwater salinity.

- Additional environmental values are maintained if the more sensitive environmental values above are maintained.

12.0 SUMMARY OF RESPONSE TO THE NOTICE – ASSESSMENT

A summary outlining report sections that address requirements 6-13 of the notice is presented below.

No.	Requirement	
6	Assess the nature and extent of groundwater and surface water contamination from the landfill and the effects on surrounding environmental values.	This report
7	Provide a description of all surface and subsurface infrastructure (e.g. pipe, tanks, sumps, dams, bores) that could: i) Have been a source of contaminants ii) Be affected by contaminants iii) Either be a barrier to or facilitate the migration of contaminants	Section 2.4
8	Provide a description of the surrounding land including:	
I	All environmentally sensitive areas	Section 2.9
Ii	The quality of environmental values in the context of the Environmental Protection (Water) Policy 2009	Section 3.0
Iii	Surface water, groundwater, wetland and surface drainage that could be affected by or disperse contaminants	Section 2.0
iv	Any potentially impacted groundwater or surface water users	Section 2.8.1
9	Provide a conceptual site model which details potential contaminant sources and migratory pathways through the environment which may in turn impact sensitive receptors.	Section 4.0
10	Provide information on leachate analysis of any contamination identified in the surface and subsurface soil directly beneath the site, under the areas (cells) where waste is buried and actively deposited	Section 7.0 Section 8.0 Section 9.2.1
11	Identify the type(s), depth(s), locations(s) and hydrogeology of groundwater aquifers in the area.	Section 2 Section 3
12	Determine groundwater movement (transmissivity) based on the local hydrogeology	Section 2.8.4
13	Investigate and report on whether any leachate from the areas (cells) where waste is buried and actively deposited is causing groundwater contamination.	Section 5.0 to Section 11.0
14	Determine the extent of contamination of groundwater by conducting a contamination plume assessment	Section 11.4 Section 12
15	Establish an appropriate background control(s) groundwater well monitoring location to establish background data quality of each aquifer identified.	Section 10.2
16	Compare the results from background wells to the results within the plume and consider the impact of the areas (cells) where waste is buried and actively deposited, measured against relevant water quality guidelines (ANZECC 2000).	Section 10.4
17	Investigate and report on whether any leachate from under the areas (cells) where waste is buried and actively deposited is causing surface water contamination.	Section 9

13.0 CONCLUSIONS & RECOMMENDATIONS

13.1 Conclusions

Key findings of the assessment are outlined below:

Infrastructure

- Underground infrastructure which may potentially act as a preferential contaminant migration pathway exists at the site as follows:
  - Water main pipeline and surrounding backfill sands that runs from the Mackay Council water treatment plant. This pipeline is hydraulically up-gradient of the landfill cells;
  - Leachate pipes that collect and convey leachate to leachate sumps;
- Site soils generally have a low permeability, which reduces rainfall infiltration and potential leachate migration into / through site soils to groundwater.

Environmental Values

- There are no high value aquatic ecological receptors in the receiving environment.
- Multiple environmental values apply the site and receiving environment.
  - Ecosystem protection is the most conservative water quality environmental value and assessment criteria related to it were used to complete data assessment for surface water and groundwater.
  - Drinking water is an environmental value for the site, however regional water quality would not support drinking water as an EV based on the following:
    - Salinity in surface water on site and regionally.
    - Sodium concentrations exceeding the health-based ADWG guideline of 20mg/L.
  - Irrigation and stock watering are environmental values for:
    - surface water receiving environments.
    - Groundwater and groundwater users
    - Site and regional groundwater quality (TDS) would preclude use of groundwater for stock watering.
- Lagoon Creek, an ephemeral waterway (only runs during the wet season following intense rainfall) that is highly modified, is the primary aquatic ecosystem receiving environment. Riparian (creek line) vegetation associated with Lagoon Creek could potentially be a groundwater dependent ecosystem particularly at a distance downgradient from the landfill site. Other GDE were not identified in the receiving environment, and Lagoon Creek is not mapped as an aquatic GDE.

Conceptual site model

- A conceptual site model was developed the site, and the key sources of potential adverse impact to environmental values are:
  - Leachate associated with historical unlined landfill cells and adjacent water storage pond SED1 that may be impacted by leachate; and
  - Leachate irrigation and runoff from interim / final capped areas to site stormwater system and water storage ponds SED1 & SED2; and
  - Stormwater runoff from operational areas that may be contaminant impacted or sediment laden.

Monitoring Program Design

- Kelsey Creek Landfill has a documented Monitoring Program (Woodward-Clyde, May 1999); however, the program has gaps and does not reflect the current site operation, which has limited the findings of this assessment. Key data gaps included (but were not limited to) the following:
  - Leachate sumps not included in Monitoring Program (Woodward-Clyde, May 1999), resulting in insufficient data being available to fully characterise leachate signatures in leachate sumps 1 & 2;
  - Water storage ponds not included in Monitoring Program (Woodward-Clyde, May 1999), resulting in insufficient data being available to calculate statistically valid rolling medians for comparison to assessment criteria for:
    - Selected contaminants of potential concern for water storage pond SED1, particularly ammonia.
    - Water storage pond SED2;
  - The frequency of monitoring, and analytical suite for contaminants of potential concern in (Woodward-Clyde, May 1999) may not be adequate to fully characterise risks to environmental receptors.

Leachate

- Leachate characterisation was limited by data gaps but is possibly sodium chloride type in L1 and sodium bicarbonate type in L2. Leachate chemistry similar to native water chemistry will reduce the potential to detect a leachate impact signal in receiving water.
- The older waste mound area us unlined, however, it is understood to have a perimeter leachate interception system.
- The four engineered cells have leachate collection systems that gravity drain to two leachate sumps.
- Kelsey Creek Landfill site currently has a documented leachate management procedure.
- A documented leachate management strategy that identifies the volume of leachate requiring management and associated irrigation capacity required, and mechanisms to mitigate risk during irrigation does not currently exist. The leachate irrigation procedure and site-based management plan do not identify leachate irrigation management controls including avoidance of over-irrigation, wind-drift management, avoiding leachate runoff.
- Current leachate irrigation areas may not comply with the conditions of the site EA.

Surface Water

- Runoff potential from the site is greatest during the wet season months of January and February, when evaporation is less than rainfall. Runoff potential is also high during adjacent seasonal rainfall months.
- Stormwater discharge from site is to Lagoon Creek Tributary East, and Lagoon Creek Tributary West.
- Kelsey Creek Landfill has a stormwater management plan; however, it is not clear if this plan is being implemented in full to manage all risks stormwater quality associated with site operations.
- There is no hydraulically up-gradient / monitoring location for Lagoon Creek Tributary West. An appropriate monitoring location should be developed and incorporate into an updated site monitoring plan.
- Stormwater discharge from site not currently monitored at the site boundary / point of discharge that limits assessment of water quality discharged into the receiving environment. The level of risk associated with stormwater is not fully characterised, however spikes in ammonia concentrations for some monitoring rounds are noted that may reflect leachate impact to water storage ponds.
- Leachate irrigation on interim and final capped slopes of the waste mound may be entering site stormwater systems during high rainfall periods. Irrigation and stormwater management practices should be reviewed to eliminate potential leachate impacts to site stormwater via runoff from irrigation areas.

- Leachate may potentially be impacting the water storage pond SED1 in the east of the site, via seepage from the unlined landfill cell, into the pond. Historical leachate management infrastructure was understood to have been installed at surface / just below subsurface around the base of the older mound area [(Maunsell Aecom , 2008) Appendix C]. Management and maintenance of this infrastructure should be included within a whole of site leachate management strategy.
- There was insufficient data to make a statistically reliable comparison of ammonia concentrations to assessment criteria, and to assess potential impact to environmental values, for water storage ponds and selected surface water receiving environment monitoring locations SW2, SW3, SW4 & SW6. This is a key data gap and has limited the conclusions of the assessment. Continue monitoring and ensure that ammonia is monitored at every location in every round.
- Calculated rolling medians for heavy metals were generally less than ANZECC 95% trigger values for freshwater at the 95% protection level. Isolated, low level exceedances were identified, but hardness modification of trigger values was not able to be completed due to hardness data not being available. These are considered low-risk to maintenance of aquatic ecosystem environmental values, and not indicative of environmental harm. Monitoring program should be updated to include hardness for all monitoring rounds to enable hardness modification of trigger values and further assessment using hardness modified trigger values should be completed.
- Calculated rolling medians for that did not meet aquatic ecosystem protection EVs, for physico-chemical indicators (nuisance growth of aquatic plants) were detected in some receiving environment samples for some parameters. Results were generally consistent with or lower than background. These are inferred to be representative of regional background, due to the intensity of agricultural activity in the catchment.
- Site stormwater systems are a potentially active exposure pathway. Based on available data, there does not appear to be gross, widespread contamination, or significant widespread impact to environmental values offsite, due to the landfill operation. However, there are key risks which have not been adequately quantified due to data gaps, and these should be assessed. Site stormwater systems are a potentially active exposure pathway which require additional monitoring and management to characterise and mitigate risks to environmental values.

Groundwater

- There is limited information on soil geological conditions underlying the site.
- A background well was identified for the site groundwater, MW8.
- All groundwater wells appear to be installed in the same aquifer.
- Groundwater elevation is increasing slightly or stable.
- Review of available groundwater ionic balance data indicates that groundwater chemistry is relatively stable over time and is native sodium-chloride type. Leachate signatures (based on a limited data set) are sodium-chloride (L1) and sodium-bicarbonate type (L2).
- The quality of regional groundwater (based on the background well MW8) is unsuitable to maintain all of the scheduled groundwater environmental values. Specifically, pH, EC, and TDS are not acceptable quality to maintain aquatic ecosystem protection, drinking water, irrigation and stock watering EV's.
- Site groundwater generally reflects regional trends. The exception is MW5, where concentrations of certain contaminants concern appear elevated in comparison to background conditions. It is important to note; however; that:
  - There is a low risk the unlined waste disposal area would influence the area adjacent to MW5.
  - Whilst concentrations are elevated in comparison to background, is not displaying change over time toward sodium-bicarbonate type water chemistry considered representative of leachate.
- Concentration of some contaminants of concern were slightly elevated in relation to trigger values for ecosystem protection, however exceedance of the trigger values does not represent "contamination" rather that further monitoring and assessment is warranted.

- A contamination plume assessment has, therefore, not conducted to date, as evidence of potential impacts to regional environmental values has not been clearly identified within the site boundary.

13.2 Recommendations

The following actions are recommended based on the findings of this investigation:

- Prepare and document plans for the whole-of-site management of surface water and leachate, including leachate irrigation management. These should include a review of the irrigation system operation for compliance with the conditions of site EA.
- Following the development and implementation of the site stormwater and leachate management strategies, develop a whole of site Leachate Detection Monitoring Program that includes:
  - A stormwater discharge monitoring program. to support full characterisation of risk off-site receptors from current site operations.
  - A review of value of the current off-site surface water monitoring program. This may require changing the conditions of the site EA.
- Review and upgrade field QA/QC requirements, sampling methodologies, and training & competency requirements under the LDMP to ensure that data collected under the LDMP is representative of site conditions.
- Continue monitoring and implement the Leachate Detection Monitoring Program (LDMP) in full including:
  - Implementation of the full program outlined in the LDMP to support the collection of statistically valid data sets for interpretation of site conditions;
  - Update LDMP to include hardness, to enable hardness modification of metals trigger values during data interpretation.

14.0 REFERENCES

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15.0 IMPORTANT INFORMATION

Your attention is drawn to the document titled - "Important Information Relating to this Report", which is included in Appendix M of this report. The statements presented in that document are intended to inform a reader of the report about its proper use. There are important limitations as to who can use the report and how it can be used. It is important that a reader of the report understands and has realistic expectations about those matters. The Important Information document does not alter the obligations Golder Associates has under the contract between it and its client.

Signature Page

Golder Associates Pty Ltd



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James Begg
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KLC/JSB/ow

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https://golderassociates.sharepoint.com/sites/23374g/documents/deliverables/1790603-002-r-rev0 kelsey creek environmental evaluation.docx

APPENDIX A

Notice - STAT 1236- 2 November 2017 &

P1790603-001-L-Rev1

Notice

Environmental Protection Act 1994

Environmental Evaluation

Notice to conduct or commission another environmental evaluation

This notice to conduct or commission another environmental evaluation is issued by the administering authority pursuant to section 326I(2) of the Environmental Protection Act 1994.

Whitsunday Regional Council
83-85 Main Street
PROSERPINE QLD 4800

Your reference: EPPR00190813

Our Reference: CA38878 / STAT1235

2 November 2017

Take notice: that under the *Environmental Protection Act 1994* (the Act), a notice requiring you conduct or commission another environmental investigation and submit a report on the investigation is issued to Whitsunday Regional Council (you) by the administering authority. The administering authority is the Chief Executive of Department of Environment and Heritage Protection (the department).

This notice to conduct or commission another environmental evaluation is issued in respect to the activities by Whitsunday Regional Council at the Kelsey Creek Landfill on land described as Lot 160 on SP171910, Lot 277 on SP113325, and Lot 299 on SP113325 situated at Kelsey Creek Road, Proserpine QLD (the site).

A. Grounds

The notice to conduct or commission another environmental investigation is issued on the following grounds:

- Whitsunday Regional Council (WRC) hold environmental authority EPPR00190813 (EA) (previously registration certificate ENRE00693807 and conditions for which are included in developmental approval IPDE00656507), approving environmentally relevant activity (ERA) 60 – waste disposal, less than 50,000t of waste in a year [subsection 1(a)] and more than 20,000t, but less than 50,000t of waste in a year [subsection 2(e)].
- On 17 February 2016, a site inspection was conducted by departmental officers, which identified contraventions of conditions of the EA and concerns in relation to potential leachate management controls and subsequent potential exposure to groundwater and surface water.
- WRC provided the department a report titled '*December 2015 Leachate, Environmental Monitoring: Bowen and Kelsey Creek Landfills*' which contained the results of surface and groundwater monitoring conducted by Golder Associates on 17 and 18 December 2015. The department's Technical Support Unit assessed the report and advised that chemicals of concern (characteristic of leachate) were identified in both groundwater and surface water at the site and recommended further investigation.

ABN 46 640 294 485

- WRC provided the department a report titled *'May 2016 Leachate, Environmental Monitoring: Kelsey Creek Road Landfill'* which contained the results of surface and groundwater monitoring conducted by Golder Associates on 11 and 18 May 2016. The results show that numerous samples exceed the National Environment Protection Measure (NEPM) published guidelines.
- On 8 February 2017 the department issued a notice to conduct or commission an environmental investigation to you (the 8 February 2017 notice).
- On 31 July 2017 you submitted an environmental report (the report) to the department.
- On 14 August 2017 the department issued a notice requesting further information to you.
- On 11 September 2017 you submitted further information to the department.
- On 9 October 2017, the department issued a notice refusing to accept the environmental report for the environmental investigation on the grounds that the report and the further information submitted by you does not adequately address requirements 1, 2(a)(i), 2(a)(ii), 2(a)(iii), 2(b)(iv), 2(b)(v), 2(b)(vii), 2(c), 2(d), 2(e), 2(f), 2(g), 2(h), 2(i) and 2(j) of the 8 February 2017 notice.
- In accordance with s326B(l)(2) of the Act, the department is satisfied on reasonable grounds that the above reports and non-compliances at the Kelsey Creek Landfill are causing, or are likely to cause environmental harm on the following environmental values: surface water and groundwater and requires that you conduct or commission another environmental investigation.

B. Requirements

The report on the environmental investigation must address the following matters:

Terms of reference

1. Develop and submit to a terms of reference document, outlining the methodology to be used to ensure that each 'assessment' and 'remediation' requirement listed below will be achieved.
2. A **suitably qualified person** must conduct the assessment as per requirements 6 to 18. Provide details of the **suitably qualified person** who has been commissioned by Whitsunday Regional Council to undertake the assessment, including:
    a. Qualifications; and
    b. Relevant experience.

    The definition of a **suitably qualified person** is provided at the bottom of this notice.
3. Provide a communication strategy for neighbouring property owners to assist in determining the extent, if any, of the groundwater and surface water contamination plumes. The strategy must also include how you will communicate any recommended actions as an outcome of the investigation to neighbouring property owners.
4. The terms of reference document must be provided to the department on or before **20 November 2017**.
5. Any comments made by the department on the terms of reference document must be considered and, where determined in consultation with department, included or implemented to ensure that each assessment requirement listed below is adequately undertaken and achieved.

Assessment

6. Conduct an assessment of the nature and extent of groundwater and surface water contamination from the landfill, and the effects on surrounding environmental values.

7. Provide a description of all surface and subsurface infrastructure (e.g. pipes, tanks, sumps, dams, bores) that could:
   i. Have been a source of contaminants;
   ii. Be affected by contaminants; and
   iii. Either be a barrier to or facilitate the migration of contaminants.

8. Provide a description of the surrounding land, including:
   i. All environmentally sensitive areas;
   ii. The quality of existing environmental values, in the context of the *Environmental Protection (Water) Policy 2009;*
   iii. Surface water, groundwater, wetlands and surface drainage that could be affected by or disperse contaminants; and
   iv. Any potentially impacted groundwater and/or surface water users.

9. Provide a conceptual site model which details potential contaminant sources and migratory pathways through the environment which in turn may impact sensitive receptors.

10. Provide information on the leachate analysis of any contaminants identified in the surface and subsurface soil directly beneath the site; under the areas (cells) where waste is buried and actively deposited.

11. Identify the type(s), depth(s), location(s) and hydrogeology of groundwater aquifer(s) in the area.

12. Determine ground water movement (transmissivity) based on the local hydrogeology.

13. Investigate and report on whether any leachate from under the areas (cells) where waste is buried and actively deposited, is causing groundwater contamination.

14. Determine the extent of contamination of groundwater by conducting a contamination plume assessment.

15. Establish an appropriate background control(s) groundwater monitoring well location to establish background quality data of each aquifer identified.

16. Compare the results from the background wells to the results within the plume and consider the impact of the areas (cells) where waste is buried and is actively deposited, measured against relevant water quality guidelines (ANZECC 2000).

17. Investigate and report on whether any leachate from under the areas (cells) where waste is buried and actively deposited, is causing surface water contamination.

18. The environmental report must be submitted to the department on or before **21 May 2018**.

Remediation

19. Based on the results of the assessment and the extent of released contaminants (leachate), a remediation action plan must be developed by a suitably qualified person and must ensure and provide for the ongoing protection of the environmental values of the receiving environment.

20. The remediation action plan must be submitted to the department on or before **20 August 2018**.

The environmental investigation must be carried out, and the environmental report prepared, by a **suitably qualified person** with relevant qualifications and experience.

A **suitably qualified person** is defined as a person or persons who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis of performance relative to the subject matter using the relevant protocols, standards, methods or literature.

As the recipient of this notice, you are also required to provide a statutory declaration in the form attached to accompany the environmental report submitted to the department. The suitably qualified person who prepares the environmental report must also provide a statutory declaration in the form attached to accompany the environmental report submitted to the department.

You can view an electronic version of the statutory declaration for a recipient using the search term (ESR/2016/1997).[1]

Take notice:

- the requirements of the notice to conduct or commission an environmental investigation take effect immediately upon service of this notice;
- this notice remains in force until further notice from the department; and
- you are responsible for meeting the costs of conducting or commissioning the environmental investigation, preparing the environmental report and providing any further information as requested by the department.

C. Reviews and appeals

The provisions regarding reviews of decisions and appeals are found in sections 519 to 539 of the Act.

A person, who is dissatisfied with certain decisions of the department, may be able to apply to have the department review that original decision.

Generally, a request to have a decision reviewed must be made:

- within 10 business days of the decision being notified to the person;
- be supported by enough information to enable the department to decide the application for review; and
- be made using the application for review of an original decision form (ESR/2015/1573).

Where an application has been made for a decision to be reviewed, the applicant may also apply to the relevant court for a stay of the decision to secure the effectiveness of the review.

[1] This is the publication number. The publication number can be used as a search term to find the latest version of a publication at <www.ehp.qld.gov.au>.

Once the original decision has been reviewed, a person who is dissatisfied with the review decision may be able appeal against that decision to the relevant court within 22 business days after receiving notice of the review decision.

A person whose interests are or would be adversely affected by a decision of the department may be able to request a statement of reasons for a decision or a statutory order review under the *Judicial Review Act 1991*.

For further information about reviews and appeals see the information sheet - internal review and appeal to the Planning and Environment Court (ESR/2015/1572). You may have other legal rights or obligations and should seek your own legal advice.

D. Penalty

Failure to comply with a notice to conduct or commission another environmental investigation is an offence.

- The maximum penalty for an individual is 300 penalty units, totalling $37,845.00.
- The maximum penalty for a corporation is 1500 penalty units, totalling $189,225.00



Signature

2 November 2017

Date

Kate Harbert

Manager (Compliance)

Delegate of the Chief Executive

Department of Environment and Heritage Protection

Environmental Protection Act 1994

Enquiries:

Department of Environment and Heritage Protection
21-30 Wood Street
PO Box 2001
MACKAY QLD 4740
Ph: (07) 4999 6883
Email: CWES_Mackay@ehp.qld.gov.au

Queensland Government

Ref Kelsey Creek Landfill – CA38878; STAT1235; EPPR00190813
Bowen Landfill – CA39473; STAT1236; EPPR00920813

30 January 2018

Whitsunday Regional Council
83-85 Main Street
PROSERPINE QLD 4800

Attention: Adam Hagy
Email: Adam.Hagy@whitsundayrc.qld.gov.au

Attention: Kerrie Pearson
Email: Kerrie.Pearson@whitsundayrc.qld.gov.au

Dear Mr Hagy and Ms Pearson,

RE: Notice to conduct or commission another environmental evaluation: Kelsey Creek Landfill and Notice to conduct or commission another environmental evaluation: Bowen Landfill (proposed extensions)

The Department of Environment and Science (the department) refers to your letter dated 20 December 2017 requesting the following extensions:

1. Kelsey Creek landfill environmental evaluation: extending the due date from 21 May 2018 to 21 August 2018 for requirement 18 for the submission of an environmental report.
2. Kelsey Creek landfill environmental evaluation: extending the due date from 20 August 2018 to 20 November 2018 for requirement 20 for the submission of the remediation action plan.
3. Bowen landfill environmental evaluation: extending the due date from 21 May 2018 to 21 August 2018 for requirement 18 for the submission of an environmental report.
4. Bowen landfill environmental evaluation: extending the due date from 20 August 2018 to 20 November 2018 for requirement 20 for the submission of the remediation action plan.

The history of the Bowen Landfill is as follows:

1. On 15 February 2017 the department issued a notice to conduct an environmental evaluation to you.
2. On 9 October 2017 the department issued a notice refusing to accept the report for the environmental investigation to you.

Level1
22-30 Wood St
PO Box 2001 Mackay
Queensland 4740 Australia
Telephone + 61 7 4999 6883
Website www.des.qld.gov.au
ABN 46 640 294 485

3. On 2 November 2017, the department issued another notice to conduct or commission an environmental evaluation to you. The notice required that you submit an environmental report by 21 May 2018.

The history of the Kelsey Creek Landfill is as follows:

1. On 8 February 2017 the department issued a notice to conduct an environmental evaluation to you.
2. On 9 October 2017 the department issued a notice refusing to accept the report for the environmental investigation to you.
3. On 2 November 2017, the department issued another notice to conduct or commission an environmental evaluation to you. The notice required that you submit an environmental report by 21 May 2018.

On 7 December 2017, you attended a meeting with the department to discuss the terms of reference that had been submitted on 20 November 2017 for the Bowen and Kelsey Creek landfills. During that meeting you proposed extending the timeframes for submission of the environmental reports and remediation action plans. The extensions were requested due to financial impacts associated with the regions recovery from ex Tropical Cyclone Debbie.

The department has considered your requests to extend the due date for submission of the environmental report and remediation action plans for Kelsey Creek Landfill and Bowen Landfill and has consented to these extensions. The new due dates are as follows:

- **Kelsey Creek Landfill environmental report: 21 August 2018**
- **Kelsey Creek Landfill remediation action plan: 20 November 208**
- **Bowen Landfill environmental report: 21 August 2018**
- **Bowen Landfill remediation action plan: 20 November 208**

All other requirements of the notices remain the same.

Please note that under section 326D of the *Environmental Protection Act 1994*, it is an offence to fail to comply with a notice to conduct or commission an environmental evaluation unless the person has a reasonable excuse.

If you wish to discuss this matter, please contact Naomi Camilleri, Senior Environmental Officer on telephone (07) 4999 6884 or via email, Naomi.Camilleri@ehp.qld.gov.au.

Yours sincerely

Kate Harbert
Manager, Compliance
Environmental Services and Regulation
Department of Environment and Science

24th November 2018 Proposal No. P1790603-002-L-Rev1

Kerrie Pearson
Whitsunday Regional Council
PO Box 104
Proserpine
QLD 4800

BOWEN & KELSEY CREEK LANDFILLS – PROPOSAL FOR ENVIRONMENTAL EVALUATIONS – NON-COMMERICAL

Dear Kerrie

1.0 INTRODUCTION

Further to your telephone call with Katie Carter on Friday 8th December 2017, Golder Associates is pleased to present this revised proposal to conduct two Environmental Evaluations, in response to notices received from the Department of Environment & Heritage Protection as follows:

- Bowen Landfill – Notice to conduct or commission another environmental evaluation – dated 2nd November 2017 (Ref CA39473 /STAT1236, Environmental Authority – EPPR 00928013); and
- Kelsey Creek Landfill – Notice to conduct or commission another environmental evaluation – dated 2nd November 2017 (Ref CA38878 /STAT1235, Environmental Authority – EPPR 00190813).

Our updated proposal takes into account WRC's request that the base case for the EE's would involve all environmental sampling to be conducted by WRC personnel.

We propose the following methodology / Terms of Reference to respond to the notices.

2.0 DESKTOP REVIEW AND DATA GATHERING

We propose to conduct a desktop study to collate, and update available information, to respond to the notice, and assist in gap analysis for finalising the works (if any) that may be required to respond fully to the notices.

- **Review of Historical aerial photographs** – to validate the historical extents of landfilling operations, and environmental controls (e.g. leachate and sedimentation capture ponds), and delineate / define the footprint and lateral extents of the source for potential leachate contamination of sensitive environmental receptors by landfilling operations at the site (s). This task will also contribute information toward update / development of Conceptual Site Models (CSM).
- **EHP Reports Online Search –** to assist in identifying Sensitive Environmental Receptors and defining environmental values for the receiving environment, contributor to update of CSM.
- **Review of Queensland Globe** - to further define & document current environmental values and sensitive environmental receptors with legislative protection, contributor to update of CSM.
- **Review of previous investigation reports**, to identify monitoring infrastructure (groundwater wells, surface water monitoring points, leachate management infrastructure, stormwater management infrastructure. Key outputs of this task will include: review of groundwater monitoring borehole logs to collect information on water bearing strata, long-term well gauging information to determine changes in groundwater heights at the site(s) and contribute to development of groundwater contour plots for each.

- **Review of Council records** (e.g. as-constructed drawings, survey, design drawings and design reports) for each landfill site to verify existing site conditions and proposed/installed infrastructure. Review of Site Based Management Plan(s) for each site and existing leachate and stormwater management controls.
- **Interviews** (by phone or in person) with Council operations and engineering personnel with long-term association with the landfill site to assess and document infrastructure likely to be installed at the site(s), and any historical and current stormwater and surface water management practices.
- **Data analysis – compile long term groundwater and surface water data to:**
  - Characterise leachate quality, and changes in leachate quality over time (if not completed already) to identify indicators of leachate contamination at the site(s)
  - Characterise background / regional groundwater quality, and level(s) at the sites;
  - Characterise groundwater quality in target aquifer(s) at the site(s)
  - Characterise concentrations of Contaminants of Potential Concern (COPC) in target aquifers & surface water systems at the site(s).
- **Hydrogeology – Aquifer Transmissivity**
  - Identify appropriate reference values for aquifer transmissivity for target aquifers at the site, via review of Golder Associates data holdings, published reference values, and literature search.
- **Gap Analysis**
  - Conduct a gap-analysis regarding the requirement (if any) to install additional groundwater monitoring wells, leachate sampling locations, sediment pond sampling locations, surface water sampling locations (site-impacted on site, and / or off-site receiving environment locations, or background locations).
- **Sample Analysis & Quality Plan**
  - Develop and document an SAQP for the fieldwork program, including DQO, QA/QC, Contaminants of Concern, Sample collection methodologies and frequencies.

We note that Golder has completed aspects of the above scope of works for Bowen Landfill previously.

3.0 FIELDWORK

3.1 Site Walkover Inspection

- Detailed walkover site inspection to verify / validate presence / absence of infrastructure (stormwater management structures, leachate management structures, sedimentation ponds) with current Council Operational personnel.
- Review operational area of site for evidence of leachate seepage expression on the site surface.
- Validate findings of desktop review.

3.2 Survey (Provisional Extra)

Based upon the review of Council supplied information and observations from our site inspection, Golder will identify potential data gaps where we consider that additional site survey may be necessary that could potentially include the following:

- Survey of operational domains of site(s) to determine actual catchments, catchment sizes, stormwater flow paths and discharge points. Survey information will also inform remedial strategy development, or could utilise existing Council data for the sites, depending on availability. Contour intervals for survey will be determined in consultation with Council pending the outcomes of the desktop assessment.

- Survey of Groundwater well elevations – top and bottom of casing (in mAHD) to inform accurate determination of groundwater levels (in mAHD), development of groundwater contour maps for aquifers, and determination of direction of groundwater flow (from well gauging information).

Council can undertake any additional survey required directly or Golder could organise additional survey at Council's request.

3.3 Groundwater well installation and development (Provisional Extra)

Based upon our previous assessments and well installation works at Bowen Landfill. we have assumed that installation and development of additional groundwater monitoring bores may not be required. Our rationale is as follows:

- A total of fourteen existing groundwater monitoring wells on site, inclusive of nine wells installed in 2012, following a review of the existing groundwater monitoring program. Existing wells target both deep and shallow aquifers, and were installed in response to observed significant change (approx. 5m increase in GW elevation in preceding 5 year period). On this basis, we have assumed that installation and development of additional groundwater monitoring bores is unlikely to be necessary to characterise groundwater conditions at the Bowen site. This would be confirmed following the desktop review.

The potential need for additional monitoring wells at Kelsey Creek Landfill is currently unknown. We note that eight existing groundwater monitoring wells on site, located on generally at the site perimeter. For the purposes of this proposal we have assumed the following:

- Installation and development of up to a maximum of seven additional bores (provisionally 3 deep, 3 shallow, and 1 hydraulically up-gradient / background location).

The provisional sum assumes average depth of bore installation would be 10 m (i.e. total 70 m drilled) and that all bores would be installed and developed in a single mobilisation to the site. All bores installed would be logged in the field by a Golder Associates Scientist / Engineer, and bore logs recording subsurface conditions and well construction details produced as deliverables for the investigation. Bores would be allowed to stabilise for a minimum of 3 days following development prior to groundwater sampling being completed.

3.4 Technical Oversight of Monitoring Events

In response to WRC's proposal to undertake all monitoring events in-house, we have made provision to provide technical oversight to ensure that all monitoring data collected is of appropriate quality for interpretation of site conditions. This will include: review of WRC sampling methods and procedures (documented and audit in the field), availability to provide advice during monitoring events to ensure that unusual site conditions are assessed in the investigation, advice on limits of reporting to be adopted for laboratory analytical suite. Review of collected data to determine if DQI have been achieved (ie. if re-sampling is required).

3.5 Conduct Monitoring Events (Provisional Estimate)

Conduct two monitoring events for groundwater, surface water and leachate. Completion of the monitoring program requires sample collection by suitably qualified persons (SQP) complying with the requirements of the National Environmental Protection (Contaminated Land) Measure. Council could potentially undertake the sampling as an alternative to Golder, subject to satisfying EHP that it can meet these requirements.

One of these rounds would fulfil the requirements of Councils' Annual Monitoring Event for each site, whilst the second round would fulfil the requirements of a quarterly monitoring event for each site with respect to Council's existing monitoring programs.

The exact number of samples to be collected and tested at each landfill site will be dependent upon the findings of the desk top review.

3.5.1 Gauging

Gauge groundwater heights by dipping wells to determine water levels. To manage costs associated with the environmental evaluation, we have assumed that WRC will conduct this task, and that gauging will be conducted on a monthly basis from December 2017 – April 2018 (5 events).

We note that the short period of time provided by EHP to conduct the environmental evaluation will not enable any meaningful data to be collected regarding seasonal changes in groundwater levels and quality at the site(s), associated with the wet-dry tropical climatic regime at the sites.

3.5.2 Groundwater Monitoring

Groundwater monitoring would be based on the existing Leachate Detection Monitoring Program for the Bowen site, developed in 2012 by Golder Associates.

Table 1: Groundwater Monitoring Events

Site	GWMBs	COPCs	Rationale for COPCs	QA/QC – per event	Total samples for analysis
Bowen	MB2 – MB16S (inclusive) + 2 regional background bores	Anions & Cations, incl ionic balance (Na, K,Ca, Mg, Cl, SO4, CO3, OH, HCO3) Total Alkalinity NOx – total & NO2 /NO3 NH3 as N TP & FRP 8 heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn) – total and dissolved TRH / BTEXN	Existing Leachate Detection Monitoring Program – Bowen	Blind duplicate Split duplicate Rinsate blank – metals & TRH only Field blank Trip spike (volatiles)	17 + 5 QA/QC
Kelsey Creek	MB1-MB8 (inclusive) + 2 regional bores (background, and down-gradient) +7 new bores				17 + 5 QA/QC

3.5.3 Surface Water Monitoring (Provisional Estimate)

- **Bowen** - We have made provision to establish a surface water monitoring program at the Bowen Landfill Site consisting of a maximum of 8 monitoring locations, based on the findings of the desktop review, and site inspection. Based upon our knowledge of the site, the presence of surface water run-off will be dependent upon weather conditions during the project.
- **Kelsey Creek** - use existing surface water monitoring program locations established at the Kelsey Creek Landfill, in particular due to the availability of historical data set for these sites.

Table 2: Surface Water Monitoring Program Summary

Site	Location	COPCs	Rationale for COPCs	QA/QC – per event	Total samples for analysis
Bowen	Up to 8 SW monitoring locations Up-gradient / Background (2) Site boundary (3) Receiving environment (3)	Anions & Cations, incl ionic balance (Na, K,Ca, Mg, Cl, SO4, CO3, OH, HCO3) Total Alkalinity NOx – total & NO2 /NO3 NH3 as N TP & FRP 8 heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn) – total and dissolved TRH / BTEXN	Leachate Detection Monitoring Program – Bowen	Blind duplicate Split duplicate Field blank Trip spike (volatiles)	8 +3 dupes
Kelsey Creek	SW1 –SW6 inclusive				8 +3 dupes

3.5.4 Leachate Monitoring (Provisional Estimate)

We propose to conduct two monitoring events as follows:

- Monitoring of 2 existing stormwater / leachate control structures on site (2 monitoring events)
- Collection and analysis of a maximum of 4 opportunistic samples from potential seepage points (if observed) either on-site or in the immediate vicinity of site boundaries (2 per event)
- Collection of 2 leachate samples (where possible) from each site to characterise leachate for site specific leachate signature analysis (Anion / Cation Balance, Piper Plots).

Table 3: Leachate Monitoring Program – Summary

Site	Location	COPCs	Rationale	QA/QC – per event	Total
Bowen	L1 & L2 - existing sediment / leachate ponds 2 leachate samples Seepage x 4 (where present)	Field characteristics – pH, EC, DO, T, NTU Anions & Cations, incl ionic balance (Na, K,Ca, Mg, Cl, SO4, CO3, OH, HCO3) BOD/COD Total Alkalinity NOx – total & NO2 /NO3 NH3 as N TP & FRP 8 heavy metals (As, Cd, Cr, Cu, Pb, Hg, Ni, Zn) – total and dissolved TRH / BTEXN – if visual or olfactory evidence of hydrocarbon contamination is observed at time of sample collection	Determine leachate signature Validate if ponding water observed on and offsite the site is in fact surface expression of leachate seepage	Blind duplicate Split duplicate Rinsate blank metals & TRH only Field blank Trip spike (volatiles)	8 + 3 dupes
Kelsey Creek	SW1 – SW6 L1 & L2 (sed ponds) Seepage x 4 (where present)				8 + 3 dupes

3.5.5 Aquifer Transmissivity – Requirement 12 (Provisional Extra)

Requirement 12 of the Notice states:

> *"Determine groundwater movement (transmissivity) based on the local hydrogeology"*

The desktop studies will include identify review of reference values for aquifer transmissivity based on the site geology identified in borehole construction logs from on-site groundwater monitoring wells at the site.

Based upon the desktop review we may recommend undertaking hydrogeological testing of selected groundwater wells in target aquifer(s) at the site(s) to better understand aquifer transmissivity, adopting some combination of the following:

- Slug test – rising head
- Slug test – falling head
- Slug test – pneumatic rising head (for permeable formations)

We advise that at this time (i.e. prior to desktop review completion) we see limited value in conducting pump testing at the site(s). Pump testing is not recommended in 50mm boreholes and low permeability formations due to low levels of recharge, and due to the high levels variability in recharge constants experienced in 50mm diameter GWMB, lower levels of data quality, and reliability.

3.5.6 Soil – Requirement 13

Requirement 10 of the notice is:

"Provide information on the leachate analysis of contaminants identified in the surface and subsurface soil directly beneath the site, under the areas (cells) where waste is buried and actively deposited"

Golder Associates strongly recommend that WRC not undertake drilling into the landfill cells to access the soils underlying waste material on the basis of the following:

- Where geosynthetic clay liners (GCL) exist, this would compromise the integrity of the liner system. For both lined and unlined landfills this would provide a direct and preferential contaminant migration pathway for leachate into soils underlying the landfill cells, and represent an unacceptable risk of causing groundwater contamination.
- Unacceptable risk of explosion, or landfill fire, due to ignition of landfill gas within cells by sparks or heat generated during drilling through waste. To undertake such would breach Councils duties of care to site employees and Contractors working on the site.
- Due to the likelihood of equipment loss (drill strings, rods, etc.) and interaction with waste, we advise that we would be unable to provide a cost-estimate for this item due to significant risks of the program (bogging strings, downtime to recover lost rods, inability to collect undisturbed samples). The cost of undertaking such a program is not balanced by the benefit of the data collected, and as such does not represent a best practice or reasonable requirement.
- The quality of soils underlying the landfill cells is presents negligible risk compared to the mechanisms for overall environmental risk to environmental values offsite. Soils beneath the cells will not be disturbed due to the waste interred above. The key risk is of leachate impact to groundwater, not to soils. The potential contaminant source in this instance is leachate impact to groundwater, and migration offsite to adversely impact human health, beneficial uses of groundwater, or ecological receptors.

3.5.7 Contamination Plume Assessment – Requirement 14 (Provisional Extra)

Were this step is considered necessary based upon the findings of the desktop assessment and monitoring data then Geophysical Investigation techniques would be adopted in the first instance to evaluate extents of any plume(s).

Depending on the findings of the desktop assessment and monitoring data we may potentially recommend completing this task before the installation of new monitoring wells to better refine their location and number.

Techniques adopted may include use of Electromagnetic Methods (radio detection magnetics, ground penetrating radar), Electrical Resistivity Imaging (ER), Induced Polarisation, Spontaneous Potential. Golder have substantial experience in geophysical methods, and experience in use of geophysical methods to mal leachate impacted plumes at landfill sites, using EM31 & ERI.

4.0 DATA ANALYSIS & INTERPRETATION

Data collected by the investigation will be collated, subject to statistical analyses, and data analysis and interpretation conducted. Data will be reviewed to assess the potential that site groundwater or surface water is being impacted by leachate from site operations, at concentrations that would present an unacceptable risk to environmental values.

5.0 REPORTING - RESPONSE TO THE NOTICE(S)

We will compile a factual report for each site outlining the findings of the investigation(s) and responding to the notices. Included in each report will be a table outlining the requirements of the notice(s), and the relevant section(s) in the report where each requirement is addressed. The report will address the requirements 6-18 of the notices, including (but not limited to):

- Define the environmental values of sensitive receptors.
- Establish / update Conceptual Site Models, including potential and actual sources, pathways, and receptors.
- Comparison of site data to reference (background) and relevant assessment criteria (NEPM 1999, ANZECC 2000) and environmental values under the EPP Water.
- Characterisation of leachate at each site, and assessment of the presence/ absence, and risks presented by, leachate signatures present in environmental media, to environmental values (if any).

The report will include conclusions regarding the potential for impact to environmental values, and recommendations regarding the requirements to be addressed in development of a remediation action plan.

6.0 REMEDIATION ACTION PLAN (PROVISIONAL EXTRA)

A provisional scope of services for a remediation action plan, and provisional sums for implementation will be provided as a stand-alone letter for each site. It is envisaged that this step will also include a full audit of compliance against the site EA's.

7.0 SUITABLY QUALIFIED PERSON(S)

Requirement 2 of the Notice(s) stipulates that the assessment must be conducted by SQP. The proposed project team is outlined in Table 4 below. Detailed CV's are available on request.

Table 4: Project team - SQP's

Personnel	Project Role	Qualifications & Experience
Paul Scells – Principal Engineer Contaminated	Project Director Technical lead Approved signatory	**BEng MIEAust CPEng** Paul is a Principal in the Contaminated Land Service line in Qld, with over 30 years' experience in management of contaminated land, environmental management, and soil and groundwater investigations.
James Begg – Principal Geo-Environmental Engineer Landfills	Technical lead Approved signatory	**BEng RPEQ CPEng** James is a geo-environmental engineer with 30 years' experience. He is currently working with a significant number of Northern Queensland local governments in design, operation, rehabilitation, and management of open and closed landfills.
Iwan Owen – Senior Project Manager	Project Manager	Iwan will monitor the project completion to schedule and budget.
Katie Carter – Senior Environmental Scientist	Client contact Desktop reviews Development of CSM Data analysis & interpretation Reporting	**BSc (Hons) MRACI CChem** Katie has some 15 years' experience including contaminated sites, operational environmental management, auditing & environmental compliance, mining, water and wastewater. Katie has recent experience conducting environmental evaluations.
Emma Cornish – Environmental Scientist	Fieldwork Data analysis Reporting	**BSc** Emma is an Environmental Scientist with 5 years' experience in contaminated land investigation and environmental monitoring, including for landfills. Emma has recently been involved in developing Landfill Environmental Risk Assessments for a number of FNQ Councils.
Darcy Simpson	Fieldwork Data analysis & reporting	**B Eng / BSc (Environmental)** Darcy is an Engineer professional with over 4 years' experience in contaminated land assessment, and environmental monitoring and has been involved in a number of soil and groundwater projects on municipal landfills in FNQ.

8.0 SCHEDULE

We have updated our proposed timing to complete the key tasks for the project, based on WRC's EOT request to Council, and timing is presented in Table 5.

Table 5: Proposed Project Schedule

Task	Timing
Project initiation meeting & Preliminary Site inspection Data handover	December
Desktop Review	January
Fieldwork – Install & develop GWMBs Detailed site walkover	February
Fieldwork – Monitoring Round 1	March
Data collation & analysis	March / April
Fieldwork – Monitoring Round 2	June
*Aquifer Transmissivity Testing – if required (based on initial data analysis and Round 1 Monitoring)	July
*Geophysics – if required (based on initial data analysis & Round 1 Monitoring)	July
Final laboratory results received	Early July
Report Issue	7 August 2018

GOLDER ASSOCIATES





Katie Carter
Senior Environmental Scientist

James Begg
Principal

KLC/JB/kc/ow

CC: Paul Scells

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APPENDIX B

Historical Aerial Imagery



SITE

CLIENT: Whitsunday Regional Council		PROJECT: Bowen & Kelsey Creek EE	
DRAWN: DIS	DATE: 8/8/2018	TITLE: **AERIAL PHOTO 1945**	
CHECKED:	DATE:		
SCALE: Not to Scale		PROJECT No: 1790603	APPENDIX No: D / REV No: 0 / A4

GOLDER

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SITE

CLIENT: Whitsunday Regional Council		PROJECT: Bowen & Kelsey Creek EE	
DRAWN: DIS	DATE: 8/8/2018	TITLE: **AERIAL PHOTO 1960**	
CHECKED	DATE		
SCALE: Not to Scale		PROJECT No: 1790603	APPENDIX No: D / REV No: 0 / A4

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SITE

GOLDER	CLIENT: Whitsunday Regional Council		PROJECT: Bowen & Kelsey Creek EE			
	DRAWN: DIS	DATE: 8/8/2018	TITLE: **AERIAL PHOTO 1970**			
	CHECKED	DATE				
	SCALE: Not to Scale		PROJECT No: 1790603	APPENDIX No: **D**	REV No: **0**	**A4**

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SITE

GOLDER

CLIENT: Whitsunday Regional Council		PROJECT: Bowen & Kelsey Creek EE	
DRAWN: DIS	DATE: 8/8/2018	TITLE: **AERIAL PHOTO 1980**	
CHECKED	DATE		
SCALE: Not to Scale		PROJECT No: 1790603	APPENDIX No: D / REV No: 0 / A4

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SITE

GOLDER	CLIENT: Whitsunday Regional Council		PROJECT: Bowen & Kelsey Creek EE		
	DRAWN: DIS	DATE: 8/8/2018	TITLE: **AERIAL PHOTO 1990**		
	CHECKED	DATE			
	SCALE: Not to Scale		PROJECT No: 1790603	APPENDIX No: **D**	REV No: **0** / **A4**

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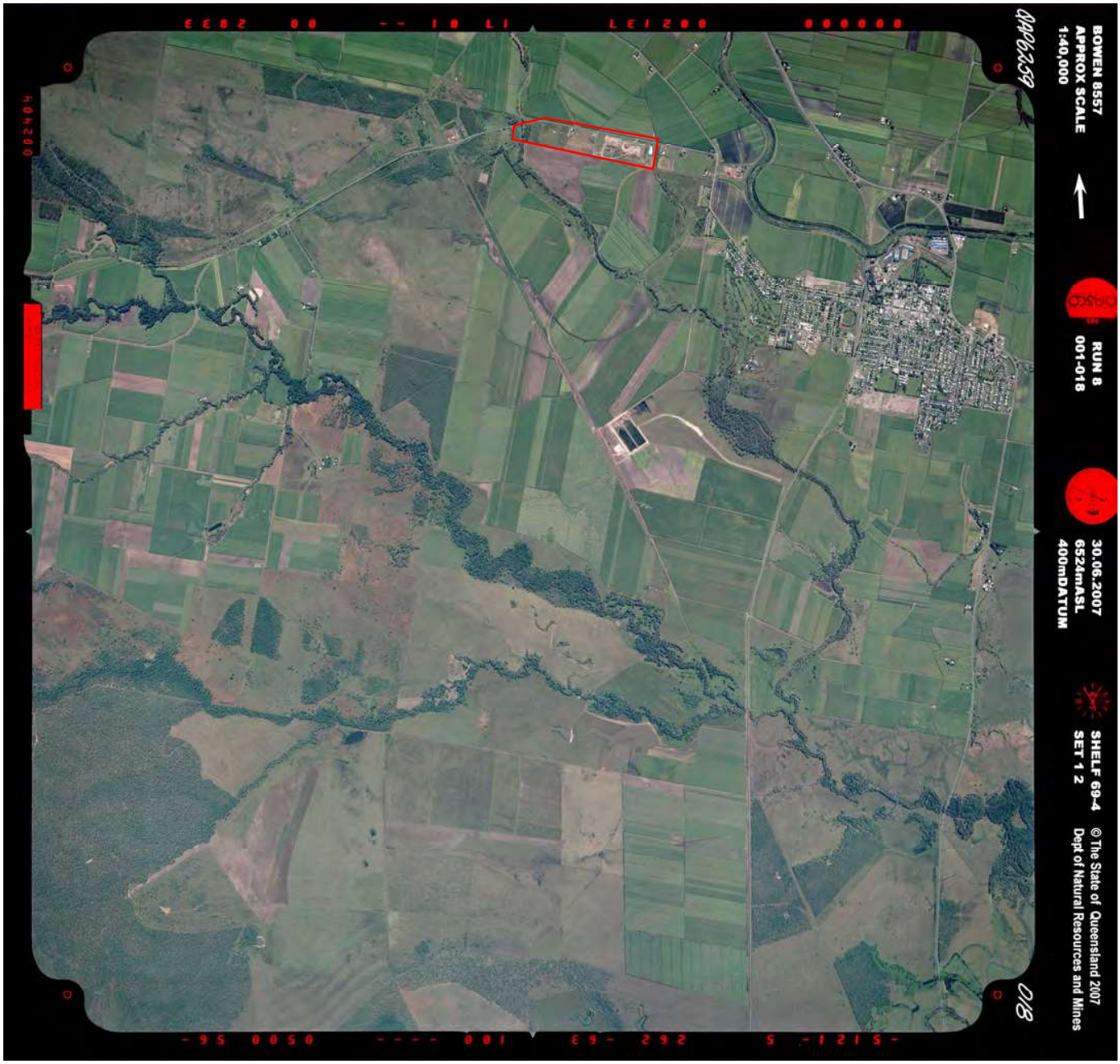


SITE

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CLIENT: Whitsunday Regional Council		PROJECT: Bowen & Kelsey Creek EE	
DRAWN: DIS	DATE: 8/8/2018	TITLE: **AERIAL PHOTO 1996**	
CHECKED:	DATE:		
SCALE: Not to Scale		PROJECT No: 1790603	APPENDIX No: **D** / REV No: **0** / **A4**



SITE

CLIENT: Whitsunday Regional Council		PROJECT: Bowen & Kelsey Creek EE	
DRAWN: DIS	DATE: 8/8/2018	TITLE: **AERIAL PHOTO 2005**	
CHECKED	DATE		
SCALE: Not to Scale		PROJECT No: 1790603	APPENDIX No: D / REV No: 0 / A4

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CLIENT: Whitsunday Regional Council		PROJECT: Bowen & Kelsey Creek EE	
DRAWN: DIS	DATE: 8/8/2018	TITLE: **AERIAL PHOTO Latest Available**	
CHECKED:	DATE:		
SCALE: Not to Scale		PROJECT No: 1790603	APPENDIX No: **D** / REV No: **0** / **A4**

APPENDIX C

Infrastructure Information

LEACHATE IRRIGATION AT KELSEY CREEK LANDFILL PROCEDURE

Table of Contents

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2. SCOPE....2
3. REFERENCES....2
4. DEFINITIONS....2
5. RESPONSIBILITY....2
6. PROCEDURE....2
7. DOCUMENTS....5



1. PURPOSE
To describe the procedure for managing the Leachate Irrigation system at Kelsey Creek Landfill.

2. SCOPE
Department of Environmental Services, Catchment Management, Waste Management Officer and the Kelsey Creek Landfill Contractor.

3. REFERENCES
Nil

4. DEFINITIONS
Nil.

5. RESPONSIBILITY
CMS officers

6. PROCEDURE
Whitsunday Regional Council has installed a leachate irrigation system at Kelsey Creek Landfill. The system is configured so that it can pump leachate from all lined cells by using two submersible pressure pumps. A valve allows leachate to be pumped from the two pressure pumps to a holding tank (Figure 1). When a pressure pumped is turned on, it take approximately 2 hours for the pump to fill the holding tank. The holding tank pressure pump will empty the holding tank quicker then it is recharged.

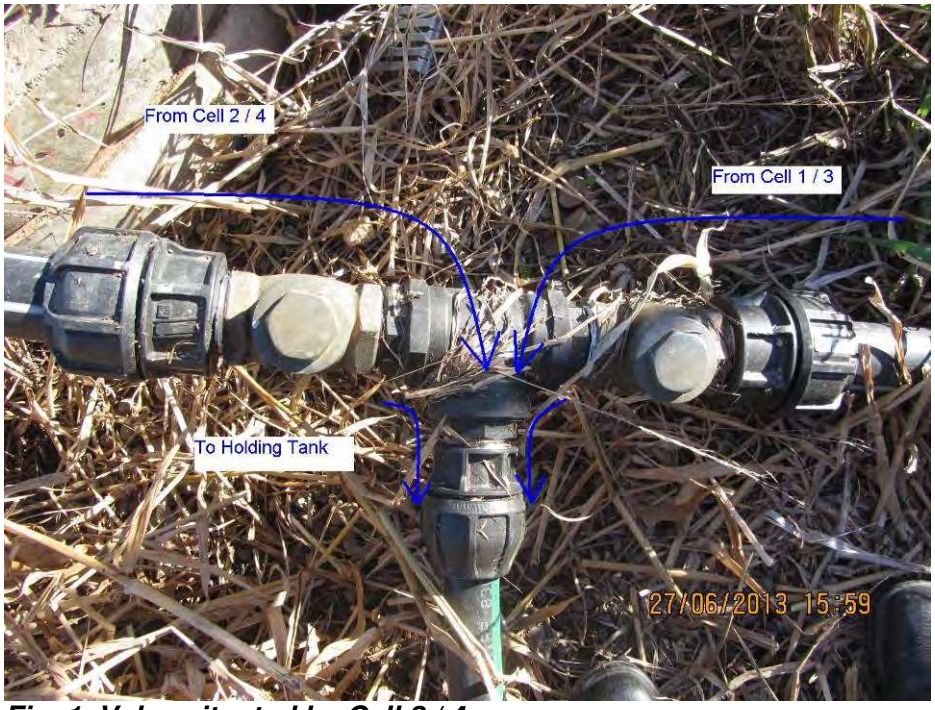


Fig. 1 Valve situated by Cell 2 / 4



Fig. 2 Holding Tank

There are two sensors installed in the holding tank, which automates the irrigation system. The sensors turn the holding tank pump on at 90% capacity and turn the holding tank pump off at 5% capacity.

The holding tank pressure pump that delivers the leachate from the holding tank to the sprinklers is adjustable (see Fig. 3). The two pumps which feed the holding tank from the two-leachate wells continuously runs and can not be remotely turned off.



Fig. 3 Adjustment of pump speed

On a setting of 4 for example, with 6 sprinklers open, the tank will empty (from 100% full) in a little over 2 hours whilst being recharged by the well pump, so that the cycle of full tank to empty tank to full tank takes 4 to 4.5 hours. With a pump setting of 8, and with 7 sprinklers open, the tank will empty in a little over 1 hour while being recharged by the well pump, meaning that the cycle takes approx. 3 to 3.5 hours. This means that during a normal working day it is possible to carry out two cycles of emptying / re-filling the holding tank, thereby allowing perhaps 75,000 to 80,000 litres of leachate to be irrigated per day.

The Process should be as follows:

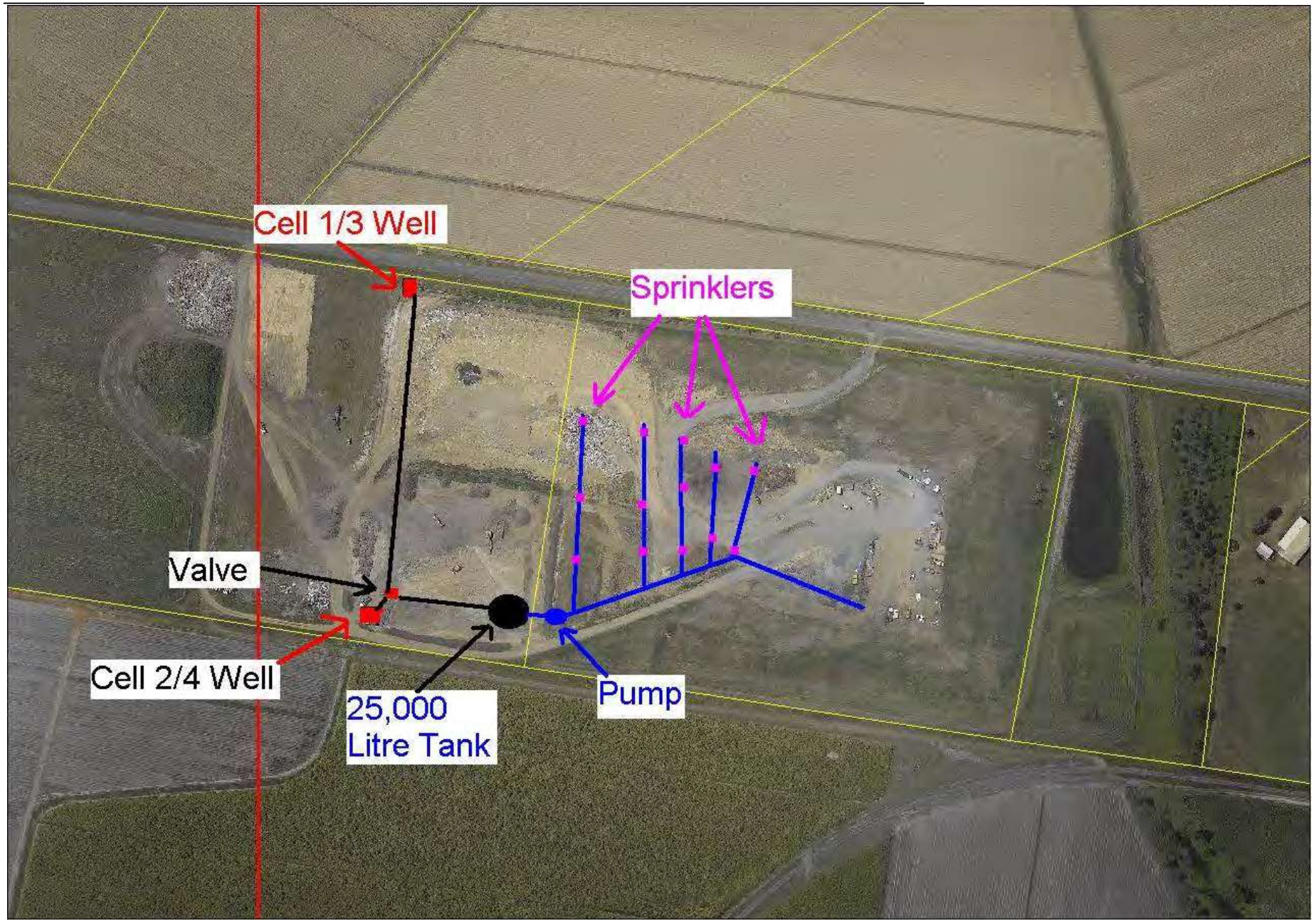
i) At 0800 hrs, turn on the pump at either Cell 1/3 or 2/4.
ii) Ensure that sufficient (7 or 8) sprinkler valves are open and immediately turn on the Irrigation Pump by turning on the Isolator to “On” and turning the switch to “Auto” (See Fig. 4), and set to position 8.
iii) After each day check the irrigation system to ensure that it is operating effectively and that there is no pooling of water and/or runoff (if this is occurring turn the pump off).
iv) On Monday morning and Friday afternoon of each week, measure the distance from the lid seat to the surface of the leachate (in cm) in each well and email these measurements to the Council’s Waste Management Officer or other designated Officer.



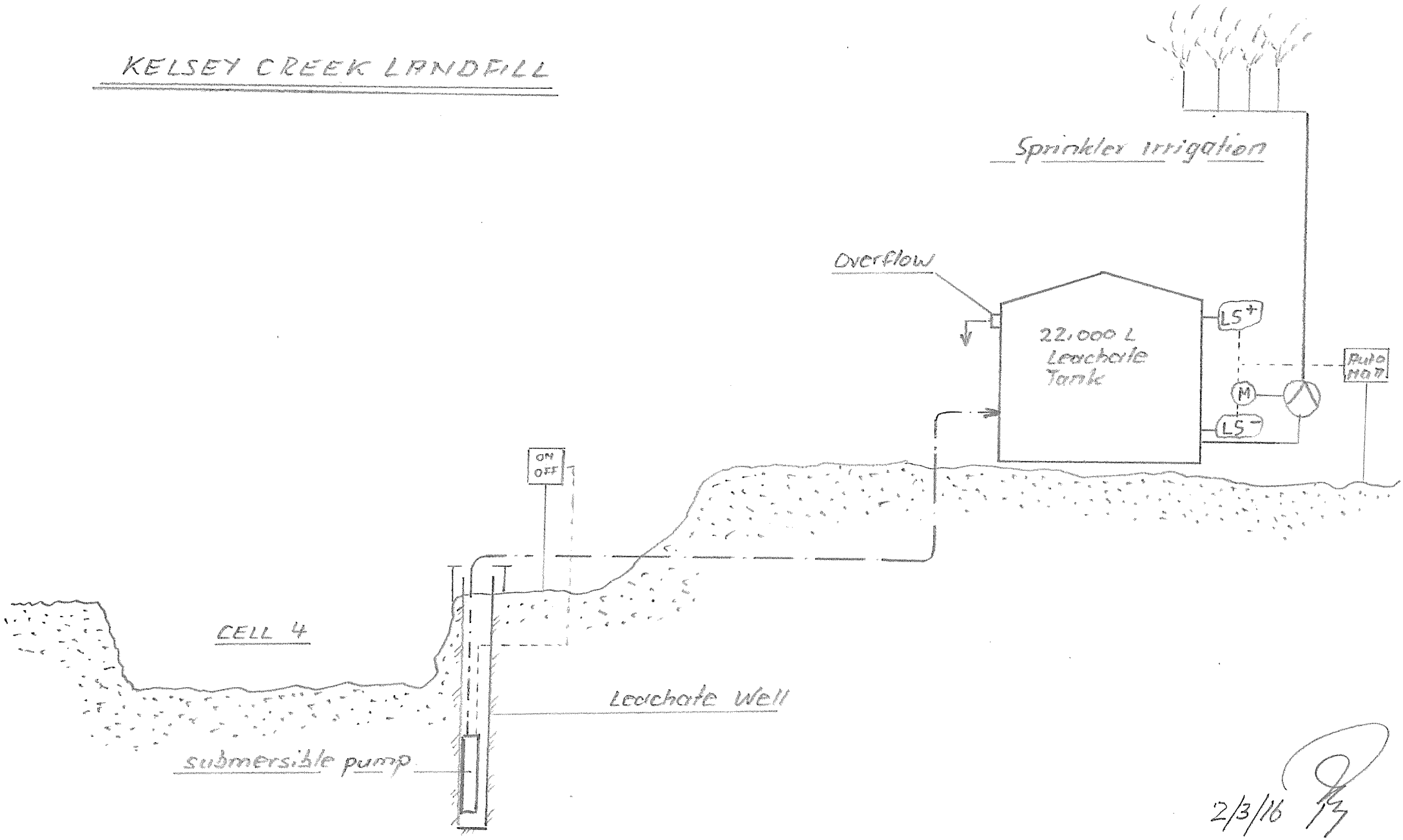
Fig. 4 Pump Isolator turned on and switch set to Auto

7. DOCUMENTS

R:\Archive 2009-2012\PC\Community&Environment\Catchment\Current_2010\Projects\Waste\Kelsey Creek Landfill\KCL leachate\Evaluating the use of irrigation in managing leachate at Kelsey creek landfill-12-9-11.doc

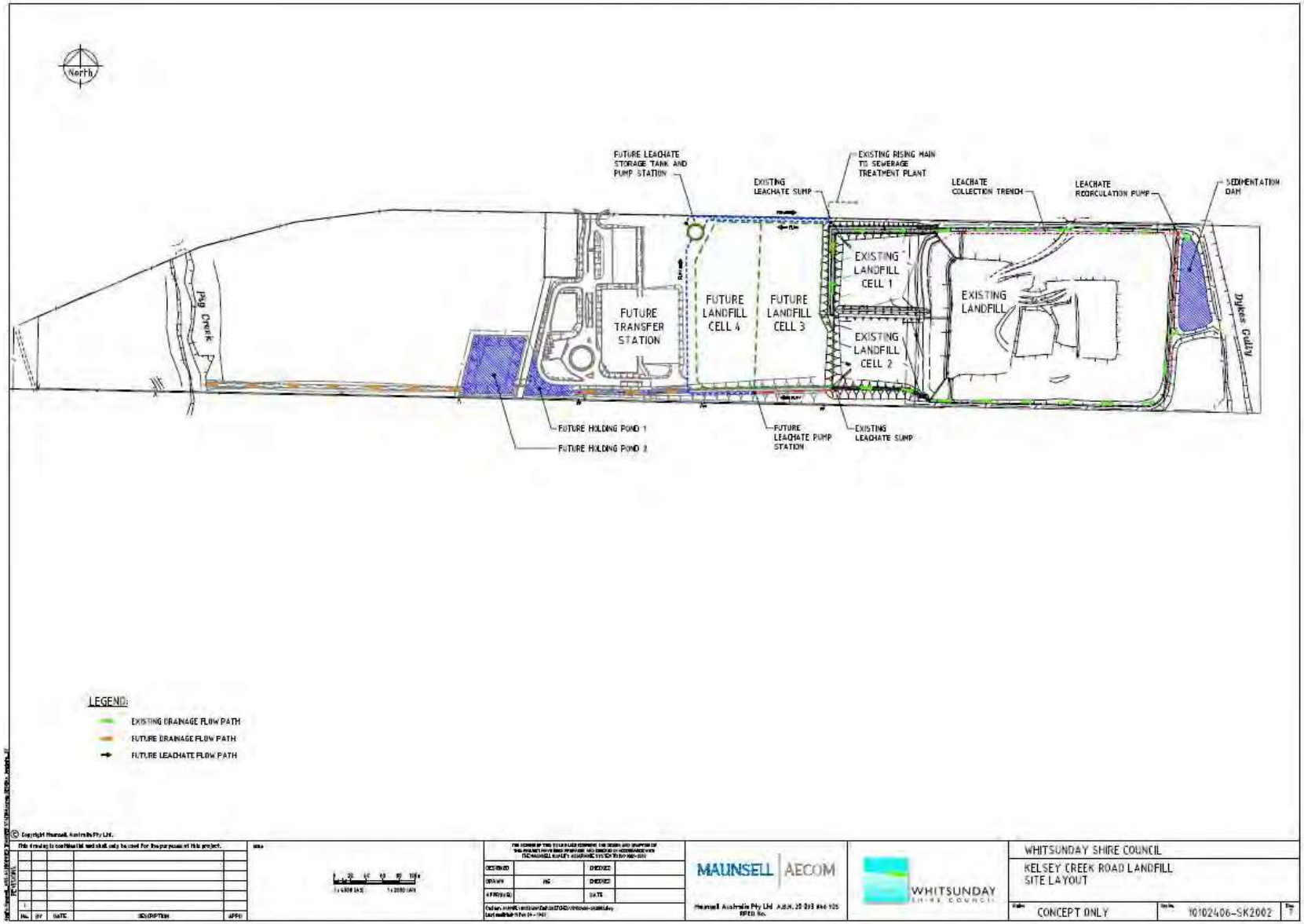

Cell 1/3 Well
Sprinklers
Valve
Cell 2/4 Well
25,000
Litre Tank
Pump

KELSEY CREEK LANDFILL

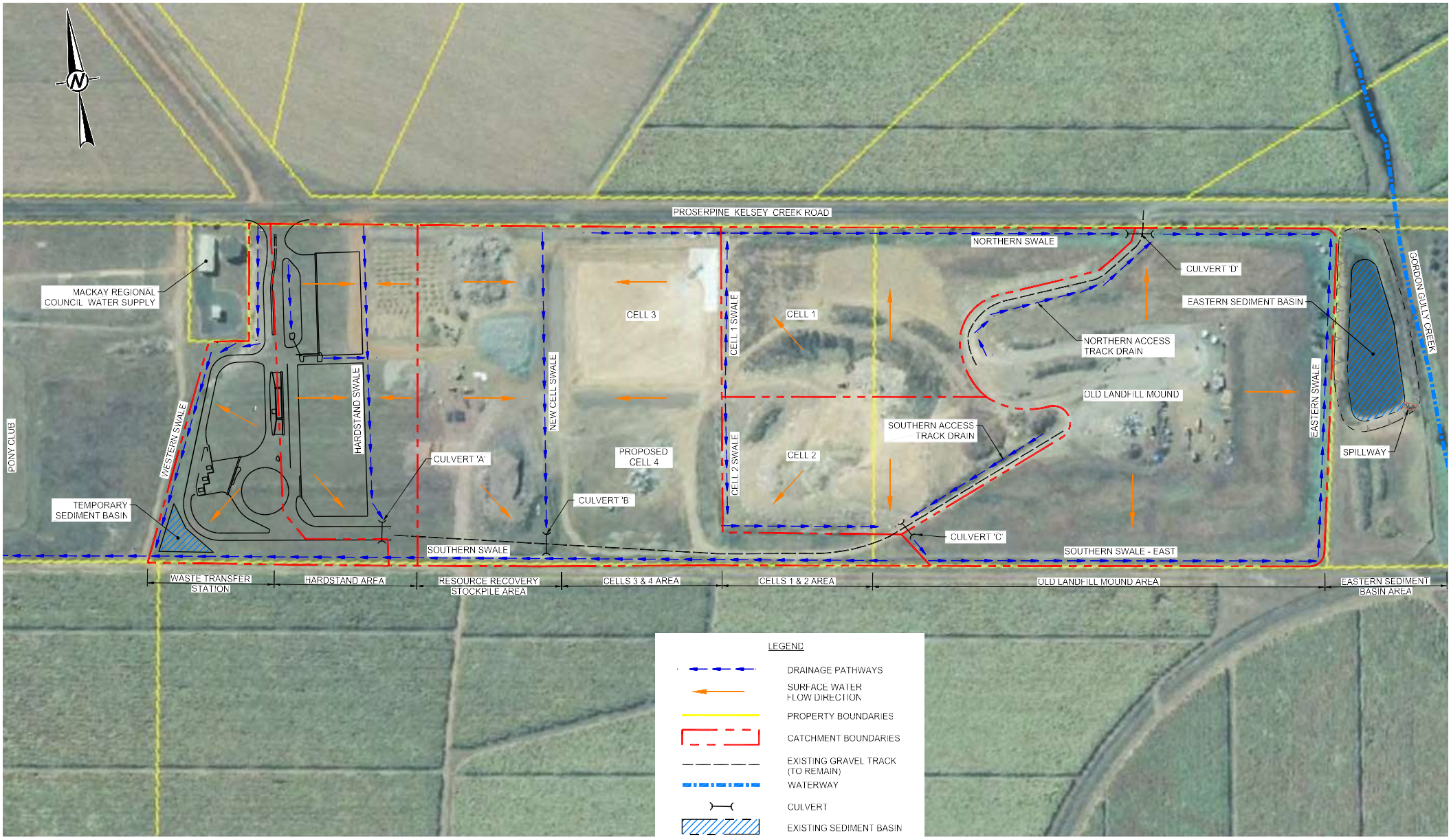


2/3/16

Figure 1 Site Layout and Details



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NOTE: AERIAL IMAGERY SUPPLIED BY WHITSUNDAY REGIONAL COUNCIL

DRAWING TAKEN FROM WS GROUP DRG. No.14348S01.Rev C.dwg DATED 03/2012

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CLIENT	WHITSUNDAY REGIONAL COUNCIL	PROJECT	KELSEY CR. LANDFILL, STORMWATER MANAGEMENT PLAN
DRAWN BY: WAZ	DATE: 06.08.2012	DRAWING TITLE	STORMWATER DRAINAGE PLAN CURRENT STORMWATER CONDITIONS
CHECKED BY: JSB	DATE: 06.08.2012		
SCALE: AS SHOWN	SHEET SIZE: A3		

PROJECT No	DOC No	DOC TYPE	FIGURE No	REVISION	
127673014	001	R	A1	0	A1

Plot Date: 9 August 2012 Time:11:10:22 AM By: Ziebell, Warren Path: K:\ENV\2012\127673014 - Proserpine Landfill\Figures - File Name:127673014-001-R-F03A-RevA.dwg
Xref:GAP_LOGO-A3.dwg; KCL - air photo 2009a.jpg;

APPENDIX D

WRC Internal Memorandum Summary of Borehole Construction Information – Kelsey Creek Landfill

WHITSUNDAY SHIRE COUNCIL - MEMORANDUM

TO: Peter Driemel **DATE:** **14-9-04**

FROM: Scott Hardy **FILE** 00/0297

MIN No. **Ref**

Kelsey creek landfill bores

Peter,

I have had a look at the bores for Kelsey creek and have summarised the data in the following table.

Bore number	Location	Gravel pack upper	Gravel pack lower	Slotted	Aquifer material
MW1	NW corner of landfill site	5.2	10m	7-10m	Medium to coarse sandstone
MW2D	SE corner of landfill site	8.5	14.8	11.8 – 14.8	Sandstone
MW2S		2.3	6	3-6m	Clayey sand
MW3	South area of landfill site	5.5	10	7-10	Coarse sandstone
MW4	NE corner of landfill site	4.5	8.5	5.5-8.5	Sand and clay
MW5	South boundary of reserve area – 200m from landfill	5.7	12	9-12	Clay from 7-10m, then sandstone from 10 to 11.5m
MW6	West of landfill – 400m	5.5	11	8-11	Sand from 5-9.5, then sandstone from 9.5 to 11m
MW7	West of landfill – 600m	3.9	8	5-8m	Sandstone
MW8	West of landfill 800m	6.4	10	7-10m	Sandstone

Bores – Mw1, Mw2, Mw3, Mw 7 and Mw 8 appear to be sampling the same aquifer

Bores – Mw 4 appears to be sampling a different aquifer and depth – sand at 5.5 – 8.5

- Mw 5 appears to sample a narrow sandstone layer which may be related to the Mw1,2,3,7 and 8.
- Mw 6 may be sampling two aquifers

ULLMAN & NOLAN

Technical Services Pty Ltd
A.C.N. 103 205 205

UNGR 103G
(-/1.03)

Borehole No. MW2D
Sheet 1 of 2

BOREHOLE LOG

Client: Whitsunday Shire Council
Date: 2.12.03 Job No: 21128.1
Location: Refer Locality Sketch
Project: Water Quality Monitoring
Surface R.L.: - Datum: -
Site: Kelsey Creek Landfill
Supervisor MB Chkd: AW
Drill Contractor Ullman & Nolan Technical Services Drill Model Jacro 350 Mounting Truck Diameter 75mm

STRATA				DRILLING			TESTING			VISUAL SOIL DESCRIPTION
Depth (m)	R.L.	Log	Classification	Method & Bit	Support	Sampling		Moisture	Consistency	
0.25			SC	A T	C			D	Stiff	**Clayey Sand;** dark brown-grey, fine to coarse grained (Fill) MPS 2 LL 20 P75 25
0.45								M	Very Stiff	brown (Fill)
0.80										very pale grey, fine to medium grained MPS 0.6 LL 40 P75 40
0.90										
1										
1.10				W T						
1.60			SW						Very Dense	fine to coarse grained MPS 2 LL 35 P75 30
2										**Sand;** very pale grey-white, fine to coarse grained, with clay MPS 2 LL 15 P75 10
3										
3.90										
4			SC						Hard	**Clayey Sand;** very pale grey-white, fine to coarse grained MPS 4 LL 20 P75 20
5										
6										
7										
7.70			CI							**Sandy Clay;** very pale grey mottled orange-brown, sand is fine to coarse grained MPS 2 LL 50 P75 65
8										

METHOD
A auger
W washbore
P percussion
H hammer
C core
R rotary air flush

BIT
R roller
B blank
V V bit
T TC bit
D diamond

SUPPORT
C casing
M mud

SAMPLING
U undisturbed sample & size in mm
D disturbed sample
N Standard Penetration Test & Result
PP Pocket Penetrometer Value

MOISTURE
D dry
M moist
W wet

VISUAL DESCRIPTION
MPS maximum particle size
LL Liquid Limit
P75 % passing 75um sieve

ULLMAN & NOLAN

Technical Services Pty Ltd
A.C.N. 103 205 205

UNGR 103G
(-/1/03)

Borehole No. MW2D
Sheet 2 of 2

BOREHOLE LOG

Client: Whitsunday Shire Council
Date: 2.12.03 Job No: 21128.1
Location: Refer Locality Sketch
Project: Water Quality Monitoring
Surface R.L.: - Datum: -
Site: Kelsey Creek Landfill
Supervisor MB Chkd: AW
Drill Contractor Ullman & Nolan Technical Services Drill Model Jacro 350 Mounting Truck Diameter 75mm

STRATA				DRILLING			TESTING	VISUAL SOIL DESCRIPTION		
Depth (m)	R.L	Log	Classification	Method & Bit	Support	Sampling		Moisture	Consistency	
8.00			CI	W T				M	Hard	**Sandy Clay;** refer sheet 1, depth 7.70m
9										
10										
10.10			SC							**Clayey Sand;** pale grey mottled brown, fine to coarse grained MPS 1.5 LL 30 P75 25
10.70									Dense	MPS 2 LL 10 P75 10
11										
12										
13										
14										
15										
16										

METHOD
A auger
W washbore
P percussion
H hammer
C core
R rotary air flush

BIT
R roller
B blank
V V bit
T TC bit
D diamond

SUPPORT
C casing
M mud

SAMPLING
U undisturbed sample & size in mm
D disturbed sample
N Standard Penetration Test & Result
PP Pocket Penetrometer Value

MOISTURE
D dry
M moist
W wet

VISUAL DESCRIPTION
MPS maximum particle size
LL Liquid Limit
P75 % passing 75um sieve

APPENDIX E

DNRM Registered Bore Search Information

20°22'20"S 148°32'53"E

20°22'20"S 148°35'10"E



20°24'28"S 148°32'53"E

20°24'28"S 148°35'10"E

A product of Queensland Globe



N

500 metres

Print Date: 9/8/2018
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Legend

Contour

- Index
- Intermediate

Mountain

- Mountain

Range

- Great Dividing Range

Coastline

Lake

Reservoir

Canal line

Canal area

Watercourse area

- Perennial
- Non Perennial

Watercourse line

- Minor Watercourse
- Major Watercourse
- Minor Culvert
- Major Culvert

Water area edge

Current water level monitoring bores [DNRM]

Past water monitoring and investigation bores [DNRM]

Water monitoring bores with near real time data [DNRM]

All mine monitoring water bores [DNRM and private]

Mine monitoring water bores with water levels [DNRM and private]

Surat CMA underground water impact reporting monitoring bores [DNRM and private]

CSG online monitoring bores [DNRM and private]

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Legend

Registered water bores [DNRM and private]

- Artesian bore
- Artesian bore (abandoned but useable)
- Artesian bore (abandoned and destroyed)
- Artesian bore, ceased to flow
- Artesian bore, ceased to flow (abandoned but useable
- Artesian bore, ceased to flow (abandoned and destroyed)
- Sub-artesian facility
- Sub-artesian facility (abandoned but useable)
- Sub-artesian facility (abandoned and destroyed)
- Surface water facility
- Surface water facility (abandoned but useable)
- Surface water facility (abandoned and destroyed)

CSG net monitoring bores [Private]

Railway

Road

- Highway
- Main
- Local
- Private

Cities and Towns

GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 12200038

REGISTRATION DETAILS

		BASIN	1220	**LATITUDE**	20-23-13	**MAP-SCALE**	104
OFFICE	Mackay	**SUB-AREA**		**LONGITUDE**	148-32-59	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	7340-WHITSUNDAY REG	**EASTING**	661719	**MAP-NO**	V 38920
D/O FILE NO.		**LOT**		**NORTHING**	7744923	**MAP NAME**	
R/O FILE NO.		**PLAN**		**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**	SKET	**PRES EQUIPMENT**	NE
				GPS ACC			
GIS LAT	-20.387062733	**PARISH NAME**	4467-TAWVALE			**ORIGINAL BORE NO**	TA9
GIS LNG	148.549673005	**COUNTY**	HERBERT			**BORE LINE**	FOX-FOXDALE LINE
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	07/05/1974			**DATA OWNER**	DNR
STATUS	Existing	**DRILLERS NAME**					
ROLES	IN	**DRILL COMPANY**					
	SM	**METHOD OF CONST.**	ROTARY RIG				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	07/05/1974	1	Plastic Casing			51	0.00	7.30

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	0.20	TOP SOIL
3	0.20	1.80	FINE TO MED WTHD SANDSTONE
5	1.80	3.40	COARSE WTHD SANDSTONE WITH GRAVEL
7	3.40	4.40	GREY & BROWN WTHD SANDSTONE
9	4.40	5.20	COARSE WTHD SANDSTONE
11	5.20	6.10	FINE WTHD SANDSTONE
13	6.10	7.30	COARSE WTHD SANDSTONE WITH GRAVEL
15	7.30	7.90	WTHD CLAYEY SANDSTONE

BORE REPORT

REG NUMBER 12200038

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
17	7.90	8.20	WTHD SANDSTONE WITH GRAVEL BANDS
19	8.20	19.50	WTHD FINE SANDSTONE
21	19.50	23.20	GREY OIL SHALE
902			00/00/0000 SWL -1.20 M TMP NUL C

STRATIGRAPHY DETAILS

SOURCE	RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
DNR	1			ALLUVIUM

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	6.00	7.00	CSAN GRAV							UC	ALLUVIUM

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
A	11/02/1974	14.88	SVY	AHD	R	
X	10/02/1974	14.44	SVY	AHD	N	

WATER ANALYSIS PART1

BORE REPORT

REG NUMBER 12200038

PIPE	DATE	RD	ANALYST	QAN	DEPTH (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS (mg/L)	TOTAL SOLIDS (mg/L)	HARD	ALK	FIG. OF MERIT	SAR	RAH
A	29/03/1988	1	GCL	124266		AI	GB	330	6.4	33	164.50	194.40	1	5	0.0	32.6	0.09
A	15/08/2000	1	GCL	207191		AI	GB	432	6.7	27	223.90	240.18	2	17	0.0	24.2	0.30

WATER ANALYSIS PART 2

PIPE	DATE	RD	Na	K	Ca	Mg	Mn	HCO3	Fe	CO3	Cl	F	NO3	SO4	Zn	Al	B	Cu
A	29/03/1988	1	61.0	0.4	0.1	0.1	0.00	6.1	0.80	0.0	87.0	0.10	4.2	4.7				
A	15/08/2000	1	79.9	0.4	0.0	0.5	0.01	20.7	0.03	0.0	115.1	0.01	3.3	4.0	0.08	0.00	0.00	0.09

WATER LEVEL DETAILS

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
A	11/02/1974	-0.70	R		NR	A	07/05/1975	-1.16	R		NR	A	17/07/1975	-1.34	R		NR
A	21/10/1975	-1.39	R		NR	A	10/12/1975	-1.41	R		NR	A	09/03/1976	-0.95	R		NR
A	01/07/1976	-1.28	R		NR	A	09/09/1976	-7.75	R		NR	A	03/11/1976	-1.02	R		NR
A	16/02/1977	-1.12	R		NR	A	05/05/1977	-0.95	R		NR	A	14/07/1977	-1.70	R		NR
A	12/10/1977	-7.72	R		NR	A	25/01/1978	-7.74	R	D	NR	A	13/04/1978	-4.75	R		NR
A	16/05/1978	-7.40	R		NR	A	19/06/1978	-7.72	R		NR	A	19/07/1978	-6.60	R		NR
A	30/08/1978	-7.74	R	D	NR	A	03/10/1978	-7.74	R	D	NR	A	31/10/1978	-7.74	R	D	NR
A	12/12/1978	-7.74	R	D	NR	A	13/02/1979	-0.49	R		NR	A	20/03/1979	-1.10	R		NR
A	24/04/1979	-5.35	R		NR	A	04/07/1979	-3.64	R		NR	A	04/09/1979	-6.10	R		NR
A	02/10/1979	-7.51	R		NR	A	05/11/1979	-7.74	R	D	NR	A	04/12/1979	-7.74	R	D	NR
A	16/01/1980	-1.25	R		NR	A	04/03/1980	-0.50	R		NR	A	15/04/1980	-0.73	R		NR
A	20/05/1980	-1.25	R		NR	A	24/06/1980	-1.35	R		NR	A	05/08/1980	-3.31	R		NR
A	30/09/1980	-5.38	R		NR	A	25/11/1980	-7.46	R		NR	A	17/02/1981	-2.00	R		NR
A	07/04/1981	-1.75	R		NR	A	21/07/1981	-3.85	R		NR	A	22/09/1981	-7.22	R		NR
A	24/11/1981	-7.42	R		NR	A	09/03/1982	-7.45	R		NR	A	01/06/1982	-1.31	R		NR
A	24/08/1982	-7.15	R		NR	A	09/11/1982	-7.74	R	D	NR	A	25/09/1984	-1.60	R		NR
A	31/10/1984	-6.22	R		NR	A	03/12/1984	-4.65	R		NR	A	31/01/1985	-7.20	R		NR
A	28/02/1985	-6.81	R		NR	A	19/03/1985	-0.80	R		NR	A	20/05/1985	-1.00	R		NR
A	27/06/1985	-1.30	R		NR	A	23/07/1985	-1.27	R		NR	A	24/09/1985	-6.55	R		NR
A	17/12/1985	-3.00	R		NR	A	21/01/1986	-3.50	R		NR	A	25/02/1986	-3.00	R		NR
A	01/04/1986	-2.10	R		NR	A	30/04/1986	-0.55	R		NR	A	21/05/1986	-0.55	R		NR

BORE REPORT

REG NUMBER 12200038

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
A	23/06/1986	-0.70	R		NR	A	22/07/1986	-2.85	R		NR	A	20/08/1986	-5.40	R		NR
A	17/09/1986	-6.21	R		NR	A	17/12/1986	-6.45	R		NR	A	16/02/1987	-6.35	R		NR
A	11/05/1987	-0.74	R		NR	A	10/06/1987	-1.22	R		NR	A	28/07/1987	-1.35	R		NR
A	24/08/1987	-1.62	R		NR	A	23/09/1987	-5.20	R		NR	A	28/10/1987	-6.00	R		NR
A	24/11/1987	-6.10	R		NR	A	06/01/1988	-6.13	R		NR	A	16/02/1988	-1.32	R		NR
A	21/03/1988	-1.38	R		NR	A	29/03/1988	-1.10	R		NR	A	10/05/1988	-1.20	R		NR
A	21/06/1988	-0.98	R		NR	A	03/08/1988	-1.42	R		NR	A	04/08/1988	-1.42	R		NR
A	15/09/1988	-1.40	R		NR	A	18/10/1988	-4.65	R		NR	A	20/02/1989	-1.31	R		NR
A	21/03/1989	-0.52	R		NR	A	20/06/1989	-1.14	R		NR	A	11/10/1989	-4.40	R		NR
A	04/12/1989	-1.20	R		NR	A	12/07/1990	-2.48	R		NR	A	31/10/1990	-4.76	R		NR
A	13/12/1990	-5.80	R		NR	A	06/03/1991	-1.05	R		NR	A	16/08/1991	-4.95	R		NR
A	21/10/1991	-4.95	R		NR	A	04/02/1992	-4.68	R		NR	A	30/04/1992	-1.58	R		NR
A	18/11/1992	-4.90	R		NR	A	04/10/1993	-4.76	R		NR	A	02/12/1993	-4.82	R		NR
A	24/01/1994	-4.80	R		NR	A	25/05/1994	-1.55	R		NR	A	13/09/1994	-4.82	R		NR
A	25/10/1994	-4.91	R		NR	A	28/03/1996	-1.43	R		NR	A	12/08/1996	-1.41	R		NR
A	24/06/1997	-1.30	R		NR	A	28/04/1999	-1.10	R		NR	A	08/08/2000	-1.23	R		NR
A	15/08/2000	-1.35	R		NR	A	24/10/2000	-2.95	R		NR	A	11/04/2001	-0.75	R		NR
A	31/07/2001	-2.67	R		NR	A	19/09/2001	-2.76	R		NR	A	10/01/2002	-1.15	R		ACT
A	03/04/2002	-1.31	R		ACT	A	19/07/2002	-2.59	R		ACT	A	21/11/2002	-2.45	R		ACT
A	21/01/2003	-2.00	R		NR	A	14/04/2003	-1.33	R		ACT	A	13/11/2003	-1.41	R		ACT
A	13/01/2004	-1.40	R		NR	A	07/04/2004	-2.24	R		ACT	A	14/07/2004	-2.79	R		ACT
A	05/11/2004	-2.81	R		ACT	A	03/02/2005	-1.12	R		ACT	A	20/04/2005	-1.24	R		ACT
A	26/07/2005	-1.38	R		NR	A	26/10/2005	-2.41	R		ACT	A	16/01/2006	-2.46	R		ACT
A	07/08/2006	-1.29	R		ACT	A	15/12/2006	-2.10	R		ACT	A	14/03/2007	-1.32	R		ACT
A	02/07/2007	-1.18	R		NR	A	24/09/2007	-2.15	R		ACT	A	13/12/2007	-1.20	R		ACT
A	19/03/2008	-1.14	R		ACT	A	15/07/2008	-2.40	R		ACT	A	17/09/2008	-2.00	R		ACT
A	25/03/2009	-1.17	R		ACT	A	09/07/2009	-1.76	R		ACT	A	08/10/2009	-2.33	R		ACT
A	09/12/2009	-1.96	R		ACT	A	07/05/2010	-1.20	R		ACT	A	06/07/2010	-1.96	R		ACT
A	13/10/2010	-1.09	R		ACT	A	06/05/2011	-1.42	R		ACT	A	17/08/2011	-2.00	R		NR
A	20/10/2011	-2.00	R		ACT	A	13/02/2012	-1.12	R		NR	A	09/05/2012	-1.53	R		NR
A	29/08/2013	-1.76	R		NR	A	16/01/2014	-1.76	R		NR	A	05/08/2014	-1.57	R		ACT
A	28/11/2014	-1.82	R		NR	A	01/12/2015	-2.28	R		ACT	A	30/03/2016	-1.28	R		ACT
A	25/07/2016	-0.78	R		ACT	A	30/09/2016	-1.58	R		ACT	A	03/01/2017	-1.91	R		ACT

BORE REPORT

REG NUMBER 12200038

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
A	15/05/2017	-3.12	R		ACT
A	18/12/2017	-1.31	R		ACT
A	12/07/2017	-1.72	R		ACT
X	07/05/1974	-1.20	N		NR
A	24/10/2017	-2.04	R		ACT

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	23/07/1985		495							PU	GB
A	17/09/1986		285							PU	GB
A	23/04/1987		300								GB
A	23/09/1987		375							PU	GB
A	29/03/1988		307							PU	GB
A	21/03/1989		366							PU	GB
A	16/08/2000		439	7.3	19.6					PU	GB

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

BORE REPORT

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GROUNDWATER DATABASE

BORE REPORT

REG NUMBER 162615

REGISTRATION DETAILS

		BASIN	1220	**LATITUDE**	20-23-52	**MAP-SCALE**	
OFFICE	Mackay	**SUB-AREA**		**LONGITUDE**	148-33-12	**MAP-SERIES**	
DATE LOG RECD	02-DEC-16	**SHIRE**	7340-WHITSUNDAY REG	**EASTING**	662090	**MAP-NO**	
D/O FILE NO.	MAC0021	**LOT**	48	**NORTHING**	7743734	**MAP NAME**	
R/O FILE NO.		**PLAN**	SP266901	**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	
				GPS ACC			
GIS LAT	-20.39777486	**PARISH NAME**	6000-NO LONGER USED			**ORIGINAL BORE NO**	TEST HOLE 4
GIS LNG	148.55333457	**COUNTY**				**BORE LINE**	-
CHECKED	Y						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	02/11/2016			**DATA OWNER**	
STATUS	Abandoned and Destroyed	**DRILLERS NAME**	LIST, CARL DAVID				
ROLES	WS	**DRILL COMPANY**	AYR BORING				
		METHOD OF CONST.	AUGER				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
X	02/11/2016	1	Grout			150	0.00	5.00
X	02/11/2016	2	Bentonite Seal			150	5.00	6.00
X	02/11/2016	3	Gravel Pack			150	6.00	14.00
X	02/11/2016	4	Cuttings or other fill between casing and ho			150	14.00	20.00

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	2.50	TOPSOIL
2	2.50	3.00	RED CLAY
3	3.00	6.50	SOFT GREY CLAY
4	6.50	12.00	WHITE CLAY BAND, MED SAND
5	12.00	18.00	HARD AND SOFT LAYERS OF CLAY

BORE REPORT

REG NUMBER 162615

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
6	18.00	20.00	COARSE WHITE SAND WITH SOME CLAY
7	20.00		HARD CLAY

STRATIGRAPHY DETAILS

**** NO RECORDS FOUND ****

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	17.60		CLAY	02/11/2016	-2.80	N	POTABLE	19.00	Y	SC	LAGOON CREEK ALLUVIUM

PUMP TEST DETAILS PART 1

**** NO RECORDS FOUND ****

PUMP TEST DETAILS PART 2

**** NO RECORDS FOUND ****

BORE CONDITION

**** NO RECORDS FOUND ****

ELEVATION DETAILS

**** NO RECORDS FOUND ****

WATER ANALYSIS PART1

**** NO RECORDS FOUND ****

WATER ANALYSIS PART 2

**** NO RECORDS FOUND ****

WATER LEVEL DETAILS

**** NO RECORDS FOUND ****

WIRE LINE LOG DETAILS

BORE REPORT

REG NUMBER 162615

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

**** NO RECORDS FOUND ****

SPECIAL WATER ANALYSIS

**** NO RECORDS FOUND ****

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BORE REPORT

REG NUMBER 12200039

REGISTRATION DETAILS

		BASIN	1220	**LATITUDE**	20-24-10	**MAP-SCALE**	104
OFFICE	Mackay	**SUB-AREA**		**LONGITUDE**	148-32-38	**MAP-SERIES**	M
DATE LOG RECD		**SHIRE**	7340-WHITSUNDAY REG	**EASTING**	661084	**MAP-NO**	V 38920
D/O FILE NO.		**LOT**		**NORTHING**	7743190	**MAP NAME**	
R/O FILE NO.		**PLAN**		**ZONE**	55	**PROG SECTION**	
H/O FILE NO.		**ORIGINAL DESCRIPTION**		**ACCURACY**		**PRES EQUIPMENT**	NE
				GPS ACC			
GIS LAT	-20.402885157	**PARISH NAME**	4467-TAWVALE			**ORIGINAL BORE NO**	TA6
GIS LNG	148.543863769	**COUNTY**	HERBERT			**BORE LINE**	FOX-FOXDALE LINE
CHECKED	N						
						POLYGON	
						RN OF BORE REPLACED	
FACILITY TYPE	Sub-Artesian Facility	**DATE DRILLED**	16/10/1973			**DATA OWNER**	DNR
STATUS	Existing	**DRILLERS NAME**					
ROLES	IN	**DRILL COMPANY**					
	SM	**METHOD OF CONST.**	ROTARY RIG				

CASING DETAILS

PIPE	DATE	RECORD NUMBER	MATERIAL DESCRIPTION	MAT SIZE (mm)	SIZE DESC	OUTSIDE DIAM (mm)	TOP (m)	BOTTOM (m)
A	16/10/1973	1	Plastic Casing			51	0.00	23.60

STRATA LOG DETAILS

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
1	0.00	0.20	TOP SOIL
3	0.20	4.90	CLAYBOUND WTHD SANDSTONE
5	4.90	5.80	WTHD SANDSTONE WITH GRAVEL BANDS
7	5.80	11.90	GREY & BROWN WTHD FINE SANDSTONE
9	11.90	12.50	COARSE WTHD SANDSTONE
11	12.50	22.60	GREY & BROWN WTHD FINE SANDSTONE
13	22.60	23.50	WTHD COARSE SANDSTONE WITH GRAVEL
15	23.50	27.10	WEATHERED SANDSTONE

BORE REPORT

REG NUMBER 12200039

RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
17	27.10	31.10	DARK BROWN OIL SHALE
902			00/00/0000 SWL -6.70 M TMP NUL C

STRATIGRAPHY DETAILS

SOURCE	RECORD NUMBER	STRATA TOP (m)	STRATA BOT (m)	STRATA DESCRIPTION
DNR	1			ALLUVIUM

AQUIFER DETAILS

REC	TOP BED(M)	BOTTOM BED(M)	BED LITHOLOGY	DATE	SWL (m)	FLOW	QUALITY	YIELD (l/s)	CTR	CONDIT	FORMATION NAME
1	22.00	23.00	GRAV SAND							UC	ALLUVIUM

PUMP TEST DETAILS PART 1

****** NO RECORDS FOUND ******

PUMP TEST DETAILS PART 2

****** NO RECORDS FOUND ******

BORE CONDITION

****** NO RECORDS FOUND ******

ELEVATION DETAILS

PIPE	DATE	ELEVATION	PRECISION	DATUM	MEASUREMENT POINT	SURVEY SOURCE
A	17/07/1975	14.29	SVY	AHD	R	
X	16/07/1975	13.95	SVY	AHD	N	

WATER ANALYSIS PART1

PIPE	DATE	RD	ANALYST	QAN	DEPTH (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS (mg/L)	TOTAL SOLIDS (mg/L)	HARD	ALK	FIG. OF MERIT	SAR	RAH

BORE REPORT

REG NUMBER 12200039

PIPE	DATE	RD	ANALYST	QAN	DEPTH (m)	RMK	SRC	COND (uS/cm)	pH	Si (mg/L)	TOTAL IONS (mg/L)	TOTAL SOLIDS (mg/L)	HARD	ALK	FIG. OF MERIT	SAR	RAH
A	29/03/1988	1	GCL	124339		AI	GB	8200	8.1	86	4890.00	4840.00	990	215	0.3	20.5	0.00
A	25/05/1994	1	GCL	155967		AI	GB	8390	7.8	102	4920.31	4887.02	934	221	0.3	21.3	0.00
A	06/11/2000	1	GCL	207253		PG	GB	8630	7.1	92	5022.62	4977.52	1016	221	0.3	20.9	0.00
A	20/09/2001	1	GCL	211122	22.60	PG	GB	8680	6.9	88	5248.13	5200.21	1032	220	0.3	21.1	0.00
A	21/11/2002	1	GCL	207345	21.00	PG	GB	8850	6.9	109	5044.77	5015.44	1008	223	0.3	21.3	0.00
A	13/11/2003	1	GCL	211052	15.00	PA	GB	8150	7.1	103	4853.94	4821.47	922	219	0.3	21.7	0.00
A	03/11/2004	1	GCL	207237		PG	GB	8040	6.8	102	4820.00	4780.00	945	220	0.3	21.0	0.00
A	26/10/2005	1	GCL	217077		PG	GB	8580	6.8	102	4810.00	4780.00	945	215	0.3	21.0	0.00
A	03/10/2006	1	GCL	220929		PG	GB	8130	6.7	102	5010.00	4980.00	954	216	0.3	22.0	0.00
A	24/09/2007	1	GCL	223970		PG	GB	8690	6.9	93	4900.00	4860.00	974	211	0.3	20.0	0.00
A	05/11/2008	1	GCL	227054		AI	GB	8710	8.1	94	4910.00	4870.00	965	215	0.3	21.0	0.00
A	14/06/2011	1	GCL	302574	16.00	AI	GB	8490	8.2	99	4740.00	4710.00	883	215	0.3	21.0	0.00

WATER ANALYSIS PART 2

PIPE	DATE	RD	Na	K	Ca	Mg	Mn	HCO3	Fe	CO3	Cl	F	NO3	SO4	Zn	Al	B	Cu
A	29/03/1988	1	1500.0	1.5	125.0	165.0	0.16	255.0	0.05	3.5	2800.0	0.20	0.5	35.0				
A	25/05/1994	1	1497.0	0.9	114.7	157.5	0.00	266.4	0.00	1.8	2847.0	0.18	0.0	34.9				
A	06/11/2000	1	1532.6	0.0	126.4	170.4	0.50	268.9	0.00	0.3	2887.4	0.15	3.8	32.6	0.00	0.00	0.00	0.00
A	20/09/2001	1	1558.0	0.8	126.8	174.1	0.51	267.4	0.00	0.2	3011.0	0.17	53.4	56.2	0.03	0.00	0.10	0.03
A	21/11/2002	1	1552.5	0.8	121.2	171.5	0.34	271.9	0.00	0.3	2883.8	0.19	0.0	42.6	0.02	0.02	0.07	0.02
A	13/11/2003	1	1514.0	0.7	114.0	155.0	0.25	266.5	0.00	0.3	2768.4	0.17	0.0	34.8	0.00	0.01	0.28	0.00
A	03/11/2004	1	1490.0	0.7	112.0	162.0	0.23	267.0	< 0.01	0.2	2750.0	0.10	< 10.0	< 40.0	< 0.01	< 0.05	0.08	< 0.03
A	26/10/2005	1	1520.0	0.7	115.0	160.0	0.38	263.0	< 0.01	0.1	2730.0	0.10	< 5.0	35.0	0.05	< 0.05	0.15	0.03
A	03/10/2006	1	1570.0	0.7	112.0	164.0	0.33	264.0	< 0.01	0.1	2830.0	0.20	28.0	46.0	< 0.01	< 0.05	0.06	< 0.03
A	24/09/2007	1	1470.0	0.8	115.0	167.0	0.38	258.0	< 0.01	0.1	2850.0	0.14	< 5.0	41.0	0.03	< 0.05	0.09	< 0.03
A	05/11/2008	1	1500.0	0.6	113.0	166.0	0.37	257.0	< 0.01	2.5	2820.0	0.17	< 5.0	43.0	< 0.01	< 0.05	0.31	0.09
A	14/06/2011	1	1450.0	0.2	110.0	148.0	0.41	254.0	< 0.01	3.7	2700.0	0.21	< 5.0	39.0	< 0.01	< 0.05	0.10	< 0.03

WATER LEVEL DETAILS

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE

BORE REPORT

REG NUMBER 12200039

PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE	PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
A	13/06/1978	-6.50	R		NR	A	19/07/1978	-6.30	R		NR	A	03/10/1978	-6.65	R		NR
A	31/10/1978	-6.66	R		NR	A	12/12/1978	-6.65	R		NR	A	16/01/1979	-6.52	R		NR
A	27/04/1979	-6.10	R		NR	A	04/07/1979	-6.11	R		NR	A	04/09/1979	-6.13	R		NR
A	02/10/1979	-6.15	R		NR	A	05/11/1979	-6.47	R		NR	A	04/12/1979	-6.76	R		NR
A	16/01/1980	-6.59	R		NR	A	04/03/1980	-6.40	R		NR	A	16/04/1980	-6.15	R		NR
A	20/05/1980	-6.17	R		NR	A	24/06/1980	-6.20	R		NR	A	05/08/1980	-6.21	R		NR
A	30/09/1980	-6.40	R		NR	A	25/11/1980	-6.62	R		NR	A	17/02/1981	-6.30	R		NR
A	07/04/1981	-6.13	R		NR	A	21/07/1981	-6.11	R		NR	A	22/09/1981	-6.35	R		NR
A	24/11/1981	-6.38	R		NR	A	09/03/1982	-6.55	R		NR	A	01/06/1982	-6.25	R		NR
A	24/08/1982	-6.48	R		NR	A	09/11/1982	-6.85	R		NR	A	02/02/1983	-6.91	R		NR
A	19/04/1983	-7.20	R		NR	A	10/05/1983	-7.11	R		NR	A	07/06/1983	-7.10	R		NR
A	13/07/1983	-6.81	R		NR	A	23/08/1983	-6.70	R		NR	A	20/09/1983	-6.69	R		NR
A	25/10/1983	-7.05	R		NR	A	22/11/1983	-7.04	R		NR	A	13/12/1983	-7.10	R		NR
A	24/01/1984	-7.10	R		NR	A	21/02/1984	-7.00	R		NR	A	20/03/1984	-6.90	R		NR
A	30/04/1984	-6.88	R		NR	A	28/05/1984	-6.96	R		NR	A	26/06/1984	-6.98	R		NR
A	23/07/1984	-7.00	R		NR	A	20/08/1984	-7.00	R		NR	A	25/09/1984	-7.40	R		NR
A	06/11/1984	-7.41	R		NR	A	03/12/1984	-7.44	R		NR	A	25/03/1985	-7.00	R		NR
A	23/04/1985	-6.97	R		NR	A	25/06/1985	-7.10	R		NR	A	23/07/1985	-7.01	R		NR
A	24/09/1985	-7.10	R		NR	A	22/07/1986	-6.80	R		NR	A	16/09/1986	-6.90	R		NR
A	16/12/1986	-7.30	R		NR	A	02/06/1987	-7.39	R		NR	A	28/07/1987	-7.22	R		NR
A	22/09/1987	-7.35	R		NR	A	06/01/1988	-7.76	R		NR	A	29/03/1988	-7.38	R		NR
A	03/08/1988	-7.10	R		NR	A	18/10/1988	-6.85	R		NR	A	20/02/1989	-6.56	R		NR
A	22/03/1990	-6.90	R		NR	A	03/07/1990	-6.35	R		NR	A	31/10/1990	-7.05	R		NR
A	20/03/1991	-6.62	R		NR	A	22/08/1991	-6.91	R		NR	A	04/02/1992	-8.23	R		NR
A	30/04/1992	-7.53	R		NR	A	18/11/1992	-8.56	R		NR	A	04/10/1993	-7.62	R		NR
A	24/01/1994	-8.85	R	P	NR	A	25/05/1994	-7.88	R		NR	A	28/07/1994	-7.67	R		NR
A	13/09/1994	-8.13	R		NR	A	24/10/1994	-8.64	R		NR	A	26/04/1995	-8.65	R		NR
A	12/08/1996	-7.82	R		NR	A	09/01/1997	-8.15	R		NR	A	17/07/1998	-6.94	R		NR
A	27/11/1998	-6.54	R		NR	A	31/03/1999	-6.52	R		NR	A	16/06/1999	-6.30	R		NR
A	30/09/1999	-6.53	R		NR	A	31/12/1999	-7.12	R		NR	A	30/06/2000	-6.62	R		NR
A	30/09/2000	-6.70	R		NR	A	06/11/2000	-6.08	R		NR	A	30/12/2000	-6.80	R		NR
A	30/03/2001	-6.62	R		NR	A	24/09/2001	-6.08	R		NR	A	30/09/2002	-6.41	R		NR
A	21/11/2002	-8.06	R		NR	A	30/12/2002	-6.53	R		NR	A	30/03/2003	-6.08	R		NR

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PIPE	DATE	MEASURE (m)	N/R	RMK	MEAS TYPE
A	30/06/2003	-8.32	R		NR
A	30/03/2004	-7.12	R		NR
A	03/11/2004	-8.02	R		NR
A	30/03/2005	-6.41	R		NR
A	26/10/2005	-7.58	R		NR
A	30/09/2006	-6.62	R		NR
A	30/03/2007	-6.52	R		NR
A	14/06/2011	-5.10	R		NR
A	13/11/2003	-8.72	R		NR
A	30/06/2004	-7.12	R		NR
A	17/11/2004	-8.32	R		NR
A	30/06/2005	-6.75	R		NR
A	30/12/2005	-7.53	R		NR
A	03/10/2006	-7.20	R		NR
A	24/09/2007	-6.62	R		NR
X	16/10/1973	-6.70	N		NR
A	30/12/2003	-6.08	R		NR
A	30/09/2004	-6.62	R		NR
A	30/12/2004	-8.32	R		NR
A	30/09/2005	-8.32	R		NR
A	30/06/2006	-6.08	R		NR
A	30/12/2006	-7.53	R		NR
A	05/11/2008	-6.66	R		NR

WIRE LINE LOG DETAILS

**** NO RECORDS FOUND ****

FIELD MEASUREMENTS

PIPE	DATE	DEPTH (m)	COND (uS/cm)	pH	TEMP (C)	NO3 (mg/L)	DO (mg/L)	Eh (mV)	ALK (mEq)	METH	SOURCE
A	18/10/1973		8550							PU	GB
A	23/07/1985		2260							PU	GB
A	16/09/1986		2160							PU	GB
A	02/06/1987		4130							BA	GB
A	22/09/1987		7770							PU	GB
A	29/03/1988		7420							PU	GB
A	25/05/1994		7700							PU	GB
A	06/11/2000	6.08	8590	6.2	27.3		63.00	83		PU	GB
A	20/09/2001	-6.15	9040	6.0	26.8			93		PU	GB
A	20/11/2002	22.00	9160	7.3	27.3					PG	GB
A	13/11/2003	22.00	9030	6.2	26.0					PU	GB
A	03/11/2004		8500	6.5	26.6					PU	GB
A	03/10/2006		8650	6.3	25.3					PU	GB
A	24/09/2007		8940	6.4	26.2					PU	GB
A	05/11/2008		8870	7.9						PU	GB
A	14/06/2011		8510		24.9					PU	GB

BORE REPORT

REG NUMBER 12200039

SPECIAL WATER ANALYSIS

PIPE A **DATE** 06/11/2000 **REC** 1

VARIABLE ********** Lead as Pb - total

MEASUREMENT 0.00000 **UNITS** Micrograms/Litre

DEPTH

WR ANAL NO	207253	**METHOD**	BA	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	22-NOV-00	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 06/11/2000 **REC** 1

VARIABLE ********** Cadmium as Cd - total

MEASUREMENT 0.00000 **UNITS** Micrograms/Litre

DEPTH

WR ANAL NO	207253	**METHOD**	BA	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	22-NOV-00	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 06/11/2000 **REC** 1

VARIABLE ********** Zinc as Zn - total ug/L

MEASUREMENT 50.00000 **UNITS** Micrograms/Litre

DEPTH

WR ANAL NO	207253	**METHOD**	BA	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	22-NOV-00	**SOURCE**	GB		
COMMENT					

REG NUMBER 12200039

PIPE A **DATE** 06/11/2000 **REC** 1

VARIABLE ********** Nickel as Ni - total

MEASUREMENT 0.00000 **UNITS** Micrograms/Litre

DEPTH

WR ANAL NO	207253	**METHOD**	BA	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	22-NOV-00	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 06/11/2000 **REC** 1

VARIABLE ********** Manganese as Mn - total

MEASUREMENT 470.00000 **UNITS** Micrograms/Litre

DEPTH

WR ANAL NO	207253	**METHOD**	BA	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	22-NOV-00	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 06/11/2000 **REC** 1

VARIABLE ********** Chromium as Cr - total

MEASUREMENT 0.00000 **UNITS** Micrograms/Litre

DEPTH

WR ANAL NO	207253	**METHOD**	BA	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	22-NOV-00	**SOURCE**	GB		

COMMENT

BORE REPORT

REG NUMBER 12200039

PIPE A **DATE** 06/11/2000 **REC** 1

VARIABLE ********** Iron as Fe - total

MEASUREMENT 340.00000 **UNITS** Micrograms/Litre

DEPTH

WR ANAL NO	207253	**METHOD**	BA	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	22-NOV-00	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 06/11/2000 **REC** 1

VARIABLE ********** Copper as Cu - total

MEASUREMENT 0.00000 **UNITS** Micrograms/Litre

DEPTH

WR ANAL NO	207253	**METHOD**	BA	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	22-NOV-00	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 06/11/2000 **REC** 2

VARIABLE ********** Total Nitrogen

MEASUREMENT 0.22080 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	207253	**METHOD**	BA	**PRESERVATIVES**	**PROJECTS**
BOTTLE	D	**ANALYST**	GCL	FR	GWAN
		COL AUTH	DG		
RECD AT LAB	22-NOV-00	**SOURCE**	GB		

COMMENT

BORE REPORT

REG NUMBER 12200039

PIPE A **DATE** 06/11/2000 **REC** 2

VARIABLE ********** Total Phosphorus as P

MEASUREMENT 0.07290 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO 207253 **METHOD** BA **PRESERVATIVES** **PROJECTS**

BOTTLE D **ANALYST** GCL FR GWAN

COL AUTH DG

RECD AT LAB 22-NOV-00 **SOURCE** GB

COMMENT

PIPE A **DATE** 20/09/2001 **REC** 1

VARIABLE ********** Total Nitrogen

MEASUREMENT 0.58320 **UNITS** Milligrams/Litre

DEPTH 22.60

WR ANAL NO 211122 **METHOD** MA **PRESERVATIVES** **PROJECTS**

BOTTLE D **ANALYST** GCL FR GWAN

COL AUTH DG

RECD AT LAB 02-OCT-01 **SOURCE** GB

COMMENT

PIPE A **DATE** 20/09/2001 **REC** 1

VARIABLE ********** Total Phosphorus as P

MEASUREMENT 0.45900 **UNITS** Milligrams/Litre

DEPTH 22.60

WR ANAL NO 211122 **METHOD** MA **PRESERVATIVES** **PROJECTS**

BOTTLE D **ANALYST** GCL FR GWAN

COL AUTH DG

RECD AT LAB 02-OCT-01 **SOURCE** GB

COMMENT

BORE REPORT

REG NUMBER 12200039

PIPE A **DATE** 21/11/2002 **REC** 1

VARIABLE ********** Total Phosphorus as P

MEASUREMENT 0.15070 **UNITS** Milligrams/Litre

DEPTH 21.00

WR ANAL NO 207345 **METHOD** PG **PRESERVATIVES** **PROJECTS**

BOTTLE D **ANALYST** GCL FR GWAN

COL AUTH DG

RECD AT LAB 26-NOV-02 **SOURCE** GB

COMMENT

PIPE A **DATE** 21/11/2002 **REC** 1

VARIABLE ********** Total Nitrogen

MEASUREMENT 0.08030 **UNITS** Milligrams/Litre

DEPTH 21.00

WR ANAL NO 207345 **METHOD** PG **PRESERVATIVES** **PROJECTS**

BOTTLE D **ANALYST** GCL FR GWAN

COL AUTH DG

RECD AT LAB 26-NOV-02 **SOURCE** GB

COMMENT

PIPE A **DATE** 13/11/2003 **REC** 1

VARIABLE ********** Manganese as Mn - total

MEASUREMENT 310.00000 **UNITS** Micrograms/Litre

DEPTH 15.00

WR ANAL NO 211052 **METHOD** PA **PRESERVATIVES** **PROJECTS**

BOTTLE B **ANALYST** GCL XX GWAN

COL AUTH DG

RECD AT LAB 21-NOV-03 **SOURCE** GB

COMMENT

BORE REPORT

REG NUMBER 12200039

PIPE A **DATE** 13/11/2003 **REC** 1

VARIABLE ********** Aluminium as Al - total (ug/L)

MEASUREMENT 20.00000 **UNITS** Micrograms/Litre

DEPTH 15.00

WR ANAL NO	211052	**METHOD**	PA	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	XX	GWAN
		COL AUTH	DG		
RECD AT LAB	21-NOV-03	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 13/11/2003 **REC** 1

VARIABLE ********** Lead as Pb - total

MEASUREMENT 0.00000 **UNITS** Micrograms/Litre

DEPTH 15.00

WR ANAL NO	211052	**METHOD**	PA	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	XX	GWAN
		COL AUTH	DG		
RECD AT LAB	21-NOV-03	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 13/11/2003 **REC** 1

VARIABLE ********** Iron as Fe - total

MEASUREMENT 110.00000 **UNITS** Micrograms/Litre

DEPTH 15.00

WR ANAL NO	211052	**METHOD**	PA	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	XX	GWAN
		COL AUTH	DG		
RECD AT LAB	21-NOV-03	**SOURCE**	GB		
COMMENT					

BORE REPORT

REG NUMBER 12200039

PIPE A **DATE** 13/11/2003 **REC** 1

VARIABLE ********** Total Phosphorus as P

MEASUREMENT 0.04330 **UNITS** Milligrams/Litre

DEPTH 15.00

WR ANAL NO 211052 **METHOD** PA **PRESERVATIVES** **PROJECTS**

BOTTLE D **ANALYST** GCL CH GWAN

COL AUTH DG

RECD AT LAB 21-NOV-03 **SOURCE** GB

COMMENT

PIPE A **DATE** 13/11/2003 **REC** 1

VARIABLE ********** Total Nitrogen

MEASUREMENT 0.03160 **UNITS** Milligrams/Litre

DEPTH 15.00

WR ANAL NO 211052 **METHOD** PA **PRESERVATIVES** **PROJECTS**

BOTTLE D **ANALYST** GCL CH GWAN

COL AUTH DG

RECD AT LAB 21-NOV-03 **SOURCE** GB

COMMENT

PIPE A **DATE** 03/11/2004 **REC** 1

VARIABLE ********** Cadmium as Cd - total (lower LOR)

MEASUREMENT < 0.00100 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO 207237 **METHOD** PG **PRESERVATIVES** **PROJECTS**

BOTTLE B **ANALYST** GCL AN GWAN

COL AUTH DG

RECD AT LAB 09-NOV-04 **SOURCE** GB

COMMENT

BORE REPORT

REG NUMBER 12200039

PIPE A **DATE** 03/11/2004 **REC** 1

VARIABLE ********** Nickel as Ni -total

MEASUREMENT < 0.00500 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	207237	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	09-NOV-04	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 03/11/2004 **REC** 1

VARIABLE ********** Zinc as Zn -soluble (lower LOR)

MEASUREMENT < 0.02000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	207237	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	09-NOV-04	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 03/11/2004 **REC** 1

VARIABLE ********** Manganese as Mn - total (lower LOR)

MEASUREMENT 0.30000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	207237	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	09-NOV-04	**SOURCE**	GB		
COMMENT					

BORE REPORT

REG NUMBER 12200039

PIPE A **DATE** 03/11/2004 **REC** 1

VARIABLE ********** Iron as Fe - total (lower LOR)

MEASUREMENT 0.17000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	207237	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	09-NOV-04	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 03/11/2004 **REC** 1

VARIABLE ********** Chromium as Cr - total (lower LOR)

MEASUREMENT < 0.00300 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	207237	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	09-NOV-04	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 03/11/2004 **REC** 1

VARIABLE ********** Arsenic as As - total (lower LOR)

MEASUREMENT < 0.00500 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	207237	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	09-NOV-04	**SOURCE**	GB		

COMMENT

BORE REPORT

REG NUMBER 12200039

PIPE A **DATE** 03/11/2004 **REC** 1

VARIABLE ********** Aluminium as Al - total (lower LOR)

MEASUREMENT 0.02000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	207237	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	09-NOV-04	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 03/11/2004 **REC** 1

VARIABLE ********** Total Phosphorus as P

MEASUREMENT 0.07000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	207237	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	D	**ANALYST**	GCL	FR	GWAN
		COL AUTH	DG		
RECD AT LAB	09-NOV-04	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 03/11/2004 **REC** 1

VARIABLE ********** Total Nitrogen

MEASUREMENT 0.12000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	207237	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	D	**ANALYST**	GCL	FR	GWAN
		COL AUTH	DG		
RECD AT LAB	09-NOV-04	**SOURCE**	GB		

COMMENT

REG NUMBER 12200039

PIPE A **DATE** 26/10/2005 **REC** 1

VARIABLE ********** Cadmium as Cd - total (lower LOR)

MEASUREMENT < 0.00100 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	217077	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	01-NOV-05	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 26/10/2005 **REC** 1

VARIABLE ********** Nickel as Ni -total

MEASUREMENT < 0.00500 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	217077	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	01-NOV-05	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 26/10/2005 **REC** 1

VARIABLE ********** Total Phosphorus as P

MEASUREMENT 0.08000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	217077	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	D	**ANALYST**	GCL	FR	GWAN
		COL AUTH	DG		
RECD AT LAB	01-NOV-05	**SOURCE**	GB		
COMMENT					

BORE REPORT

REG NUMBER 12200039

PIPE A **DATE** 26/10/2005 **REC** 1

VARIABLE ********** Arsenic as As - total (lower LOR)

MEASUREMENT < 0.00500 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	217077	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	01-NOV-05	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 26/10/2005 **REC** 1

VARIABLE ********** Iron as Fe - total (lower LOR)

MEASUREMENT 0.13000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	217077	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	01-NOV-05	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 26/10/2005 **REC** 1

VARIABLE ********** Zinc as Zn -soluble (lower LOR)

MEASUREMENT < 0.02000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	217077	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	01-NOV-05	**SOURCE**	GB		

COMMENT

REG NUMBER 12200039

PIPE A **DATE** 26/10/2005 **REC** 1

VARIABLE ********** Aluminium as Al - total (lower LOR)

MEASUREMENT 0.02000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	217077	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	01-NOV-05	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 26/10/2005 **REC** 1

VARIABLE ********** Manganese as Mn - total (lower LOR)

MEASUREMENT 0.30000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	217077	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	01-NOV-05	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 26/10/2005 **REC** 1

VARIABLE ********** Total Nitrogen

MEASUREMENT 0.23600 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	217077	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	D	**ANALYST**	GCL	FR	GWAN
		COL AUTH	DG		
RECD AT LAB	01-NOV-05	**SOURCE**	GB		

COMMENT

BORE REPORT

REG NUMBER 12200039

PIPE A **DATE** 26/10/2005 **REC** 1

VARIABLE ********** Chromium as Cr - total (lower LOR)

MEASUREMENT < 0.00300 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	217077	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	01-NOV-05	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 03/10/2006 **REC** 1

VARIABLE ********** Zinc as Zn -soluble (lower LOR)

MEASUREMENT < 0.02000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	220929	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	10-OCT-06	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 03/10/2006 **REC** 1

VARIABLE ********** Total Nitrogen

MEASUREMENT 0.20960 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	220929	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	D	**ANALYST**	GCL	FR	GWAN
		COL AUTH	DG		
RECD AT LAB	10-OCT-06	**SOURCE**	GB		
COMMENT					

REG NUMBER 12200039

PIPE A **DATE** 03/10/2006 **REC** 1

VARIABLE ********** Manganese as Mn - total (lower LOR)

MEASUREMENT 0.30000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO 220929 **METHOD** PG **PRESERVATIVES** **PROJECTS**

BOTTLE B **ANALYST** GCL NL GWAN

COL AUTH DG

RECD AT LAB 10-OCT-06 **SOURCE** GB

COMMENT

PIPE A **DATE** 03/10/2006 **REC** 1

VARIABLE ********** Aluminium as Al - total (lower LOR)

MEASUREMENT 0.06000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO 220929 **METHOD** PG **PRESERVATIVES** **PROJECTS**

BOTTLE B **ANALYST** GCL NL GWAN

COL AUTH DG

RECD AT LAB 10-OCT-06 **SOURCE** GB

COMMENT

PIPE A **DATE** 03/10/2006 **REC** 1

VARIABLE ********** Arsenic as As - total (lower LOR)

MEASUREMENT < 0.00500 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO 220929 **METHOD** PG **PRESERVATIVES** **PROJECTS**

BOTTLE B **ANALYST** GCL NL GWAN

COL AUTH DG

RECD AT LAB 10-OCT-06 **SOURCE** GB

COMMENT

BORE REPORT

REG NUMBER 12200039

PIPE A **DATE** 03/10/2006 **REC** 1

VARIABLE ********** Iron as Fe - total (lower LOR)

MEASUREMENT 0.15000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	220929	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	10-OCT-06	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 03/10/2006 **REC** 1

VARIABLE ********** Nickel as Ni -total

MEASUREMENT < 0.00500 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	220929	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	10-OCT-06	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 03/10/2006 **REC** 1

VARIABLE ********** Chromium as Cr - total (lower LOR)

MEASUREMENT < 0.00300 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	220929	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	10-OCT-06	**SOURCE**	GB		

COMMENT

BORE REPORT

REG NUMBER 12200039

PIPE A **DATE** 03/10/2006 **REC** 1

VARIABLE ********** Cadmium as Cd - total (lower LOR)

MEASUREMENT < 0.00100 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	220929	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	10-OCT-06	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 03/10/2006 **REC** 1

VARIABLE ********** Total Phosphorus as P

MEASUREMENT 0.08410 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	220929	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	D	**ANALYST**	GCL	FR	GWAN
		COL AUTH	DG		
RECD AT LAB	10-OCT-06	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 24/09/2007 **REC** 1

VARIABLE ********** Total Nitrogen

MEASUREMENT 0.17130 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	223970	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	D	**ANALYST**	GCL	FR	GWAN
		COL AUTH	DG		
RECD AT LAB	11-OCT-07	**SOURCE**	GB		
COMMENT					

REG NUMBER 12200039

PIPE A **DATE** 24/09/2007 **REC** 1

VARIABLE ********** Total Phosphorus as P

MEASUREMENT 0.08280 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO 223970 **METHOD** PG **PRESERVATIVES** **PROJECTS**

BOTTLE D **ANALYST** GCL FR GWAN

COL AUTH DG

RECD AT LAB 11-OCT-07 **SOURCE** GB

COMMENT

PIPE A **DATE** 24/09/2007 **REC** 1

VARIABLE ********** Aluminium as Al - total (lower LOR)

MEASUREMENT 0.17000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO 223970 **METHOD** PG **PRESERVATIVES** **PROJECTS**

BOTTLE B **ANALYST** GCL NL GWAN

COL AUTH DG

RECD AT LAB 11-OCT-07 **SOURCE** GB

COMMENT

PIPE A **DATE** 24/09/2007 **REC** 1

VARIABLE ********** Arsenic as As - total (lower LOR)

MEASUREMENT < 0.00500 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO 223970 **METHOD** PG **PRESERVATIVES** **PROJECTS**

BOTTLE B **ANALYST** GCL NL GWAN

COL AUTH DG

RECD AT LAB 11-OCT-07 **SOURCE** GB

COMMENT

BORE REPORT

REG NUMBER 12200039

PIPE A **DATE** 24/09/2007 **REC** 1

VARIABLE ********** Cadmium as Cd - total (lower LOR)

MEASUREMENT < 0.00100 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	223970	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	11-OCT-07	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 24/09/2007 **REC** 1

VARIABLE ********** Chromium as Cr - total (lower LOR)

MEASUREMENT < 0.00400 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	223970	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	11-OCT-07	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 24/09/2007 **REC** 1

VARIABLE ********** Iron as Fe - total (lower LOR)

MEASUREMENT 0.43000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	223970	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	11-OCT-07	**SOURCE**	GB		

COMMENT

REG NUMBER 12200039

PIPE A **DATE** 24/09/2007 **REC** 1

VARIABLE ********** Manganese as Mn - total (lower LOR)

MEASUREMENT 0.40000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	223970	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	11-OCT-07	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 24/09/2007 **REC** 1

VARIABLE ********** Nickel as Ni -total

MEASUREMENT < 0.00500 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	223970	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	11-OCT-07	**SOURCE**	GB		

COMMENT

PIPE A **DATE** 24/09/2007 **REC** 1

VARIABLE ********** Zinc as Zn -soluble (lower LOR)

MEASUREMENT < 0.02000 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	223970	**METHOD**	PG	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	NL	GWAN
		COL AUTH	DG		
RECD AT LAB	11-OCT-07	**SOURCE**	GB		

COMMENT

REG NUMBER 12200039

PIPE A **DATE** 05/11/2008 **REC** 1

VARIABLE ********** Total Phosphorus as P

MEASUREMENT 0.15360 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	227054	**METHOD**	AI	**PRESERVATIVES**	**PROJECTS**
BOTTLE	D	**ANALYST**	GCL	CH	GWAN
		COL AUTH	DG		
RECD AT LAB	18-NOV-08	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 05/11/2008 **REC** 1

VARIABLE ********** Total Nitrogen

MEASUREMENT 0.14930 **UNITS** Milligrams/Litre

DEPTH

WR ANAL NO	227054	**METHOD**	AI	**PRESERVATIVES**	**PROJECTS**
BOTTLE	D	**ANALYST**	GCL	CH	GWAN
		COL AUTH	DG		
RECD AT LAB	18-NOV-08	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 14/06/2011 **REC** 1

VARIABLE ********** Aluminium as AL - total (finer LOR)

MEASUREMENT 0.89000 **UNITS** Milligrams/Litre

DEPTH 16.00

WR ANAL NO	302574	**METHOD**	AI	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	14-JUN-11	**SOURCE**	GB		
COMMENT					

BORE REPORT

REG NUMBER 12200039

PIPE A **DATE** 14/06/2011 **REC** 1

VARIABLE ********** Arsenic as Ar - total (finer LOR)

MEASUREMENT 0.00050 **UNITS** Milligrams/Litre

DEPTH 16.00

WR ANAL NO	302574	**METHOD**	AI	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	14-JUN-11	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 14/06/2011 **REC** 1

VARIABLE ********** Zinc as Zn - total (finer LOR)

MEASUREMENT 0.02200 **UNITS** Milligrams/Litre

DEPTH 16.00

WR ANAL NO	302574	**METHOD**	AI	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	14-JUN-11	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 14/06/2011 **REC** 1

VARIABLE ********** Chromium as Cr - total (finer LOR)

MEASUREMENT 0.00120 **UNITS** Milligrams/Litre

DEPTH 16.00

WR ANAL NO	302574	**METHOD**	AI	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	14-JUN-11	**SOURCE**	GB		
COMMENT					

BORE REPORT

REG NUMBER 12200039

PIPE A **DATE** 14/06/2011 **REC** 1

VARIABLE ********** Copper as Cu - total (finer LOR)

MEASUREMENT 0.00200 **UNITS** Milligrams/Litre

DEPTH 16.00

WR ANAL NO	302574	**METHOD**	AI	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	14-JUN-11	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 14/06/2011 **REC** 1

VARIABLE ********** Iron as Fe - total (finer LOR)

MEASUREMENT 1.50000 **UNITS** Milligrams/Litre

DEPTH 16.00

WR ANAL NO	302574	**METHOD**	AI	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	14-JUN-11	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 14/06/2011 **REC** 1

VARIABLE ********** Manganese as Mn - total (finer LOR)

MEASUREMENT 0.41000 **UNITS** Milligrams/Litre

DEPTH 16.00

WR ANAL NO	302574	**METHOD**	AI	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	14-JUN-11	**SOURCE**	GB		
COMMENT					

REG NUMBER 12200039

PIPE A **DATE** 14/06/2011 **REC** 1

VARIABLE ********** Lead as Pb - total (finer LOR)

MEASUREMENT 0.00110 **UNITS** Milligrams/Litre

DEPTH 16.00

WR ANAL NO	302574	**METHOD**	AI	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	14-JUN-11	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 14/06/2011 **REC** 1

VARIABLE ********** Nickel as Ni - total (finer LOR)

MEASUREMENT 0.00230 **UNITS** Milligrams/Litre

DEPTH 16.00

WR ANAL NO	302574	**METHOD**	AI	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	14-JUN-11	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 14/06/2011 **REC** 1

VARIABLE ********** Total Phosphorus as P

MEASUREMENT 0.12000 **UNITS** Milligrams/Litre

DEPTH 16.00

WR ANAL NO	302574	**METHOD**	AI	**PRESERVATIVES**	**PROJECTS**
BOTTLE	D	**ANALYST**	GCL	FR	GWAN
		COL AUTH	DG		
RECD AT LAB	14-JUN-11	**SOURCE**	GB		
COMMENT					

REG NUMBER 12200039

PIPE A **DATE** 14/06/2011 **REC** 1

VARIABLE ********** Total Nitrogen

MEASUREMENT 0.18000 **UNITS** Milligrams/Litre

DEPTH 16.00

WR ANAL NO	302574	**METHOD**	AI	**PRESERVATIVES**	**PROJECTS**
BOTTLE	D	**ANALYST**	GCL	FR	GWAN
		COL AUTH	DG		
RECD AT LAB	14-JUN-11	**SOURCE**	GB		
COMMENT					

PIPE A **DATE** 14/06/2011 **REC** 1

VARIABLE ********** Cadmium as Cd - total (finer LOR)

MEASUREMENT < 0.00100 **UNITS** Milligrams/Litre

DEPTH 16.00

WR ANAL NO	302574	**METHOD**	AI	**PRESERVATIVES**	**PROJECTS**
BOTTLE	B	**ANALYST**	GCL	AN	GWAN
		COL AUTH	DG		
RECD AT LAB	14-JUN-11	**SOURCE**	GB		
COMMENT					

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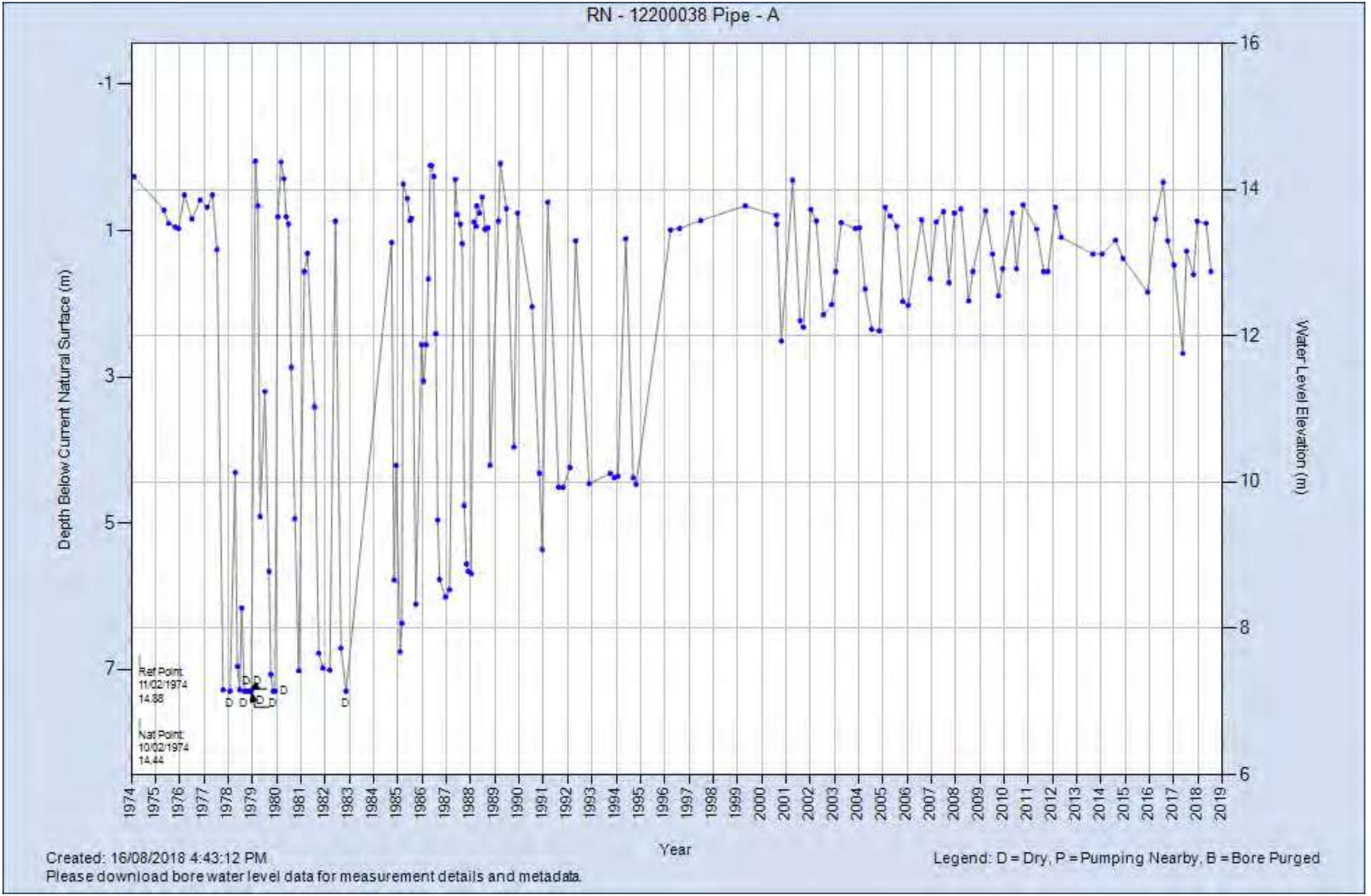
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**** End of Report. Produced:** 19/03/2018 01:03:14 PM ******


RN - 12200038 Pipe - A
Depth Below Current Natural Surface (m)
Water Level Elevation (m)
-1
1
3
5
7
16
14
12
10
8
6
1974
1975
1976
1977
1978
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2012
2013
2014
2015
2016
2017
2018
2019
Year
Ref Point:
11/02/1974
14.88
Nat Point:
10/02/1974
14.44
Created: 16/08/2018 4:43:12 PM
Please download bore water level data for measurement details and metadata.
Legend: D = Dry, P = Pumping Nearby, B = Bore Purged

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APPENDIX F

EHP Environmental Reports Online Searches

Queensland Government

Department of Environment and Science

Environmental Reports

Matters of State Environmental Significance

For the selected area of interest
Lot: 160 Plan: SP171910

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Please direct queries about these reports to: Planning.Support@des.qld.gov.au

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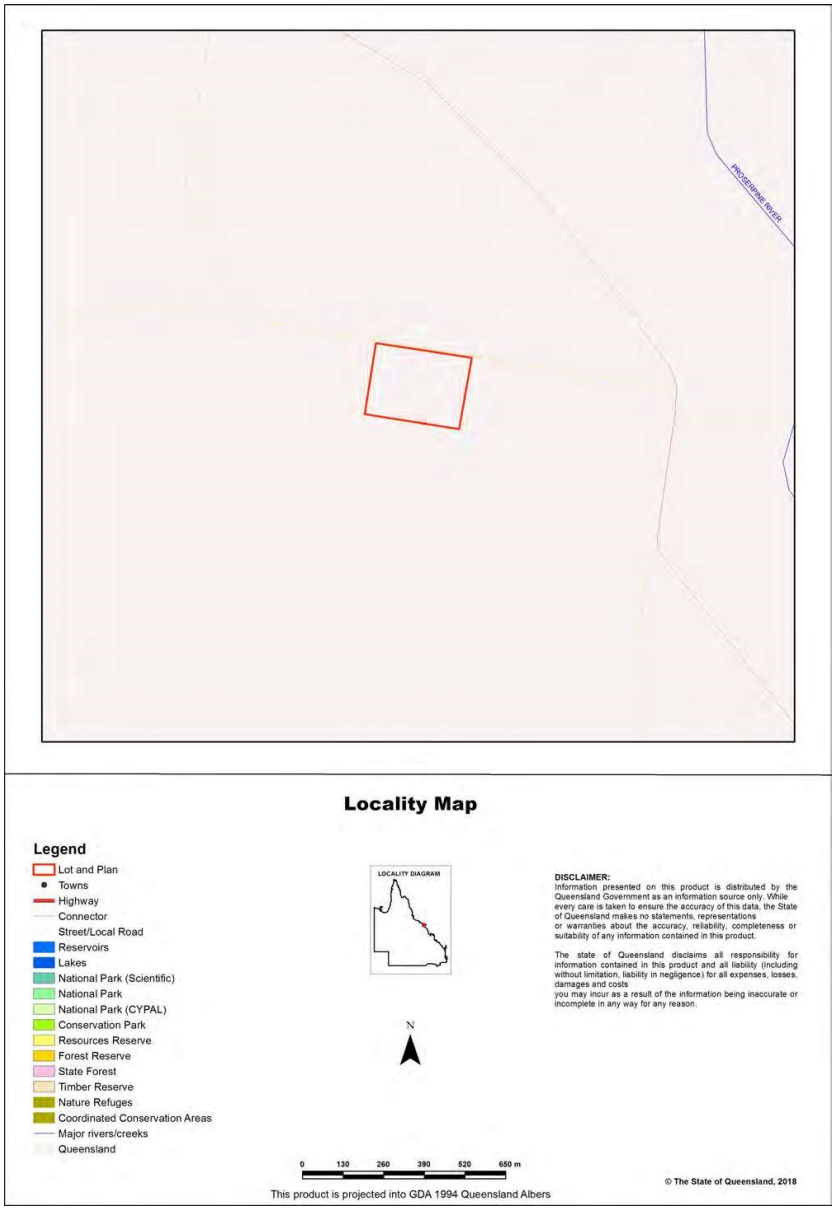
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Assessment Area Details

The following table provides an overview of the area of interest (AOI) with respect to selected topographic and environmental values.

Table 1: Summary table, details for AOI Lot: 160 Plan: SP171910

Size (ha)	7.14
Local Government(s)	Whitsunday Regional
Bioregion(s)	Central Queensland Coast
Subregion(s)	Proserpine - Sarina Lowlands
Catchment(s)	Proserpine



Matters of State Environmental Significance (MSES)

MSES Categories

Queensland's State Planning Policy (SPP) includes a biodiversity State interest that states:

'The sustainable, long-term conservation of biodiversity is supported. Significant impacts on matters of national or state environmental significance are avoided, or where this cannot be reasonably achieved; impacts are minimised and residual impacts offset.'

The MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

The SPP defines matters of state environmental significance as:

- Protected areas (including all classes of protected area except coordinated conservation areas) under the *Nature Conservation Act 1992* ;

- Marine parks and land within a 'marine national park', 'conservation park', 'scientific research', 'preservation' or 'buffer' zone under the *Marine Parks Act 2004* ;

- Areas within declared fish habitat areas that are management A areas or management B areas under the Fisheries Regulation 2008;

- Threatened wildlife under the *Nature Conservation Act 1992* and special least concern animals under the Nature Conservation (Wildlife) Regulation 2006;

- Regulated vegetation under the *Vegetation Management Act 1999* that is:

    • Category B areas on the regulated vegetation management map, that are 'endangered' or 'of concern' regional ecosystems;

    • Category C areas on the regulated vegetation management map that are 'endangered' or 'of concern' regional ecosystems;

    • Category R areas on the regulated vegetation management map;

    • Regional ecosystems that intersect with watercourses identified on the vegetation management watercourse and drainage feature map;

    • Regional ecosystems that intersect with wetlands identified on the vegetation management wetlands map;

- Strategic Environmental Areas under the *Regional Planning Interests Act 2014* ;

- Wetlands in a wetland protection area of wetlands of high ecological significance shown on the Map of Referable Wetlands under the Environmental Protection Regulation 2008;

- Wetlands and watercourses in high ecological value waters defined in the Environmental Protection (Water) Policy 2009, schedule 2;

- Legally secured offset areas.

MSES Values Present

The MSES values that are present in the area of interest are summarised in the table below:

Table 2: Summary of MSES present within the AOI

1a Protected Areas- estates	0.0 ha	0.0 %
1b Protected Areas- nature refuges	0.0 ha	0.0 %
2 State Marine Parks- highly protected zones	0.0 ha	0.0 %
3 Fish habitat areas (A and B areas)	0.0 ha	0.0 %
4 Strategic Environmental Areas (SEA)	0.0 ha	0.0 %
5 High Ecological Significance wetlands on the map of Referable Wetlands	0.0 ha	0.0 %
6a High Ecological Value (HEV) wetlands	0.0 ha	0.0 %
6b High Ecological Value (HEV) waterways **	0.0 km	Not applicable
7 Threatened species and Iconic species	0.0 ha	0.0 %
8a Regulated Vegetation - Endangered/Of concern in Category B (remnant)	0.0 ha	0.0 %
8b Regulated Vegetation - Endangered/Of concern in Category C (regrowth)	0.0 ha	0.0 %
8c Regulated Vegetation - Category R (GBR riverine regrowth)	0.0 ha	0.0 %
8d Regulated Vegetation - Essential habitat	0.0 ha	0.0 %
8e Regulated Vegetation - intersecting a watercourse **	0.0 km	Not applicable
8f Regulated Vegetation - within 100m of a Vegetation Management Wetland	0.0 ha	0.0 %
9a Legally secured offset areas- offset register areas	0.0 ha	0.0 %
9b Legally secured offset areas- vegetation offsets through a Property Map of Assessable Vegetation	0.0 ha	0.0 %

Additional Information with Respect to MSES Values Present

MSES - State Conservation Areas

1a. Protected Areas - estates

(no results)

1b. Protected Areas - nature refuges

(no results)

2. State Marine Parks - highly protected zones

(no results)

3. Fish habitat areas (A and B areas)

(no results)

Refer to **Map 1 - MSES - State Conservation Areas** for an overview of the relevant MSES.

MSES - Wetlands and Waterways

4. Strategic Environmental Areas (SEA)

(no results)

5. High Ecological Significance wetlands on the Map of Referable Wetlands

(no results)

6a. High Ecological Value (HEV) waters - wetlands

(no results)

6b. High Ecological Value (HEV) waters - waterways

(no results)

Refer to **Map 2 - MSES - Wetlands and Waterways** for an overview of the relevant MSES.

MSES - Species

7. Threatened wildlife and special least concern animal

(no results)

Threatened and special least concern species records

(no results)

Note: The Threatened and Special Least Concern Animal (7) layer originates from the previous MSES version (4.1, dated at 2014). The layer does not represent all currently listed species and is subject to review.

**Nature Conservation Act 1992 (NCA) Status- Endangered (E), Vulnerable (V) or Special Least Concern Animal (SL). Environment Protection and Biodiversity Conservation Act 1999 (EPBC) status: Critically Endangered (CE) Endangered (E), Vulnerable (V)*

To request a species list for an area, or search for a species profile, access Wildlife Online at:
https://www.qld.gov.au/environment/plants-animals/species-list/

Refer to **Map 3 - MSES - Species** for an overview of the relevant MSES.

MSES - Regulated Vegetation

8a. Regulated Vegetation - Endangered/Of concern in Category B (remnant)

Not applicable

8b. Regulated Vegetation - Endangered/Of concern in Category C (regrowth)

Not applicable

For further information relating to regional ecosystems in general, go to:
https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/
For a more detailed description of a particular regional ecosystem, access the regional ecosystem search page at:
https://environment.ehp.qld.gov.au/regional-ecosystems/

8c. Regulated Vegetation - Category R (GBR riverine regrowth)

Not applicable

8d. Regulated Vegetation - Essential habitat

Not applicable

8e. Regulated Vegetation - intersecting a watercourse**

(no results)

8f. Regulated Vegetation - within 100m of a Vegetation Management wetland

Not applicable

Refer to **Map 4 - MSES - Regulated Vegetation** for an overview of the relevant MSES.

MSES - Offsets

9a. Legally secured offset areas - offset register areas

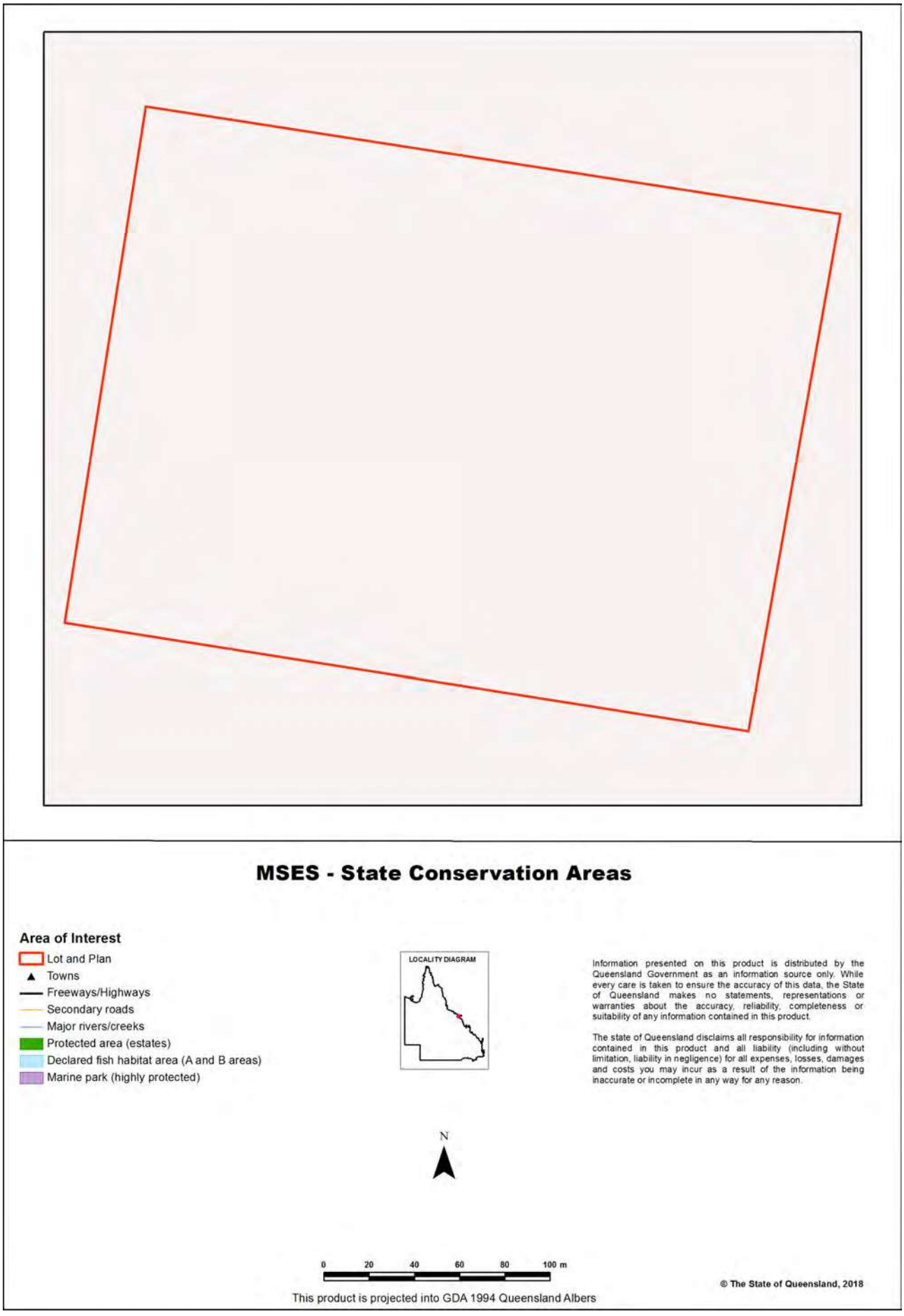
(no results)

9b. Legally secured offset areas - vegetation offsets through a Property Map of Assessable Vegetation

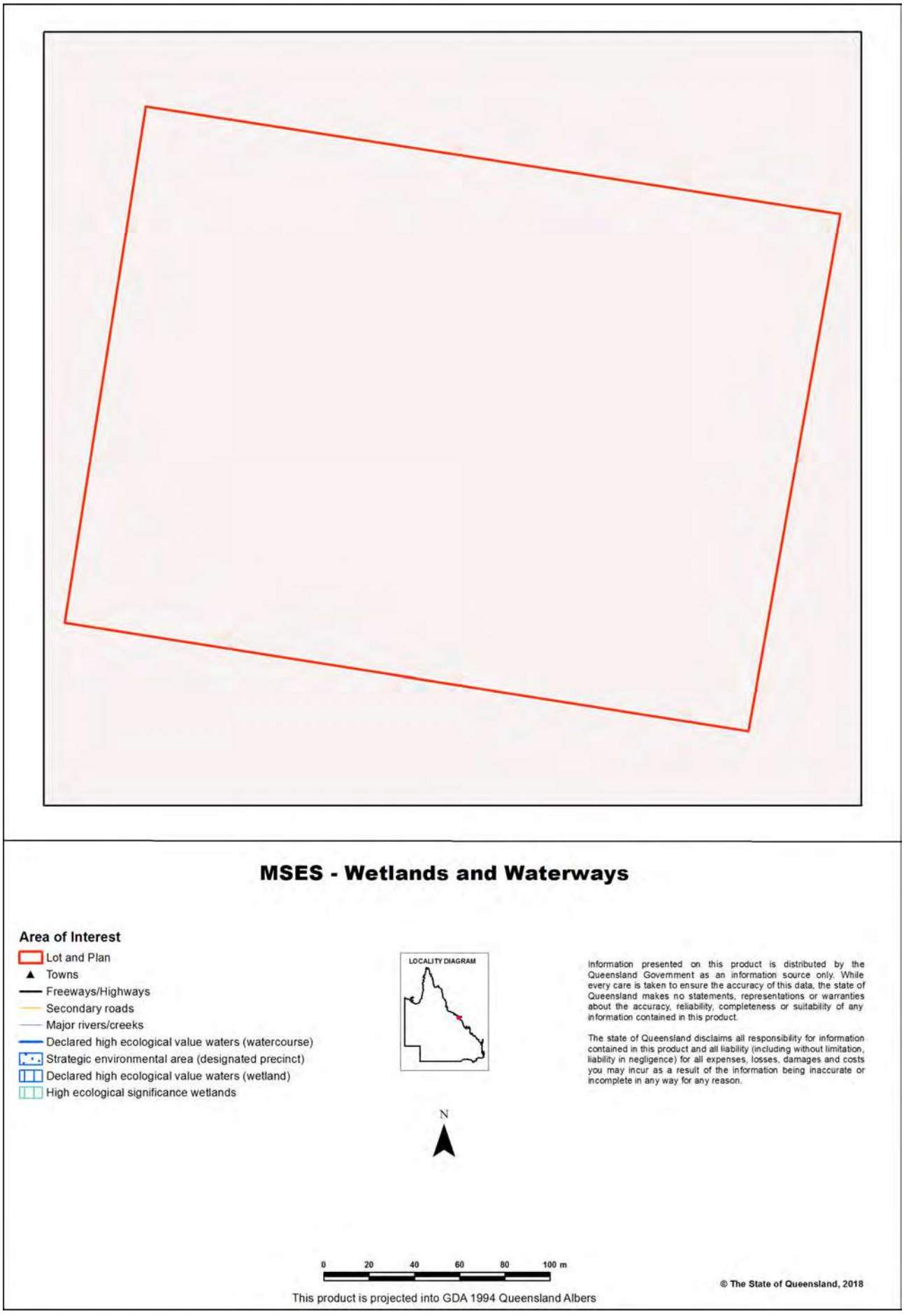
(no results)

Refer to **Map 5 - MSES - Offset Areas** for an overview of the relevant MSES.

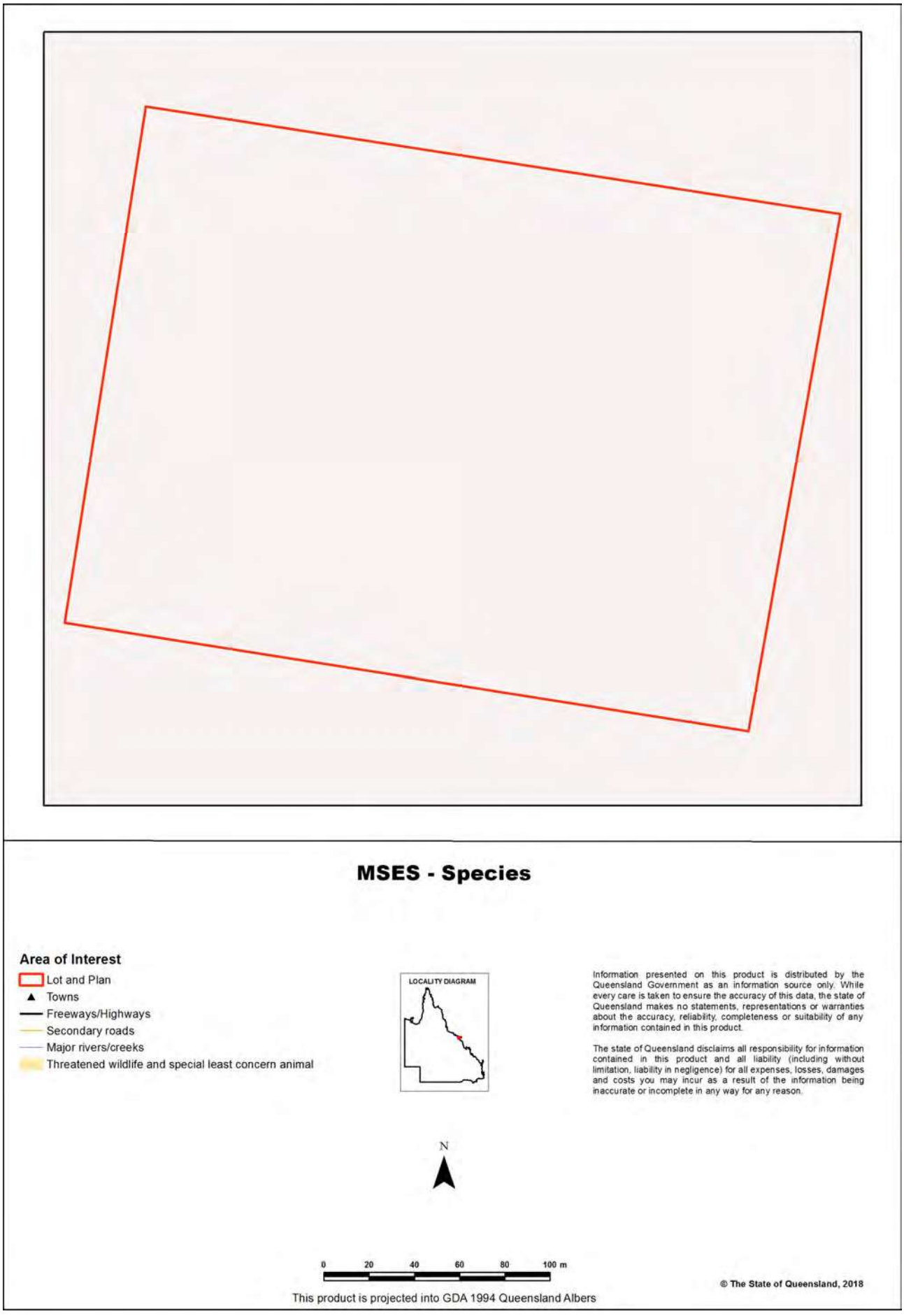
Map 1 - MSES - State Conservation Areas



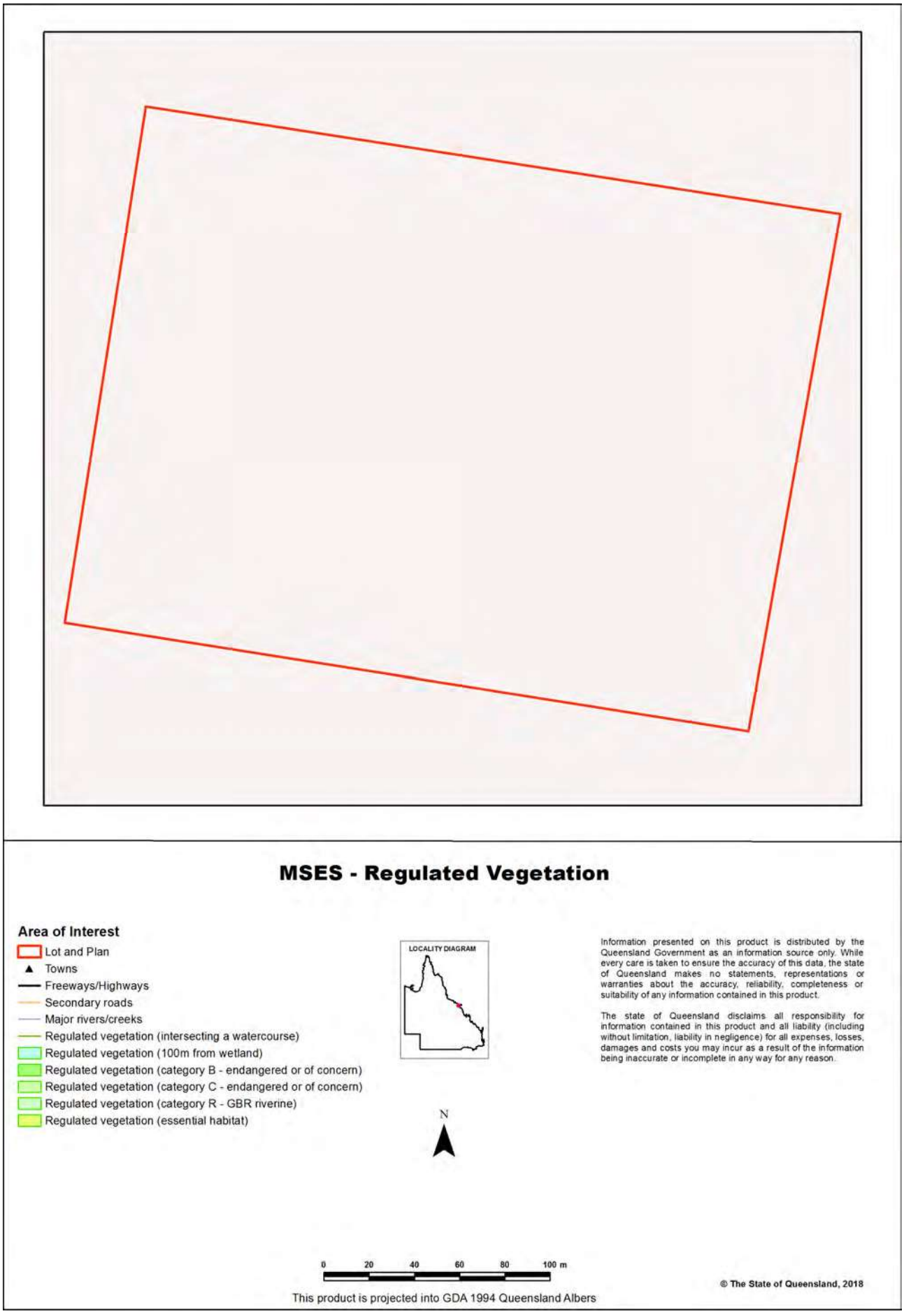
Map 2 - MSES - Wetlands and Waterways



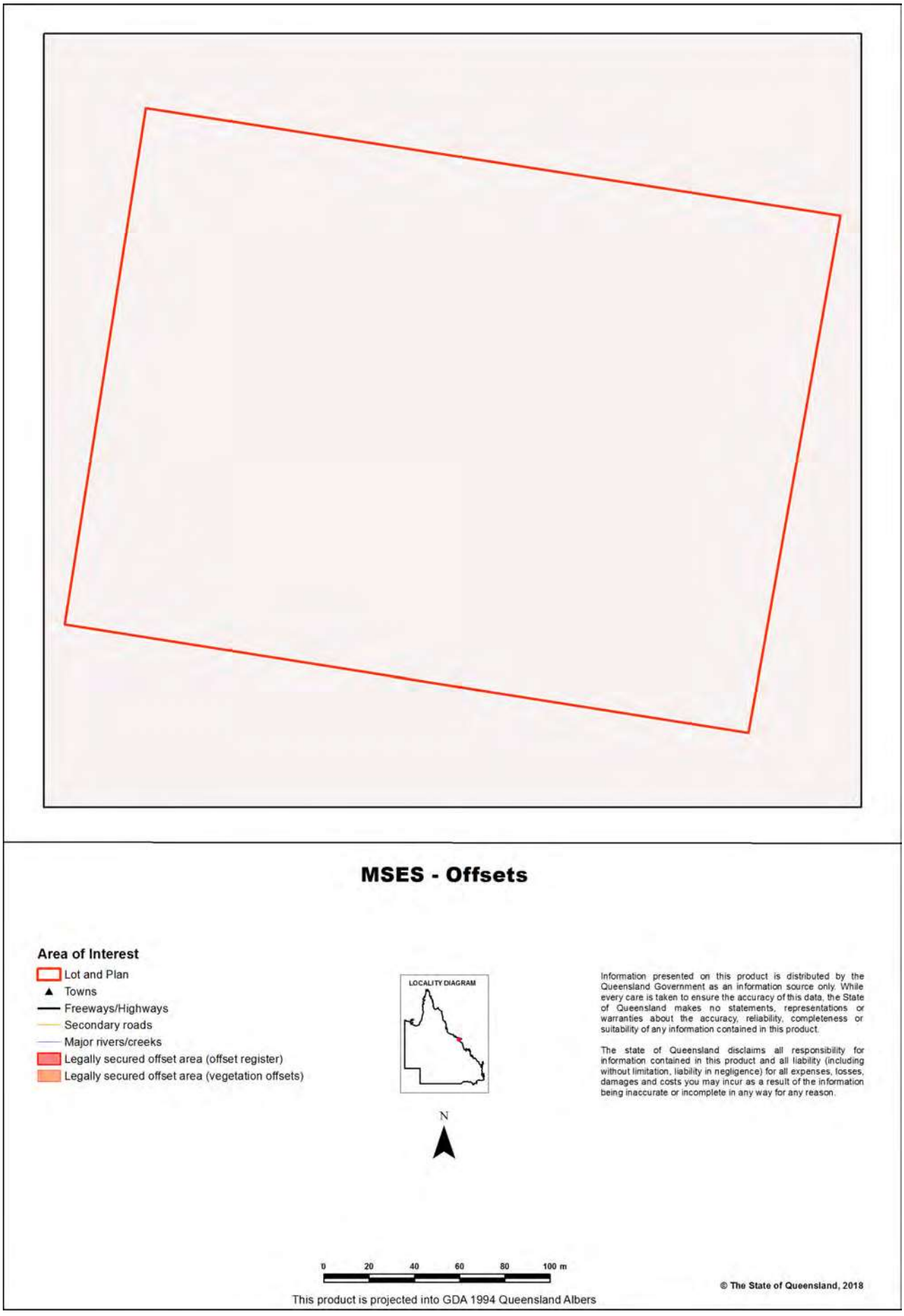
Map 3 - MSES - Species



Map 4 - MSES - Regulated Vegetation



Map 5 - MSES - Offset Areas



Appendices

Appendix 1 - Matters of State Environmental Significance (MSES) methodology

MSES mapping is a regional-scale representation of the definition for MSES under the State Planning Policy (SPP). The compiled MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

The Queensland Government's "Method for mapping - matters of state environmental significance for use in land use planning and development assessment" can be downloaded from:

http://www.ehp.qld.gov.au/land/natural-resource/method-mapping-mses.html .

Appendix 2 - Source Data

The datasets listed below are available on request from:

http://qldspatial.information.qld.gov.au/catalogue/custom/index.page

- Matters of State environmental significance

Note: MSES mapping is not based on new or unique data. The primary mapping product draws data from a number of underlying environment databases and geo-referenced information sources. MSES mapping is a versioned product that is updated generally on a twice-yearly basis to incorporate the changes to underlying data sources. Several components of MSES mapping made for the current version may differ from the current underlying data sources. To ensure accuracy, or proper representation of MSES values, it is strongly recommended that users refer to the underlying data sources and review the current definition of MSES in the State Planning Policy, before applying the MSES mapping.

Individual MSES layers can be attributed to the following source data available at QSpatial:

MSES layers	**current QSpatial data (http://qspatial.ingormation.qld.gov.au)**
Protected Areas-Estates and Nature Refuges	- Protected areas of Queensland - Nature Refuges - Queensland
Marine Park-Highly Protected Zones	Moreton Bay marine park zoning 2008
Fish Habitat Areas	Queensland fish habitat areas
Strategic Environmental Areas-designated	Regional Planning Interests Act - Strategic Environmental Areas
HES wetlands	Map of Referable Wetland - wetland layers: - Wetland management area wetlands - Wetland protection area wetlands
wetlands in HEV waters	HEV waters: - EPP Water (multiple locations) intent for waters Source Wetlands: - Queensland Wetland Mapping (Current version 4, 2015) Source Watercourses: - Vegetation management watercourse and drainage feature map (1:100000 and 1:250000) - latest version 1.4
Wildlife habitat (threatened and special least concern)	-WildNet database species records - habitat suitability models (various)
VMA regulated regional ecosystems	Vegetation management regional ecosystem and remnant map - latest version 8.0
VMA Essential Habitat	Vegetation management - essential habitat map - latest version 4.41
VMA Wetlands	Vegetation management wetlands map - latest version 2.41
Legally secured offsets	Vegetation Management Act property maps of assessable vegetation. For offset register data-contact DES
Regulated Vegetation Map	Vegetation management - regulated vegetation management map - latest version 1.41

Appendix 3 - Acronyms and Abbreviations

AOI	- Area of Interest
DES	- Department of Environment and Science
EP Act	- *Environmental Protection Act 1994*
EPP	- Environmental Protection Policy
GDA94	- Geocentric Datum of Australia 1994
GEM	- General Environmental Matters
GIS	- Geographic Information System
MSES	- Matters of State Environmental Significance
NCA	- *Nature Conservation Act 1992*
RE	- Regional Ecosystem
SPP	- State Planning Policy
VMA	- *Vegetation Management Act 1999*

Queensland Government

Department of Environment and Science

Environmental Reports

Regional Ecosystems

Biodiversity Status

For the selected area of interest
Lot: 160 Plan: SP171910

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the input coordinates.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no matters of interest have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Important Note to User

Information presented in this report is based upon the Queensland Herbarium's Regional Ecosystem framework. The Biodiversity Status has been used to depict the extent of "Endangered", "Of Concern" and "No Concern at Present" regional ecosystems in all cases, rather than the classes used for the purposes of the *Vegetation Management Act 1999* (VMA). Mapping and figures presented in this document reflect the Queensland Herbarium's Remnant and Pre-clearing Regional Ecosystem Datasets, and not the certified mapping used for the purpose of the VMA.

For matters relevant to vegetation management under the VMA, please refer to the Department of Natural Resources, Mines and Energy website

https://www.dnrme.qld.gov.au/

Please direct queries about these reports to: Queensland.Herbarium@dsiti.qld.gov.au

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness, or suitability, for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which the user may incur as a consequence of the information being inaccurate or incomplete in any way and for any reason.



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Summary Information

The following table provides an overview of the AOI with respect to selected topographic and environmental themes. Refer to **Map 1** for locality information.

Table 1: Area of interest details: Lot: 160 Plan: SP171910

Size (ha)	7.14
Local Government(s)	Whitsunday Regional
Bioregion(s)	Central Queensland Coast
Subregion(s)	Proserpine - Sarina Lowlands
Catchment(s)	Proserpine

The table below summarizes the extent of remnant vegetation classed as "Endangered", "Of concern" and "No concern at present" regional ecosystems classified by Biodiversity Status within the area of interest (AOI).

Table 2: Summary table, biodiversity status of regional ecosystems within the AOI

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	0.0	0.0
No concern at present	0.0	0.0
Total remnant vegetation	0.0	0.0

Refer to **Map 2** for further information.

Regional Ecosystems

1. Introduction

Regional ecosystems are vegetation communities in a bioregion that are consistently associated with particular combinations of geology, landform and soil (Sattler and Williams 1999). Descriptions of Queensland's Regional ecosystems are available online from the Regional Ecosystem Description Database (REDD). Descriptions are compiled from a broad range of information sources including vegetation, land system and geology survey and mapping and detailed vegetation site data. The regional ecosystem classification and descriptions are reviewed as new information becomes available. A number of vegetation communities may form a single regional ecosystem and are usually distinguished by differences in dominant species, frequently in the shrub or ground layers and are denoted by a letter following the regional ecosystem code (e.g. a, b, c). Vegetation communities and regional ecosystems are amalgamated into a higher level classification of broad vegetation groups (BVGs).

A published methodology for survey and mapping of regional ecosystems across Queensland (Neldner et al 2017) provides further details on regional ecosystem concepts and terminology.

This report provides information on the type, status, and extent of vegetation communities, regional ecosystems and broad vegetation groups present within a user specified area of interest. Please note, for the purpose of this report, the Biodiversity Status is used. This report has not been developed for application of the *Vegetation Management Act 1999* (VMA). Additionally, information generated in this report has been derived from the Queensland Herbarium's Regional Ecosystem Mapping, and not the regulated mapping certified for the purposes of the VMA. If your interest/matter relates to regional ecosystems and the VMA, users should refer to the Department of Natural Resources, Mines and Energy website.

https://www.dnrme.qld.gov.au/

With respect to the Queensland Biodiversity Status,

"Endangered" regional ecosystems are described as those where:

- remnant vegetation is less than 10 per cent of its pre-clearing extent across the bioregion; or 10-30% of its pre-clearing extent remains and the remnant vegetation is less than 10,000 hectares, or
- less than 10 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss*, or
- 10-30 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 hectares; or
- it is a rare** regional ecosystem subject to a threatening process.***

"Of concern" regional ecosystems are described as those where:

- the degradation criteria listed above for 'Endangered' regional ecosystems are not met and,
- remnant vegetation is 10-30 per cent of its pre-clearing extent across the bioregion; or more than 20 per cent of its pre-clearing extent remains and the remnant extent is less than 10,000 hectares, or
- 10-30 percent of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss.****

and "No concern at present" regional ecosystems are described as those where:

- remnant vegetation is over 30 per cent of its pre-clearing extent across the bioregion, and the remnant area is greater than 10,000 hectares, and
- the degradation criteria listed above for 'Endangered' or 'Of concern' regional ecosystems are not met.

**Severe degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 50 years even with the removal of threatening processes; or soil surface is severely degraded, for example, by loss of A horizon, surface expression of salinity; surface compaction, loss of organic matter or sheet erosion.*

***Rare regional ecosystem: pre-clearing extent (1000 ha); or patch size (100 ha and of limited total extent across its range).*

****Threatening processes are those that are reducing or will reduce the biodiversity and ecological integrity of a regional ecosystem. For example, clearing, weed invasion, fragmentation, inappropriate fire regime or grazing pressure, or infrastructure development.*

*****Moderate degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 20 years even with the removal of threatening processes; or soil surface is moderately degraded.*

2. Remnant Regional Ecosystems

The following table identifies the remnant regional ecosystems and vegetation communities mapped within the AOI and provides their short descriptions, Biodiversity Status, and remnant extent within the selected AOI. Please note, where heterogeneous vegetated patches (mixed patches of remnant vegetation mapped as containing multiple regional ecosystems) occur within the AOI, they have been split and listed as individual regional ecosystems (or vegetation communities where present) for the purposes of the table below. In such instances, associated area figures have been generated based upon the estimated proportion of each regional ecosystem (or vegetation community) predicted to be present within the larger mixed patch.

Table 3: Remnant regional ecosystems, description and status within the AOI

Regional Ecosystem	Short Description	BD Status	Area (Ha)	% of AOI
non-rem	None	None	7.14	100.05

Refer to **Map 2** for further information. **Map 3** also provides a visual estimate of the distribution of regional ecosystems present before clearing.

Table 4 provides further information in regards to the remnant regional ecosystems present within the SOI. Specifically, the extent of remnant vegetation remaining within the bioregion, the 1:1,000,000 broad vegetation group (BVG) classification, whether the regional ecosystem is identified as a wetland, and extent of representation in Queensland's Protected Area Estate. For a description of the vegetation communities within the AOI and classified according to the 1:1,000,000 BVG, refer to **Table 6**.

Table 4: Remnant regional ecosystems within the AOI, additional information

Regional Ecosystem	Remnant Extent	BVG (1 Million)	Wetland	Representation in protected estate
non-rem	None	None	None	None

Representation in Protected Area Estate: High greater than 10% of pre-clearing extent is represented; Medium 4 - 10% is represented; Low less than 4% is represented, No representation.

The distribution of mapped wetland systems within the area of interest is displayed in **Map 6**.

The following table lists known special values associated with a regional ecosystem type.

Table 5: Remnant regional ecosystems within the AOI, special values

Regional Ecosystem	Special Values
non-rem	None

3. Remnant Regional Ecosystems by Broad Vegetation Group

BVGs are a higher-level grouping of vegetation communities. Queensland encompasses a wide variety of landscapes across temperate, wet and dry tropics and semi-arid climatic zones. BVGs provide an overview of vegetation communities across the state or a bioregion and allow comparison with other states. There are three levels of BVGs which reflect the approximate scale at which they are designed to be used: the 1:5,000,000 (national), 1:2,000,000 (state) and 1:1,000,000 (regional) scales.

A comprehensive description of BVGs is available at:

https://publications.qld.gov.au/dataset/redd/resource/

The following table provides a description of the 1:1,000,000 BVGs present and their associated extent within the AOI.

Table 6: Broad vegetation groups (1 million) within the AOI

BVG (1 Million)	Description	Area (Ha)	% of AOI
None	None	7.14	100.05

Refer to **Map 4** for further information. **Map 5** also provides a representation of the distribution of vegetation communities as per the 1:5,000,000 BVG believed to be present prior to European settlement.

4. Technical and BioCondition Benchmark Descriptions

Technical descriptions provide a detailed description of the full range in structure and floristic composition of regional ecosystems (e.g. 11.3.1) and their component vegetation communities (e.g. 11.3.1a, 11.3.1b). See:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

The descriptions are compiled using site survey data from the Queensland Herbarium's CORVEG database. Distribution maps, representative images (if available) and the pre-clearing and remnant extent (hectares) of each vegetation community derived from the regional ecosystem mapping data are included. The technical descriptions should be used in conjunction with the fields from the regional ecosystem description database (REDD) for a full description of the regional ecosystem.

Technical descriptions include data on canopy height, canopy cover and native plant species composition of the predominant layer, which are attributes relevant to assessment of the remnant status of vegetation under the *Vegetation Management Act 1999*. However, as technical descriptions reflect the full range in structure and floristic composition across the climatic, natural disturbance and geographic range of the regional ecosystem, local reference sites should be used for remnant assessment where possible (Neldner et al. 2012 (PDF)* section 3.3.1 of:

https://publications.qld.gov.au/dataset/redd/resource/

The technical descriptions are subject to review and are updated as additional data becomes available.

When conducting a BioCondition assessment, these technical descriptions should be used in conjunction with BioCondition benchmarks for the specific regional ecosystem, or component vegetation community.

http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

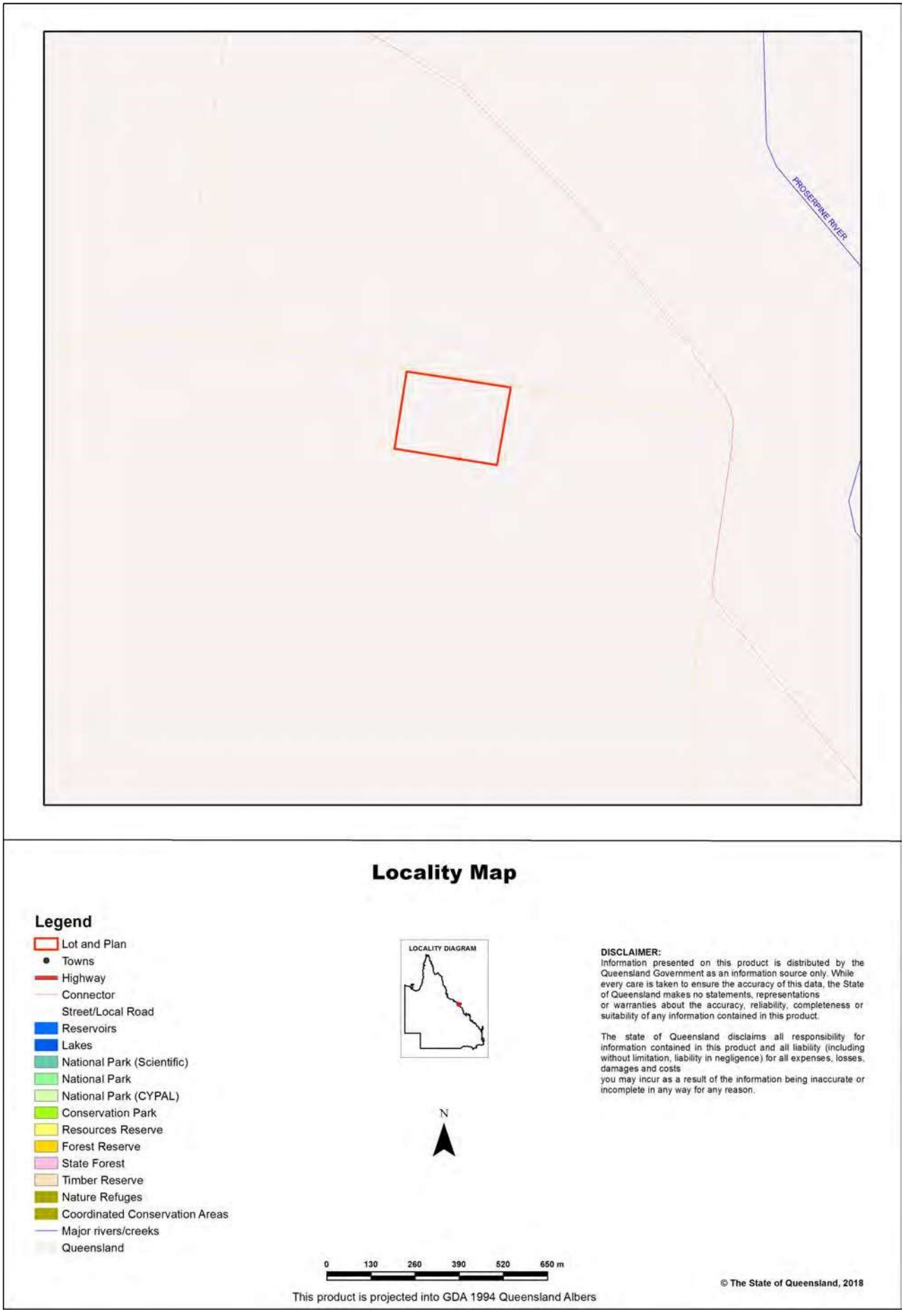
Benchmarks are based on a combination of quantitative and qualitative information and should be used as a guide only. Benchmarks are specific to one regional ecosystem vegetation community, however, the natural variability in structure and floristic composition under a range of climatic and natural disturbance regimes has been considered throughout the geographic extent of the regional ecosystem. Local reference sites should be used for this spatial and temporal (seasonal and annual) variability.

Table 7: List of remnant regional ecosystems within the AOI for which technical and biocondition benchmark descriptions are available

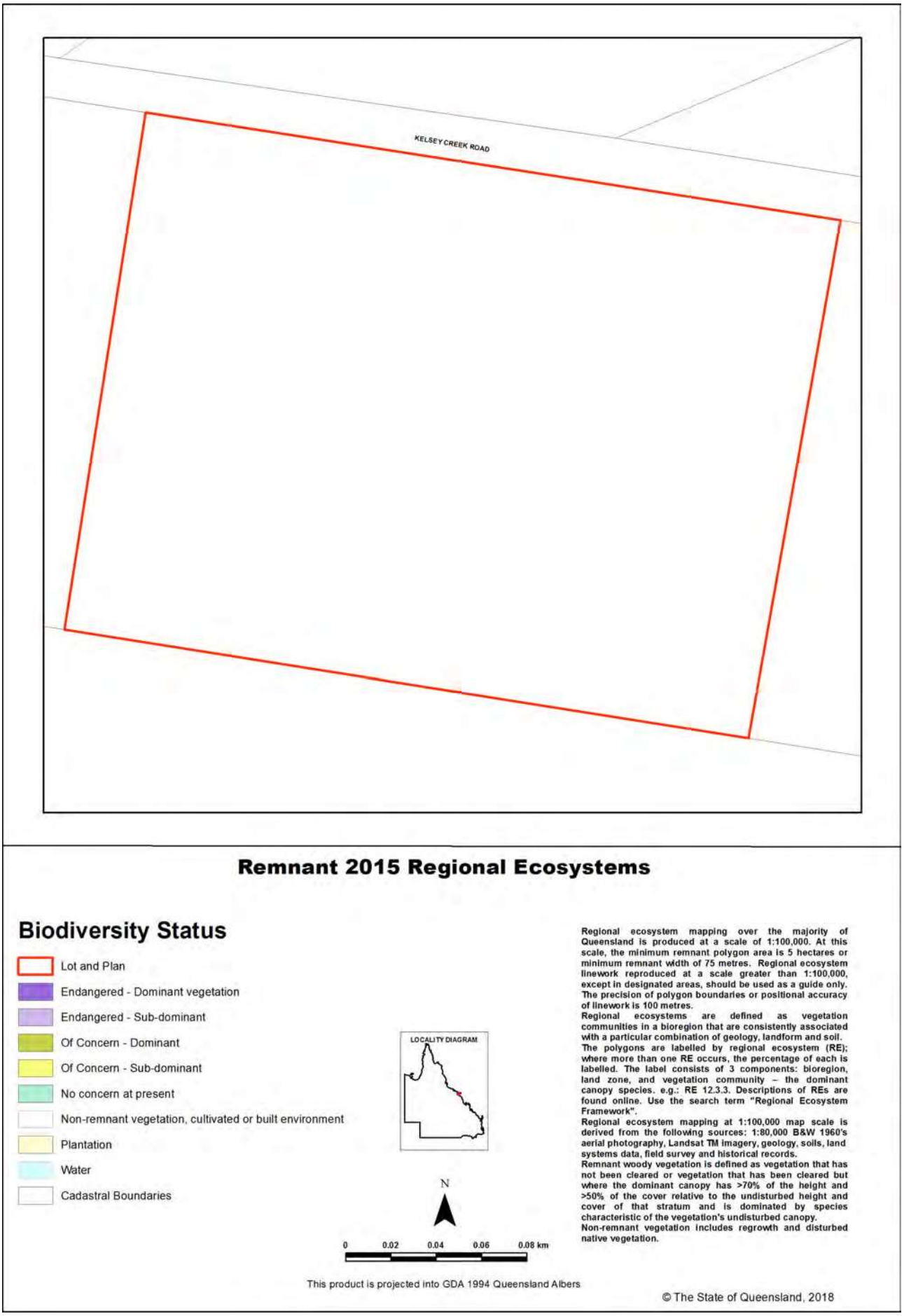
Regional ecosystems mapped as within the AOI	Technical Descriptions	Biocondition Benchmarks
non-rem	Not currently available	Not currently available

Maps

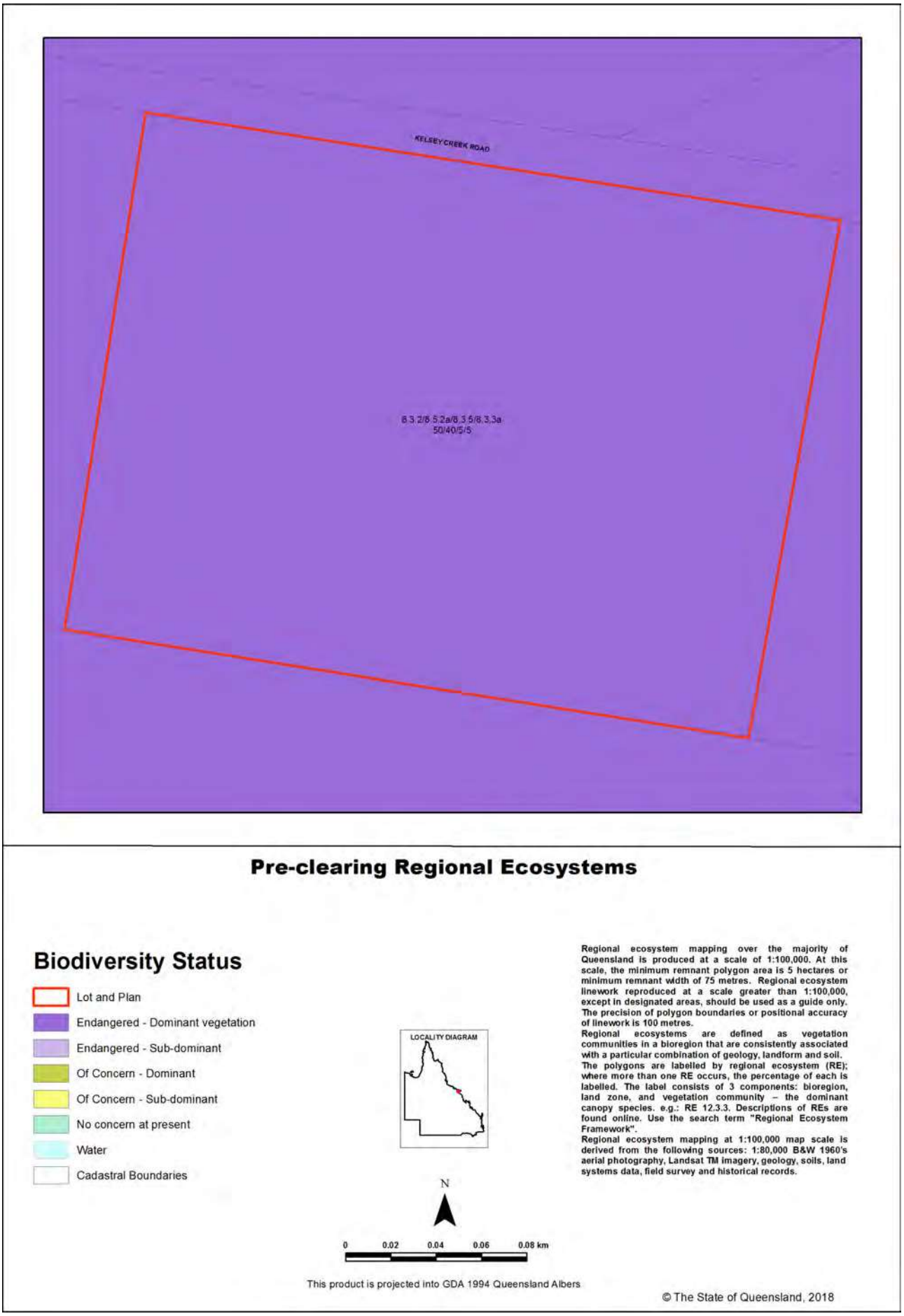
Map 1 - Location



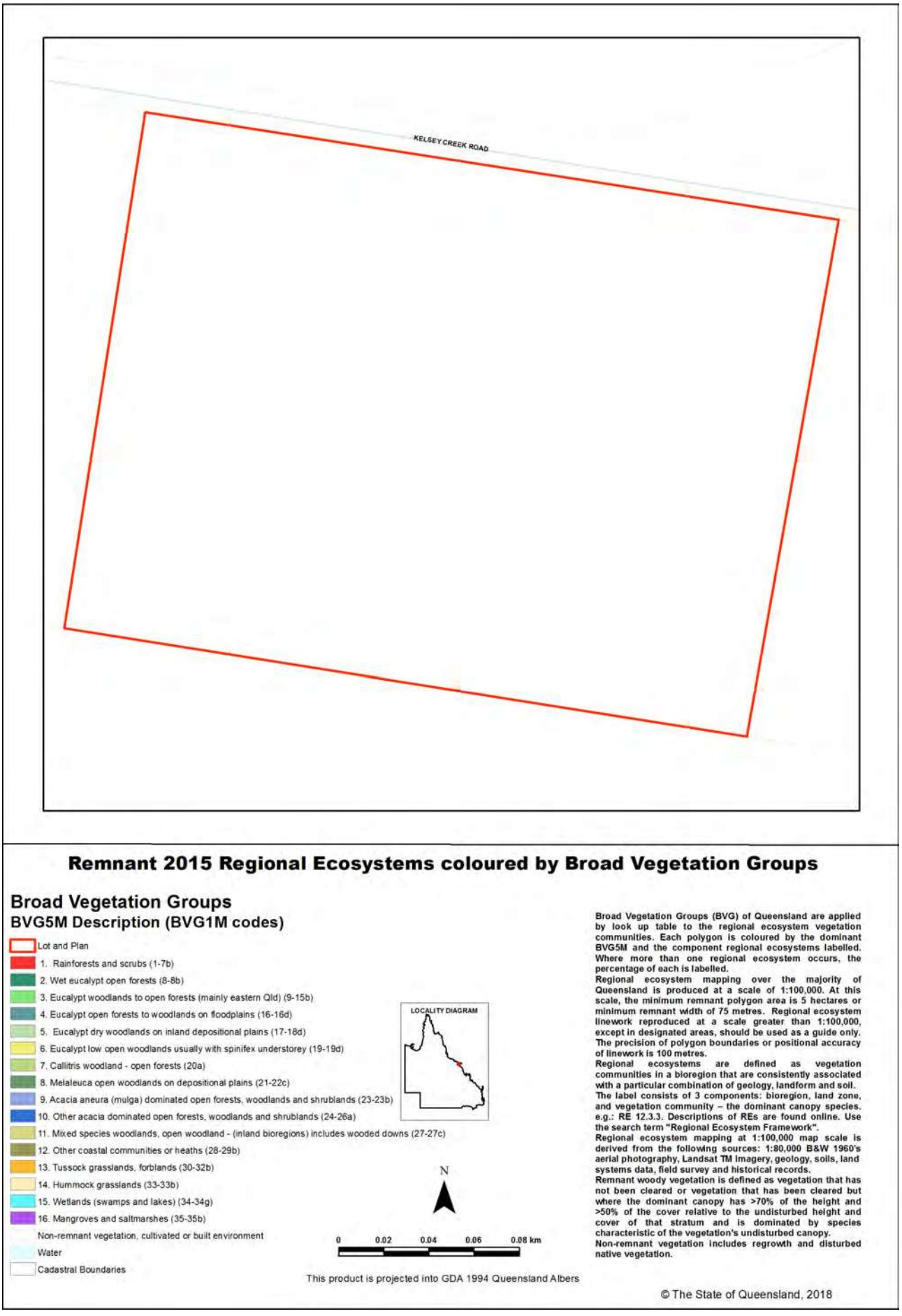
Map 2 - Remnant 2015 regional ecosystems



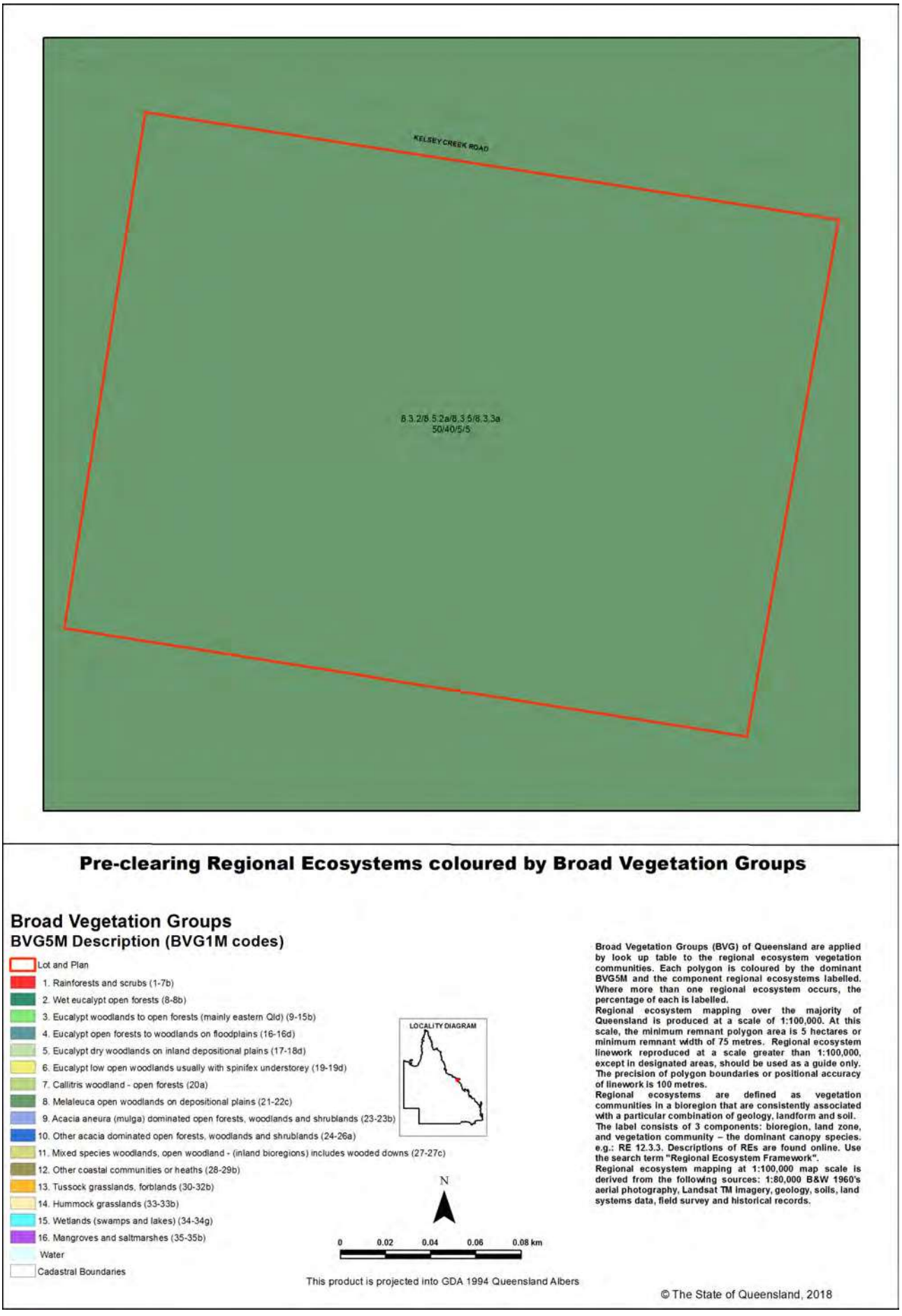
Map 3 - Pre-clearing regional ecosystems



Map 4 - Remnant 2015 regional ecosystems by BVG (5M)



Map 5 - Pre-clearing regional ecosystems by BVG (5M)



Map 6 - Wetlands and waterways



Links and Other Information Sources

The Department of Environment and Science's Website -

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/

provides further information on the regional ecosystem framework, including access to links to the Regional Ecosystem Database, Broad Vegetation Group Definitions, Regional Ecosystem and Land zone descriptions.

Descriptions of the broad vegetation groups of Queensland can be downloaded from:

https://publications.qld.gov.au/dataset/redd/resource/

The methodology for mapping regional ecosystems can be downloaded from:

https://publications.qld.gov.au/dataset/redd/resource/

Technical descriptions for regional ecosystems can be obtained from:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

Benchmarks can be obtained from:

http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

For further information associated with the remnant regional ecosystem dataset used by this report, refer to the metadata associated with the Biodiversity status of pre-clearing and Remnant Regional Ecosystems of Queensland dataset (version listed in **Appendix 1**) which is available through the Queensland Government Information System portal,

http://dds.information.qld.gov.au/dds/

The Queensland Globe is a mapping and data application. As an interactive online tool, Queensland Globe allows you to view and explore Queensland maps, imagery (including up-to-date satellite images) and other spatial data, including regional ecosystem mapping. To further view and explore regional ecosystems over an area of interest, access the Biota Globe (a component of the Queensland Globe). The Queensland Globe can be accessed via the following link:

http://www.dnrm.qld.gov.au/mapping-data/queensland-globe

References

Neldner, V.J., Niehus R.E., Wilson, B.A. McDonald, W.J.F., Ford, A.J. and Accad, A. (2017) The Vegetation of Queensland. Descriptions of Broad Vegetation Groups. Version 3.0. Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts.

(https://publications.qld.gov.au/dataset/redd/resource/78209e74-c7f2-4589-90c1-c33188359086)

Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S. and Butler, D.W. (2017) *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland*. Version 4.0. Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts.

(https://publications.qld.gov.au/dataset/redd/resource/6dee78ab-c12c-4692-9842-b7257c2511e4)

Sattler, P.S. and Williams, R.D. (eds) (1999). *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency, Brisbane.

Appendices

Appendix 1 - Source Data

The dataset listed below is available for download from:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/download/

- Regional Ecosystem Description Database

The datasets listed below are available for download from:

http://dds.information.qld.gov.au/dds/

- Biodiversity status of pre-clearing and 2015 remnant regional ecosystems of Queensland
- Pre-clearing Vegetation Communities and Regional Ecosystems of Queensland
- Queensland Wetland Data Version - Wetland lines
- Queensland Wetland Data Version - Wetland points
- Queensland Wetland Data Version - Wetland areas

Appendix 2 - Acronyms and Abbreviations

AOI	- Area of Interest
GDA94	- Geocentric Datum of Australia 1994
GIS	- Geographic Information System
RE	- Regional Ecosystem
REDD	- Regional Ecosystem Description Database
VMA	- *Vegetation Management Act 1999*

Queensland Government

Department of Environment and Science

Environmental Reports

Biodiversity and Conservation Values

Biodiversity Planning Assessments and Aquatic Conservation Assessments

For the selected area of interest
Lot: 160 Plan: SP171910

Environmental Reports - General Information

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Please direct queries about these reports to: biodiversity.planning@des.qld.gov.au

Disclaimer

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Summary Information

Tables 1 to 8 provide an overview of the AOI with respect to selected topographic and environmental values.

Table 1: Area of interest details: Lot: 160 Plan: SP171910

Size (ha)	7.14
Local Government(s)	Whitsunday Regional
Bioregion(s)	Central Queensland Coast
Subregion(s)	Proserpine - Sarina Lowlands
Catchment(s)	Proserpine

The following table identifies available Biodiversity Planning Assessments (BPAs) and Aquatic Conservation Assessments (ACAs) with respect to the AOI.

Table 2: Available Biodiversity Planning and Aquatic Conservation Assessments

Assessment Type	Assessment Area and Version
Biodiversity Planning Assessment(s)	Central Queensland Coast v1.3
Aquatic Conservation Assessment(s) (riverine)	Great Barrier Reef Catchments v1.3
Aquatic Conservation Assessment(s) (non-riverine)	Great Barrier Reef Catchments v1.3

Table 3: Remnant regional ecosystems within the AOI as per the Qld Herbarium's 'biodiversity status'

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	0.0	0.0
No concern at present	0.0	0.0

The following table identifies the extent and proportion of the user specified area of interest (AOI) which is mapped as being of "State", "Regional" or "Local" significance via application of the Queensland Department of Environment and Science's *Biodiversity Assessment and Mapping Methodology* (BAMM).

Table 4: Summary table, biodiversity significance

Biodiversity significance	Area (Ha)	% of AOI
(No Records)		

Table 5: Non-riverine wetlands intersecting the AOI

Non-riverine wetland types intersecting the area of interest	#
(No Records)	

NB. The figures presented in the table above are derived from the relevant non-riverine Aquatic Conservation Assessment(s). Later releases of wetland mapping produced via the Queensland Wetland Mapping Program may provide more recent information in regards to wetland extent.

Table 6: Named waterways intersecting the AOI

(no results)

Refer to **Map 1** for general locality information.

The following two tables identify the extent and proportion of the user specified AOI which is mapped as being of "Very High", "High", "Medium", "Low", or "Very Low" aquatic conservation value for riverine and non-riverine wetlands via application of the Queensland Department of Environment and Science's *Aquatic Biodiversity Assessment and Mapping Method* (AquaBAMM).

Table 7: Summary table, aquatic conservation significance (riverine)

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0
High	7.14	100.0
Medium	0.0	0.0
Low	0.0	0.0
Very Low	0.0	0.0

Table 8: Summary table, aquatic conservation significance (non-riverine)

Aquatic conservation significance (non-riverine wetlands)	Area (Ha)	% of AOI
(No Records)		

Biodiversity Planning Assessments

Introduction

The Department of Environment and Science (DES) attributes biodiversity significance on a bioregional scale through a Biodiversity Planning Assessment (BPA). A BPA involves the integration of ecological criteria using the *Biodiversity assessment and Mapping Methodology* (BAMM) and is developed in two stages: 1) **diagnostic criteria**, and 2) **expert panel criteria**. The diagnostic criteria are based on existing data which is reliable and uniformly available across a bioregion, while the expert panel criteria allows for the refinement of the mapped information from the diagnostic output by incorporating local knowledge and expert opinion.

The BAMM methodology has application for identifying areas with various levels of significance solely for biodiversity reasons. These include threatened ecosystems or taxa, large tracts of habitat in good condition, ecosystem diversity, landscape context and connection, and buffers to wetlands or other types of habitat important for the maintenance of biodiversity or ecological processes. While natural resource values such as dryland salinity, soil erosion potential or land capability are not dealt with explicitly, they are included to some extent within the biodiversity status of regional ecosystems recognised by the DES.

Biodiversity Planning Assessments (BPAs) assign three levels of overall biodiversity significance.

- **State significance** - areas assessed as being significant for biodiversity at the bioregional or state scales. They also include areas assessed by other studies/processes as being significant at national or international scales. In addition, areas flagged as being of State significance due to the presence of endangered, vulnerable and/or near threatened taxa, are identified as "State Habitat for EVNT taxa".
- **Regional significance** - areas assessed as being significant for biodiversity at the subregional scale. These areas have lower significance for biodiversity than areas assessed as being of State significance.
- **Local significance and/or other values** - areas assessed as not being significant for biodiversity at state or regional scales. Local values are of significance at the local government scale.

For further information on released BPAs and a copy of the underlying methodology, go to:

http://www.qld.gov.au/environment/plants-animals/biodiversity/planning/

The GIS results can be downloaded from the Queensland Spatial Catalogue at:

http://qspatial.information.qld.gov.au/geoportal/

The following table identifies the extent and proportion of the user specified AOI which is mapped as being of "State", "Regional" or "Local" significance via application of the BAMM.

Table 9: Summary table, biodiversity significance

Biodiversity significance	Area (Ha)	% of AOI
(No Records)		

Refer to **Map 2** for further information.

Diagnostic Criteria

Diagnostic criteria are based on existing data which is reliable and uniformly available across a bioregion. These criteria are diagnostic in that they are used to filter the available data and provide a "first-cut" or initial determination of biodiversity significance. This initial assessment is then combined through a second group of other essential criteria.

A description of the individual diagnostic criteria is provided in the following sections.

Criteria A. Habitat for EVNT taxa: Classifies areas according to their significance based on the presence of endangered, vulnerable and/or rare (EVNT) taxa. EVNT taxa are those scheduled under the *Nature Conservation Act 1992* and/or the *Environment Protection and Biodiversity Conservation Act 1999*. It excludes highly mobile fauna taxa which are instead considered in Criterion H and brings together information on EVNT taxa using buffering of recorded sites or habitat suitability models (HSM) where available.

Criteria B. Ecosystem value: Classifies on the basis of biodiversity status of regional ecosystems, their extent in protected areas (presence of poorly conserved regional ecosystems), the presence of significant wetlands; and areas of national importance such as the presence of Threatened Ecological Communities, World Heritage areas and Ramsar sites. Ecosystem value is applied at a bioregional (**B1**) and regional (**B2**) scale.

Criteria C. Tract size: Measures the relative size of tracts of vegetation in the landscape. The size of any tract is a major indicator of ecological significance, and is also strongly correlated with the long-term viability of biodiversity values. Larger tracts are less susceptible to ecological edge effects and are more likely to sustain viable populations of native flora and fauna than smaller tracts.

Criteria D. Relative size of regional ecosystems: Classifies the relative size of each regional ecosystem unit within its bioregion (**D1**) and its subregion (**D2**). Remnant units are compared with all other occurrences with the same regional ecosystem. Large examples of a regional ecosystem are more significant than smaller examples of the same regional ecosystem because they are more representative of the biodiversity values particular to the regional ecosystem, are more resilient to the effects of disturbance, and constitute a significant proportion of the total area of the regional ecosystem.

Criteria F. Ecosystem diversity: Is an indicator of the number of regional ecosystems occurring within an area. An area with high ecosystem diversity will have many regional ecosystems and ecotones relative to other areas within the bioregion.

Criteria G. Context and connection: Represents the extent to which a remnant unit incorporates, borders or buffers areas such as significant wetlands, endangered ecosystems; and the degree to which it is connected to other vegetation.

A summary of the biodiversity status based upon the diagnostic criteria is provided in the following table.

Table 10: Summary of biodiversity significance based upon diagnostic criteria with respect to the AOI

Biodiversity significance	Description	Area (Ha)	% of AOI
(No Records)			

Assessment of diagnostic criteria with respect to the AOI

The following table reflects an assessment of the individual diagnostic criteria noted above in regards to the AOI.

Table 11: Assessment of individual diagnostic criteria with respect to the AOI

Diagnostic Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
(No Records)								

Other Essential Criteria

Other essential criteria (also known as expert panel criteria) are based on non-uniform information sources and which may rely more upon expert opinion than on quantitative data. These criteria are used to provide a "second-cut" determination of biodiversity significance, which is then combined with the diagnostic criteria for an overall assessment of relative biodiversity significance. A summary of the biodiversity status based upon the other essential criteria is provided in the following table.

Table 12: Summary of biodiversity significance based upon other essential criteria with respect to the AOI

Biodiversity significance	Description	Area (Ha)	% of AOI
(No Records)			

A description of each of the other essential criteria and associated assessment in regards to the AOI is provided in the following sections.

Criteria H. Essential and general habitat for priority taxa: Priority taxa are those which are at risk or of management concern, taxa of scientific interest as relictual (ancient or primitive), endemic taxa or locally significant populations (such as a flying fox camp or heronry), highly specialised taxa whose habitat requirements are complex and distributions are not well correlated with any particular regional ecosystem, taxa important for maintaining genetic diversity (such as complex spatial patterns of genetic variation, geographic range limits, highly disjunct populations), taxa critical for management or monitoring of biodiversity (functionally important or ecological indicators), or economic and culturally important taxa.

Criteria I. Special biodiversity values: areas with special biodiversity values are important because they contain multiple taxa in a unique ecological and often highly biodiverse environment. Areas with special biodiversity values can include the following:

- Ia - centres of endemism - areas where concentrations of taxa are endemic to a bioregion or subregion are found.
- Ib - wildlife refugia (Morton *et al*. 1995), for example, islands, mound springs, caves, wetlands, gorges, mountain ranges and topographic isolates, ecological refuges, refuges from exotic animals, and refuges from clearing. The latter may include large areas that are not suitable for clearing because of land suitability/capability.
- Ic - areas with concentrations of disjunct populations.
- Id - areas with concentrations of taxa at the limits of their geographic ranges.
- Ie - areas with high species richness.
- If - areas with concentrations of relictual populations (ancient and primitive taxa).
- Ig - areas containing REs with distinct variation in species composition associated with geomorphology and other environmental variables.
- Ih - an artificial waterbody or managed/manipulated wetland considered by the panel/s to be of ecological significance.
- Ii - areas with a high density of hollow-bearing trees that provide habitat for animals.

- Ij - breeding or roosting sites used by a significant number of individuals.
- Ik - climate change refuge.

The following table identifies the value and extent area of the Other Essential Criteria H and I within the AOI.

Table 13: Relative importance of expert panel criteria (H and I) used to access overall biodiversity significance with respect to the AOI

Expert Panel	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
(No Records)								

NB. Whilst biodiversity values associated with Criteria I may be present within the site (refer to tables 12 and 15), for the New England Tableland and Central Queensland Coast BPAs, area and % area figures associated with Criteria Ia through to Ij cannot be listed in the table above (due to slight variations in data formats between BPAs).

Criteria J. Corridors: areas identified under this criterion qualify either because they are existing vegetated corridors important for contiguity, or cleared areas that could serve this purpose if revegetated. Some examples of corridors include riparian habitats, transport corridors and "stepping stones".

Bioregional and subregional conservation corridors have been identified in the more developed bioregions of Queensland through the BPAs, using an intensive process involving expert panels. Map 3 displays the location of corridors as identified under the Statewide Corridor network. The Statewide Corridor network incorporates BPA derived corridors and for bioregions where no BPA has been assessed yet, corridors derived under other planning processes. *Note: as a result of updating and developing a statewide network, the alignment of corridors may differ slightly in some instances when compared to those used in individual BPAs.*

The functions of these corridors are:

- **Terrestrial** Bioregional corridors, in conjunction with large tracts of remnant vegetation, maintain ecological and evolutionary processes at a landscape scale, by:
  - Maintaining long term evolutionary/genetic processes that allow the natural change in distributions of species and connectivity between populations of species over long periods of time;
  - Maintaining landscape/ecosystems processes associated with geological, altitudinal and climatic gradients, to allow for ecological responses to climate change;
  - Maintaining large scale seasonal/migratory species processes and movement of fauna;
  - Maximising connectivity between large tracts/patches of remnant vegetation;
  - Identifying key areas for rehabilitation and offsets; and

- **Riparian** Bioregional Corridors also maintain and encourage connectivity of riparian and associated ecosystems.

The location of the corridors is determined by the following principles:

- Terrestrial
  - Complement riparian landscape corridors (i.e. minimise overlap and maximise connectivity);
  - Follow major watershed/catchment and/or coastal boundaries;
  - Incorporate major altitudinal/geological/climatic gradients;
  - Include and maximise connectivity between large tracts/patches of remnant vegetation;
  - Include and maximise connectivity between remnant vegetation in good condition; and

- Riparian
  - Located on the major river or creek systems within the bioregion in question.

The total extent of remnant vegetation triggered as being of "State", "Regional" or "Local" significance due to the presence of an overlying BPA derived terrestrial or riparian corridor within the AOI, is provided in the following table. For further information on how remnant vegetation is triggered due to the presence of an overlying BPA derived corridor, refer to the relevant landscape BPA expert panel report(s).

Table 14: Extent of triggered remnant vegetation due to the presence of BPA derived corridors with respect to the AOI

Biodiversity Significance	Area (Ha)	% of AOI
(No Records)		

NB: area figures associated with the extent of corridor triggered remnant vegetation are only available for those bioregions where a BPA has been undertaken.

Refer to **Map 3** for further information.

Threatening process/condition (Criteria K) - areas identified by experts under this criterion may be used to amend (upgrade or downgrade) biodiversity significance arising from the "first-cut" analysis. The condition of remnant vegetation is affected by threatening processes such as weeds, ferals, grazing and burning regime, selective timber harvesting/removal, salinity, soil erosion, and climate change.

Assessment of Criteria K with respect to the AOI is not currently included in the "Biodiversity and Conservation Values" report, as it has not been applied to the majority of Queensland due to data/information limitations and availability.

Special Area Decisions

Expert panel derived "Special Area Decisions" are used to assign values to Other Essential Criteria. The specific decisions which relate to the AOI in question are listed in the table below.

Table 15: Expert panel decisions for assigning levels of biodiversity significance with respect to the AOI

Decision Number	Description	Panel Recommended Significance	Criteria Values
(No Records)			

Expert panel decision descriptions:

(No Records)

Aquatic Conservation Assessments

Introduction

The Aquatic Biodiversity Assessment and Mapping Method or AquaBAMM (Clayton *et al*. 2006), was developed to assess conservation values of wetlands in queensland, and may also have application in broader geographical contexts. It is a comprehensive method that uses available data, including data resulting from expert opinion, to identify relative wetland conservation/ecological values within a specified study area (usually a catchment). The product of applying this method is an Aquatic Conservation Assessment (ACA) for the study area.

An ACA using AquaBAMM is non-social, non-economic and identifies the conservation/ecological values of wetlands at a user-defined scale. It provides a robust and objective conservation assessment using criteria, indicators and measures that are founded upon a large body of national and international literature. The criteria, each of which may have variable numbers of indicators and measures, are naturalness (aquatic), naturalness (catchment), diversity and richness, threatened species and ecosystems, priority species and ecosystems, special features, connectivity and representativeness. An ACA using AquaBAMM is a powerful decision support tool that is easily updated and simply interrogated through a geographic information system (GIS).

Where they have been conducted, ACAs can provide a source of baseline wetland conservation/ecological information to support natural resource management and planning processes. They are useful as an independent product or as an important foundation upon which a variety of additional environmental and socio-economic elements can be added and considered (i.e. an early input to broader 'triple-bottom-line' decision-making processes). An ACA can have application in:

- determining priorities for protection, regulation or rehabilitation of wetlands and other aquatic ecosystems
- on-ground investment in wetlands and other aquatic ecosystems
- contributing to impact assessment of large-scale development (e.g. dams)
- water resource and strategic regional planning prcesses

For a detailed explanation of the methodology please refer to the summary and expert panel reports relevant to the ACA utilised in this assessment. These reports can be accessed at Wetland *Info*:

http://wetlandinfo.des.qld.gov.au/wetlands/assessment/assessment-methods/aca

The GIS results can be downloaded from the Queensland Spatial Catalogue at:

http://qspatial.information.qld.gov.au/geoportal/

Explanation of Criteria

Under the AquaBAMM, eight criteria are assessed to derive an overall conservation value. Similar to the Biodiversity Assessment and Mapping Methodology, the criteria may be primarily diagnostic (quantitative) or primarily expert opinion (qualitative) in nature. The following sections provide a brief description of each of the 8 criteria.

Criteria 1. Naturalness - Aquatic: This attribute reflects the extent to which a wetland's (riverine, non-riverine, estuarine) aquatic state of naturalness is affected through relevant influencing indicators which include: presence of exotic flora and fauna; presence of aquatic communities; degree of habitat modification and degree of hydrological modification.

Criteria 2. Naturalness - Catchment: The naturalness of the terrestrial systems of a catchment can have an influence on many wetland characteristics including: natural ecological processes e.g. nutrient cycling, riparian vegetation, water chemistry, and flow. The indicators utilised to assess this criterion include: presence of exotic flora and/or fauna; riparian, catchment and flow modification.

Criteria 3. Naturalness - Diversity and Richness: This criterion is common to many ecological assessment methods and can include both physical and biological features. It includes such indicators as species richness, riparian ecosystem richness and geomorphological diversity.

Criteria 4. Threatened Species and Ecosystems: This criterion evaluates ecological rarity characteristics of a wetland. This includes both species rarity and rarity of communities / assemblages. The communities and assemblages are best represented by regional ecosystems. Species rarity is determined by NCA and EPBC status with Endangered, Vulnerable or Near-threatened species being included in the evaluation. Ecosystem rarity is determined by regional ecosystem biodiversity status i.e. Endangered, Of Concern, or Not of Concern.

Criteria 5. Priority Species and Ecosystems: Priority flora and fauna species lists are expert panel derived. These are aquatic, semi-aquatic and riparian species which exhibit at least 1 particular trait in order to be eligible for consideration. For

flora species the traits included:

- It forms significant macrophyte beds (in shallow or deep water).
- It is an important food source.
- It is important/critical habitat.
- It is implicated in spawning or reproduction for other fauna and/or flora species.
- It is at its distributional limit or is a disjunct population.
- It provides stream bank or bed stabilisation or has soil binding properties.
- It is a small population and subject to threatening processes.

Fauna species are included if they meet at least one of the following traits:

- It is endemic to the study area (>75 per cent of its distribution is in the study area/catchment).
- It has experienced, or is suspected of experiencing, a serious population decline.
- It has experienced a significant reduction in its distribution and has a naturally restricted distribution in the study area/catchment.
- It is currently a small population and threatened by loss of habitat.
- It is a significant disjunct population.
- It is a migratory species (other than birds).
- A significant proportion of the breeding population (>one per cent for waterbirds, >75 per cent other species) occurs in the waterbody (see Ramsar criterion 6 for waterbirds).
- Limit of species range.

See the individual expert panel reports for the priority species traits specific to an ACA.

Criteria 6. Special Features: Special features are areas identified by flora, fauna and ecology expert panels which exhibit characteristics beyond those identified in other criteria and which the expert panels consider to be of the highest ecological importance. Special feature traits can relate to, but are not solely restricted to geomorphic features, unique ecological processes, presence of unique or distinct habitat, presence of unique or special hydrological regimes e.g. spring-fed streams. Special features are rated on a 1 - 4 scale (4 being the highest).

Criteria 7. Connectivity: This criterion is based on the concept that appropriately connected aquatic ecosystems are healthy and resilient, with maximum potential biodiversity and delivery of ecosystem services.

Criteria 8. Representativeness: This criterion applies primarily to non-riverine assessments, evaluates the rarity and uniqueness of a wetland type in relation to specific geographic areas. Rarity is determined by the degree of wetland protection within "protected Areas" estate or within an area subject to the *Fisheries Act 1994*, *Coastal Protection and Management Act 1995*, or *Marine Parks Act 2004*. Wetland uniqueness evaluates the relative abundance and size of a wetland or wetland management group within geographic areas such as catchment and subcatchment.

Riverine Wetlands

Riverine wetlands are all wetlands and deepwater habitats within a channel. The channels are naturally or artificially created, periodically or continuously contain moving water, or connecting two bodies of standing water. AquaBAMM, when applied to riverine wetlands uses a discrete spatial unit termed subsections. A subsection can be considered as an area which encompasses discrete homogeneous stream sections in terms of their natural attributes (i.e. physical, chemical, biological and utilitarian values) and natural resources. Thus in an ACA, an aquatic conservation significance score is calculated for each subsection and applies to all streams within a subsection, rather than individual streams as such.

Please note, the area figures provided in Tables 16 and 17, are derived using the extent of riverine subsections within the AOI. Refer to **Map 5** for further information. A summary of the conservation significance of riverine wetlands within the AOI is provided in the following table.

Table 16: Overall level/s of riverine aquatic conservation significance

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
High	7.14	100.0
Medium	0.0	0.0
Low	0.0	0.0
Very Low	0.0	0.0

The individual aquatic conservation criteria ratings for riverine wetlands within the AOI are listed below.

Table 17: Level/s of riverine aquatic conservation significance based on selected criteria

Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
1. Naturalness aquatic							7.14	100.0
2. Naturalness catchment			7.14	100.0				
3. Diversity and richness					7.14	100.0		
4. Threatened species and ecosystems	7.14	100.0						
5. Priority species and ecosystems			7.14	100.0				
6. Special features								
7. Connectivity	7.14	100.0						

The table below lists and describes the relevant expert panel decisions used to assign conservation significance values to riverine wetlands within the AOI.

Table 18: Expert panel decisions for assigning overall levels of riverine aquatic conservation significance

Decision number	Special feature	Catchment	Criteria/Indicator/Measure	Conservation rating (1-4)
(No Records)				

4 is the highest rating/value

Expert panel decision descriptions:

(No Records)

Non-riverine Wetlands

Non-riverine wetlands include both lacustrine and palustrine wetlands, however, do not currently incorporate estuarine, marine or subterranean wetland types. A summary of the conservation significance of non-riverine wetlands within the AOI is provided in the following table. Refer to **Map 6** for further information.

Table 19: Overall level/s of non-riverine aquatic conservation significance

Aquatic conservation significance (non-riverine wetlands)	Area (Ha)	% of AOI
(No Records)		

The following table provides an assessment of non-riverine wetlands within the AOI and associated aquatic conservation criteria values.

Table 20: Level/s of non-riverine aquatic conservation significance based on selected criteria

Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
(No Records)								

The table below lists and describes the relevant expert panel decisions used to assign conservation significance values to non-riverine wetlands within the AOI.

Table 21: Expert panel decisions for assigning overall levels of non-riverine aquatic conservation significance.

Decision number	Special feature	Catchment	Criteria/Indicator/Measure	Conservation rating (1-4)
(No Records)				

4 is the highest rating/value

Expert panel decision descriptions:

(No Records)

Threatened and Priority Species

Introduction

This chapter contains a list of threatened and priority flora and/or fauna species that have been recorded on, or within 4km of the Assessment Area.

The information presented in this chapter with respect to species presence is derived from compiled databases developed primarily for the purpose of BPAs and ACAs. Data is collated from a number of sources and is updated periodically.

It is important to note that the list of species provided in this report, may differ when compared to other reports generated from other sources such as the State government's WildNet, Herbrecs or the federal government's EPBC database for a number of reasons.

Records for threatened and priority species are filtered and checked based on a number of rules including:

- Taxonomic nomenclature - current scientific names and status,
- Location - cross-check co-ordinates with location description,
- Taxon by location - requires good knowledge of the taxon and history of the record,
- Duplicate records - identify and remove,
- Expert panels - check records and provide new records,
- Flora cultivated records excluded,
- Use precise records less than or equal to 2000m,
- Use recent records greater than or equal to 1975 animals, greater than or equal to 1950 plants.

Threatened Species

Threatened species are those species classified as "Endangered" or "Vulnerable" under the *Environment Protection and Biodiversity Conservation Act 1999* or "Endangered", "Vulnerable" or "Near threatened" under the *Nature Conservation Act 1992*.

The following threatened species have been recorded on, or within approximately 4km of the AOI.

Table 22: Threatened species recorded on, or within 4km of the AOI

Species	Common name	NCA status	EPBC status	Back on Track rank	Migratory species*	Wetland species**	Identified flora/fauna
Crocodylus porosus	Estuarine Crocodile	V		Low	Y	Y	FA
Dasyurus hallucatus	Northern Quoll		E	Medium			FA
Petrogale persephone	Proserpine Rock-wallaby	E	E	Critical			FA

NB. Please note that the threatened species listed in this section are based upon the most recently compiled DES internal state-wide threatened species dataset. This dataset may contain additional records that were not originally available for inclusion in the relevant individual BPAs and ACAs.

**JAMBA - Japan-Australia Migratory Bird Agreement; CAMBA - China-Australia Migratory Bird Agreement; ROKAMBA - Republic of Korea-Australia Migratory Bird Agreement; CMS - Convention on the Conservation of Migratory Species.*

***Y - wetland indicator species.*

BPA Priority Species

A list of BPA priority species that have been recorded on, or within approximately 4km of the AOI is contained in the following table.

Table 23: Priority species recorded on, or within 4km of the AOI

(no results)

NB. Please note that the list of priority species is based on those species identified in the BPAs, however records for these species may be more recent than the originals used. furthermore, the BPA priority species databases are updated from time to time. At each update, the taxonomic details for all species are amended as necessary to reflect current taxonomic name and/or status changes.

ACA Priority Species

A list of ACA priority species used in riverine and non-riverine ACAs that have been recorded on, or within approximately 4km of the AOI are contained in the following tables.

Table 24: Priority species recorded on, or within 4 km of the AOI - riverine

Species	Common name	Back on Track rank	Identified flora/fauna
Ardea modesta	Eastern Great Egret	Low	FA

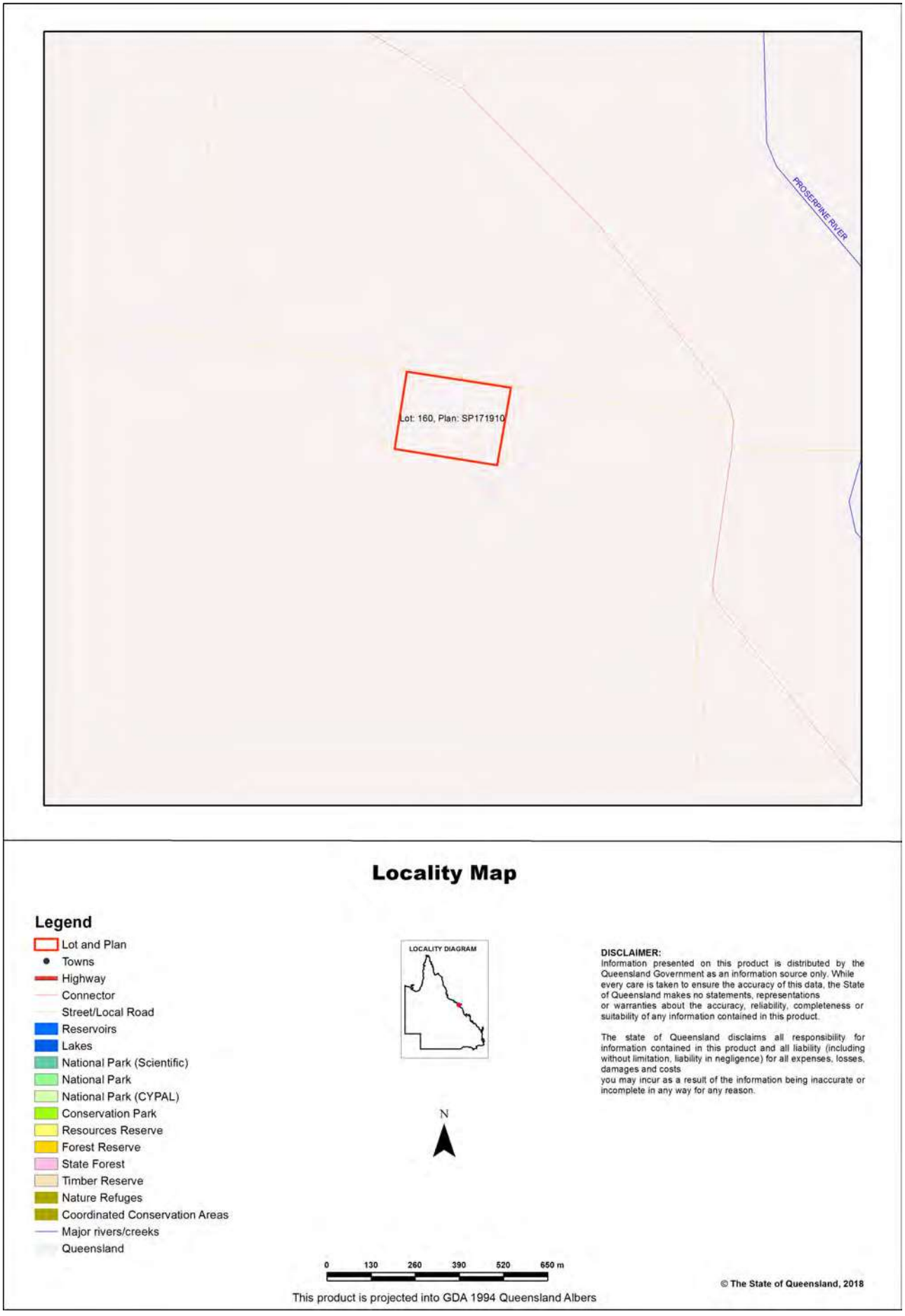
Table 25: Priority species recorded on, or within 4 km of the AOI - non-riverine

Species	Common name	Back on Track rank	Identified flora/fauna
Ardea ibis	Cattle Egret	Low	FA
Ardea modesta	Eastern Great Egret	Low	FA

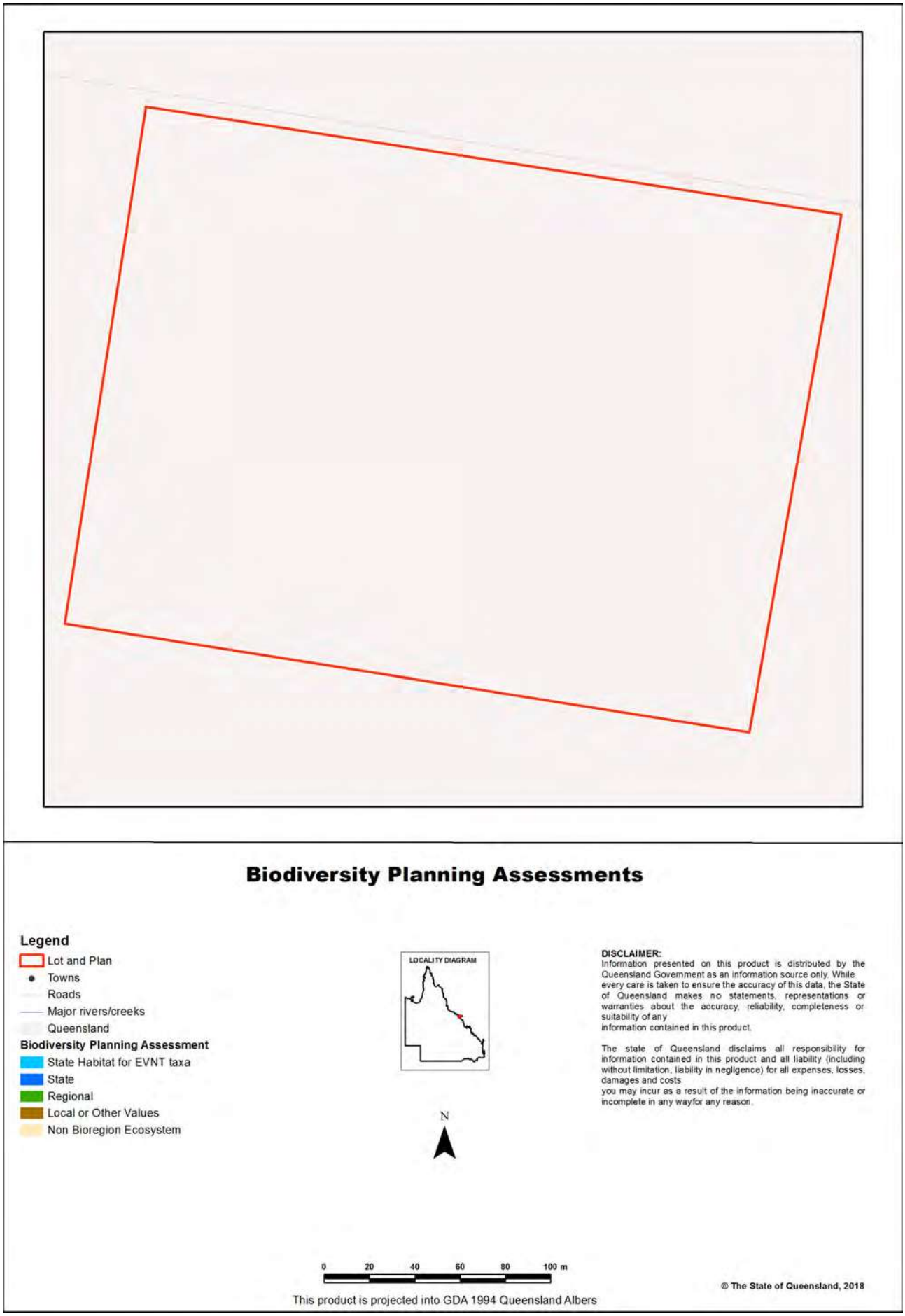
NB. Please note that the priority species records used in the above two tables are comprised of those adopted for the released individual ACAs. The ACA riverine and non-riverine priority species databases are updated from time to time to reflect new release of ACAs. At each update, the taxonomic details for all ACAs records are amended as necessary to reflect current taxonomic name and/or status changes.

Maps

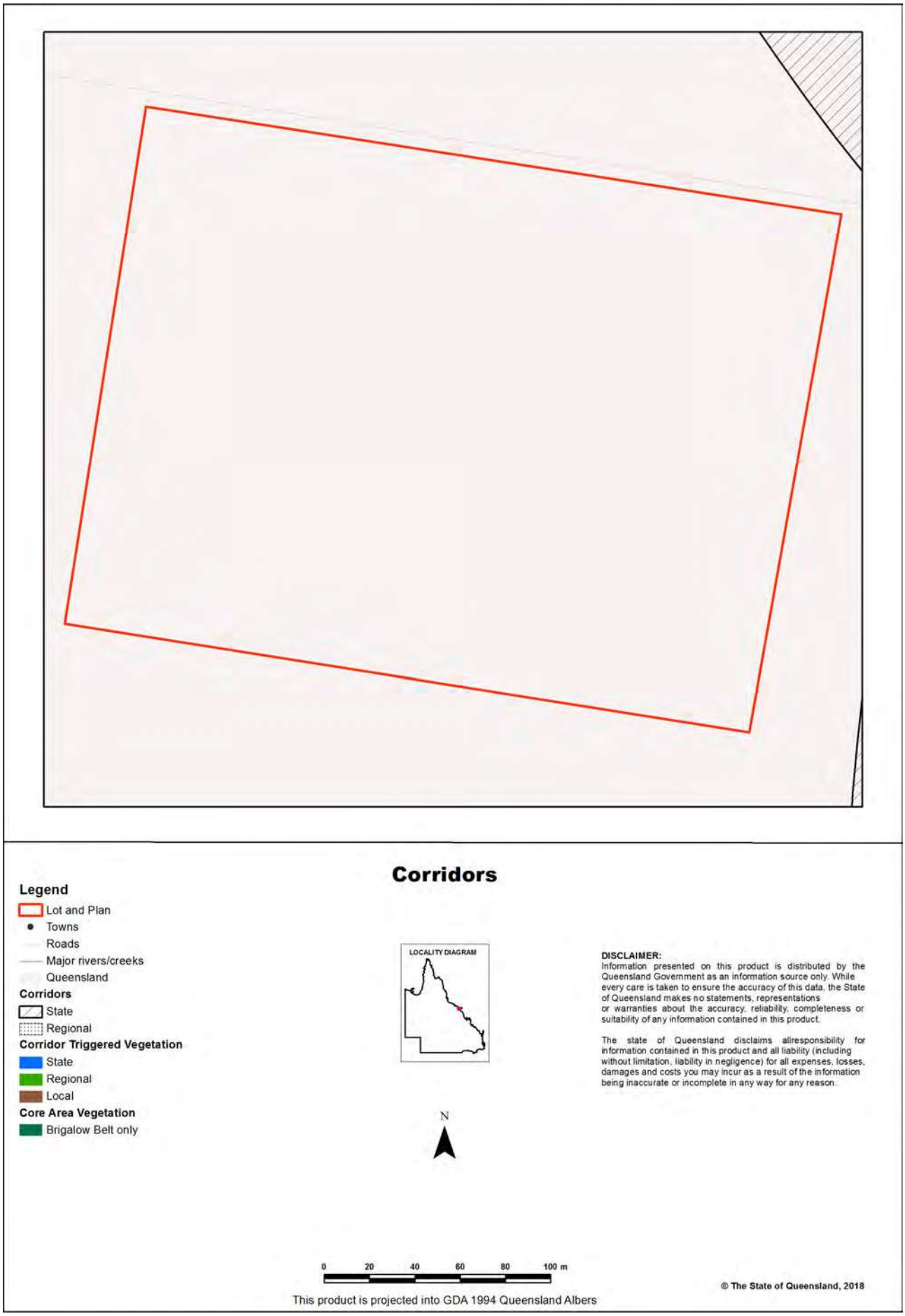
Map 1 - Locality Map



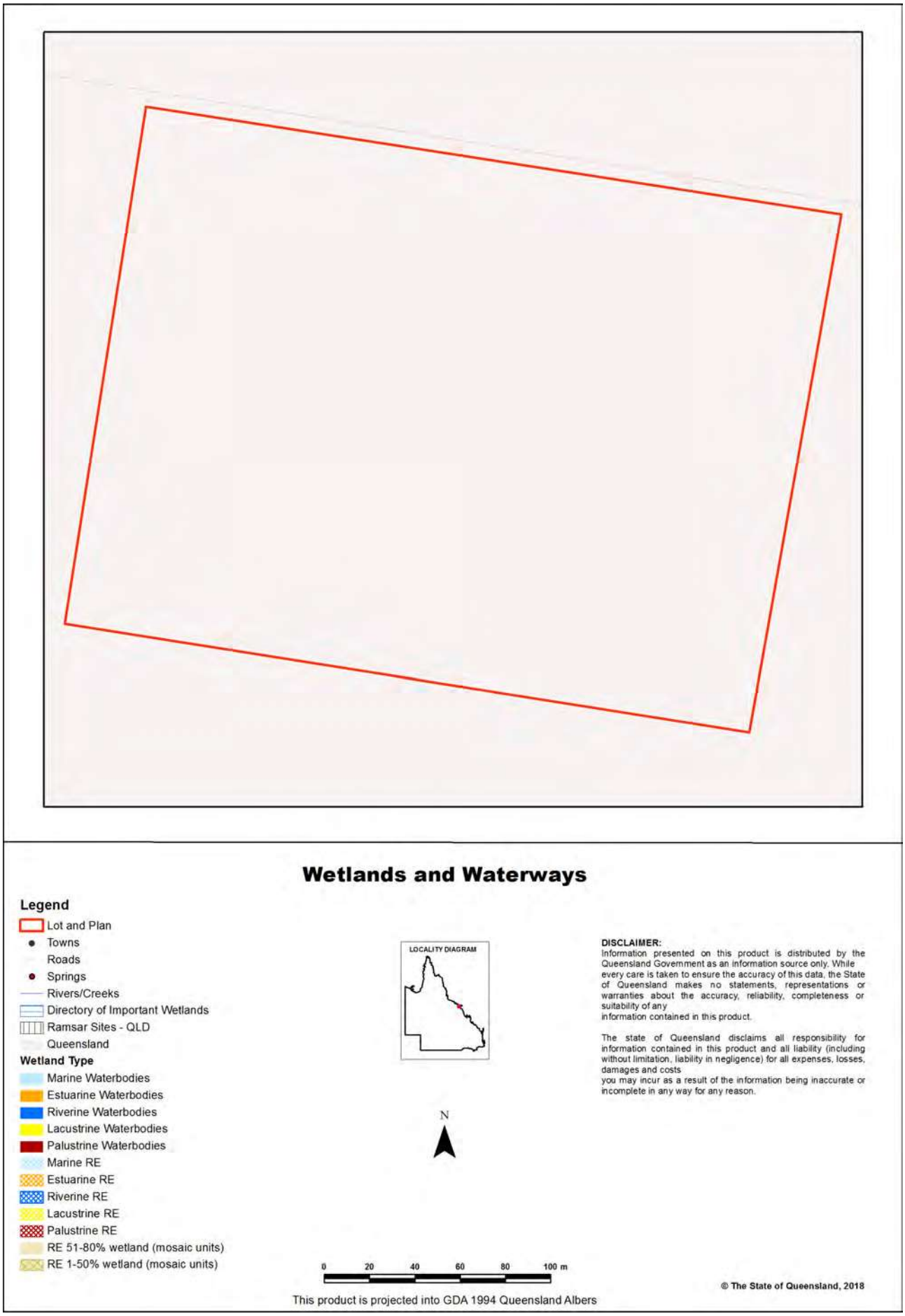
Map 2 - Biodiversity Planning Assessment (BPA)



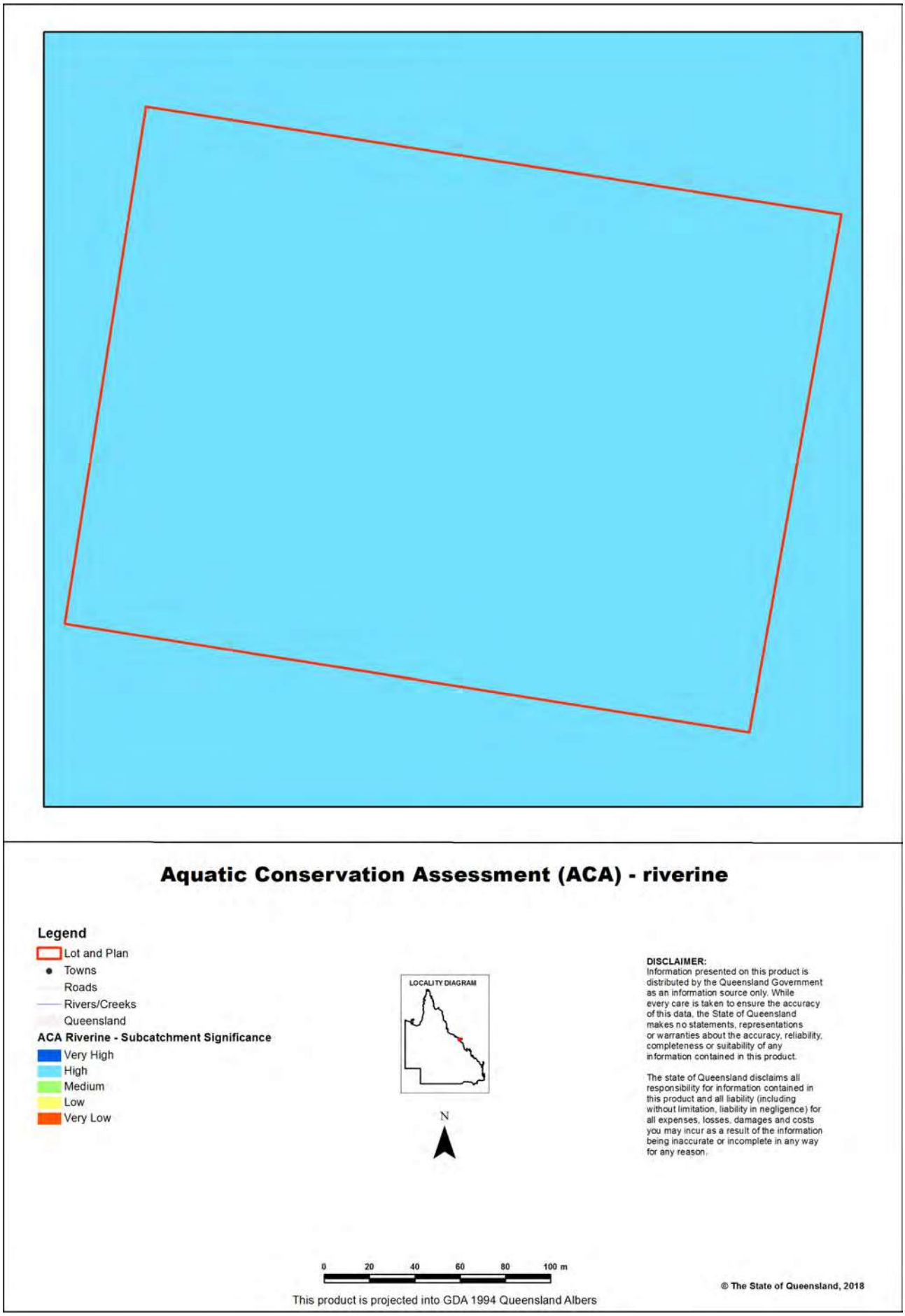
Map 3 - Corridors



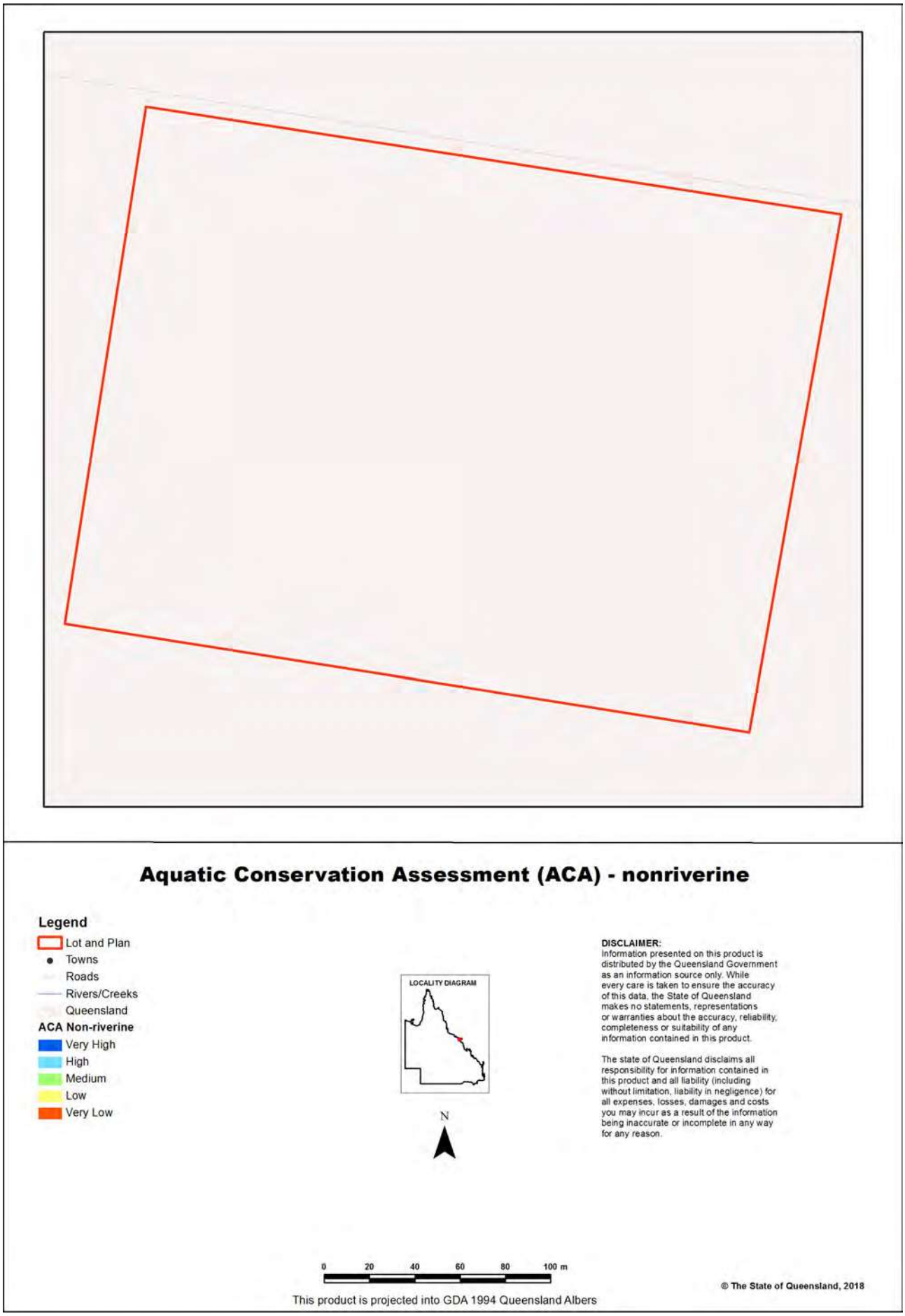
Map 4 - Wetlands and waterways



Map 5 - Aquatic Conservation Assessment (ACA) - riverine



Map 6 - Aquatic Conservation Assessment (ACA) - non-riverine



References

Clayton, P.D., Fielder, D.F., Howell, S. and Hill, C.J. (2006) *Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool for wetlands with trial application in the Burnett River catchment.* Published by the Environmental Protection Agency, Brisbane. ISBN 1-90928-07-3. Available at

http://wetlandinfo.des.qld.gov.au/wetlands/assessment/assessment-methods/aca/

Environmental Protection Agency (2002) *Biodiversity Assessment and Mapping Methodology. Version 2.1, July 2002.* (Environmental Protection Agency, Brisbane).

Morton, S. R., Short, J. and Barker, R. D. with an Appendix by G.F. Griffin and G. Pearce (1995). *Refugia for Biological Diversity in Arid and Semi-arid Australia. Biodiversity Series* , Paper No. 4, Biodiversity Unit, Environment Australia.

Sattler, P.S. and Williams, R.D. (eds) (1999). *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency, Brisbane.

Appendices

Appendix 1 - Source Data

Theme	Datasets
Aquatic Conservation Assessments Non-riverine*	Combination of the following datasets: Cape York Peninsula Non-riverine v1.1 Great Barrier Reef Catchment Non-riverine v1.3 Lake Eyre and Bulloo Basins v1.1 QMDB Non-riverine ACA v1.4 Southeast Queensland ACA v1.1 WBB Non-riverine ACA v1.1
Aquatic Conservation Assessments Riverine*	Combination of the following datasets: Cape York Peninsula Riverine v1.1 Great Barrier Reef Catchment Riverine v1.1 Lake Eyre and Bulloo Basins v1.1 QMDB Riverine ACA v1.4 Southeast Queensland ACA v1.1 WBB Riverine ACA v1.1
Biodiversity Planning Assessments*	Combination of the following datasets: Brigalow Belt BPA v2.1 Cape York Peninsula BPA v1.1 Central Queensland Coast BPA v1.3 Channel Country BPA v1.1 Desert Uplands BPA v1.3 Einasleigh Uplands BPA v1.1 Gulf Plains BPA v1.1 Mitchell Grass Downs BPA v1.1 Mulga Lands BPA v1.4 New England Tableland v2.3 Southeast Queensland v4.1
Statewide BPA Corridors*	Statewide corridors v1.4
Threatened Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.
BPA Priority Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.
ACA Priority Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.

***These datasets are available at:**

http://dds.information.qld.gov.au/DDS

Appendix 2 - Acronyms and Abbreviations

AOI	- Area of Interest
ACA	- Aquatic Conservation Assessment
AQUABAMM	- Aquatic Biodiversity Assessment and Mapping Methodology
BAMM	- Biodiversity Assessment and Mapping Methodology
BoT	- Back on Track
BPA	- Biodiversity Planning Assessment
CAMBA	- China-Australia Migratory Bird Agreement
DES	- Department of Environment and Science
EPBC	- *Environment Protection and Biodiversity Conservation Act 1999*
EVNT	- Endangered, Vulnerable, Near Threatened
GDA94	- Geocentric Datum of Australia 1994
GIS	- Geographic Information System
JAMBA	- Japan-Australia Migratory Bird Agreement
NCA	- *Nature Conservation Act 1992*
RE	- Regional Ecosystem
REDD	- Regional Ecosystem Description Database
ROKAMBA	- Republic of Korea-Australia Migratory Bird Agreement

Queensland Government

Department of Environment and Science

Environmental Reports

Matters of State Environmental Significance

For the selected area of interest
Lot: 299 Plan: SP113325

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Please direct queries about these reports to: Planning.Support@des.qld.gov.au

Disclaimer

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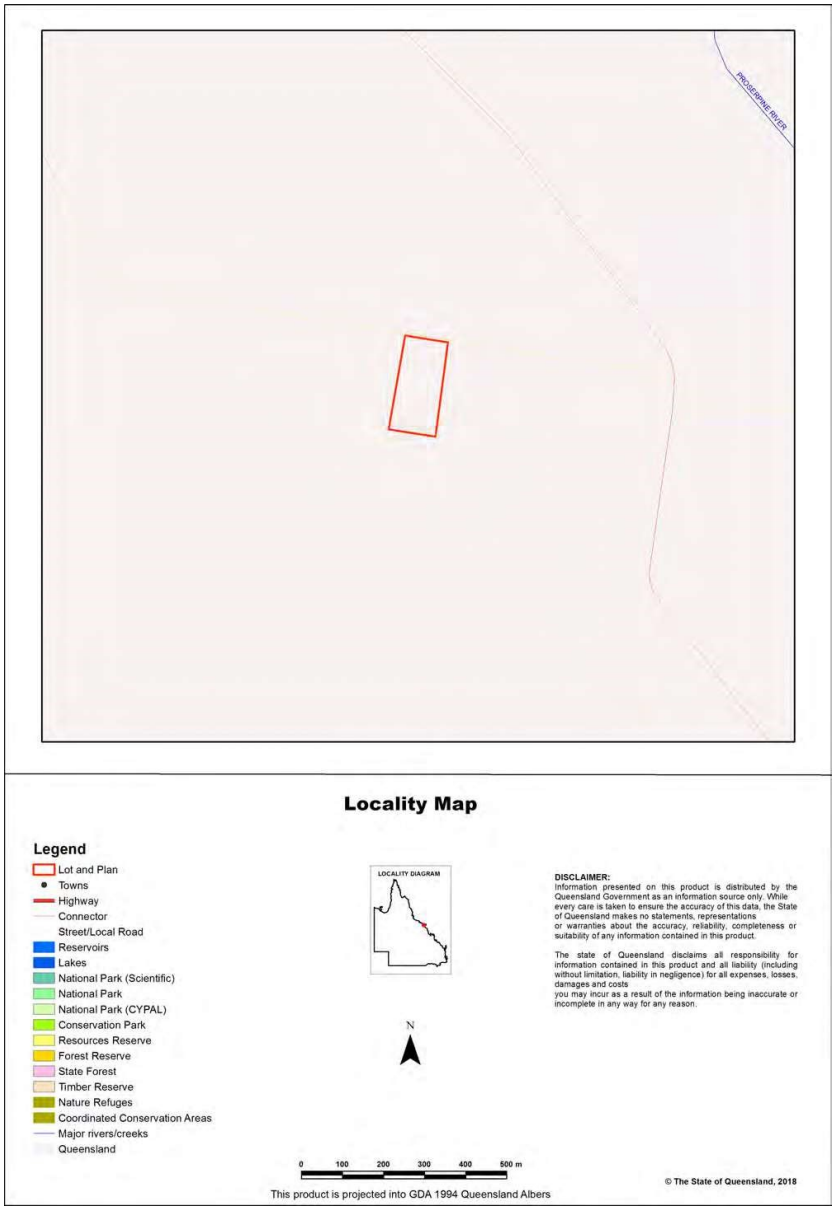
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Assessment Area Details

The following table provides an overview of the area of interest (AOI) with respect to selected topographic and environmental values.

Table 1: Summary table, details for AOI Lot: 299 Plan: SP113325

Size (ha)	2.56
Local Government(s)	Whitsunday Regional
Bioregion(s)	Central Queensland Coast
Subregion(s)	Proserpine - Sarina Lowlands
Catchment(s)	Proserpine



Matters of State Environmental Significance (MSES)

MSES Categories

Queensland's State Planning Policy (SPP) includes a biodiversity State interest that states:

'The sustainable, long-term conservation of biodiversity is supported. Significant impacts on matters of national or state environmental significance are avoided, or where this cannot be reasonably achieved; impacts are minimised and residual impacts offset.'

The MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

The SPP defines matters of state environmental significance as:

- Protected areas (including all classes of protected area except coordinated conservation areas) under the *Nature Conservation Act 1992* ;

- Marine parks and land within a 'marine national park', 'conservation park', 'scientific research', 'preservation' or 'buffer' zone under the *Marine Parks Act 2004* ;

- Areas within declared fish habitat areas that are management A areas or management B areas under the Fisheries Regulation 2008;

- Threatened wildlife under the *Nature Conservation Act 1992* and special least concern animals under the Nature Conservation (Wildlife) Regulation 2006;

- Regulated vegetation under the *Vegetation Management Act 1999* that is:

    • Category B areas on the regulated vegetation management map, that are 'endangered' or 'of concern' regional ecosystems;

    • Category C areas on the regulated vegetation management map that are 'endangered' or 'of concern' regional ecosystems;

    • Category R areas on the regulated vegetation management map;

    • Regional ecosystems that intersect with watercourses identified on the vegetation management watercourse and drainage feature map;

    • Regional ecosystems that intersect with wetlands identified on the vegetation management wetlands map;

- Strategic Environmental Areas under the *Regional Planning Interests Act 2014* ;

- Wetlands in a wetland protection area of wetlands of high ecological significance shown on the Map of Referable Wetlands under the Environmental Protection Regulation 2008;

- Wetlands and watercourses in high ecological value waters defined in the Environmental Protection (Water) Policy 2009, schedule 2;

- Legally secured offset areas.

MSES Values Present

The MSES values that are present in the area of interest are summarised in the table below:

Table 2: Summary of MSES present within the AOI

1a Protected Areas- estates	0.0 ha	0.0 %
1b Protected Areas- nature refuges	0.0 ha	0.0 %
2 State Marine Parks- highly protected zones	0.0 ha	0.0 %
3 Fish habitat areas (A and B areas)	0.0 ha	0.0 %
4 Strategic Environmental Areas (SEA)	0.0 ha	0.0 %
5 High Ecological Significance wetlands on the map of Referable Wetlands	0.0 ha	0.0 %
6a High Ecological Value (HEV) wetlands	0.0 ha	0.0 %
6b High Ecological Value (HEV) waterways **	0.0 km	Not applicable
7 Threatened species and Iconic species	0.0 ha	0.0 %
8a Regulated Vegetation - Endangered/Of concern in Category B (remnant)	0.0 ha	0.0 %
8b Regulated Vegetation - Endangered/Of concern in Category C (regrowth)	0.0 ha	0.0 %
8c Regulated Vegetation - Category R (GBR riverine regrowth)	0.0 ha	0.0 %
8d Regulated Vegetation - Essential habitat	0.0 ha	0.0 %
8e Regulated Vegetation - intersecting a watercourse **	0.0 km	Not applicable
8f Regulated Vegetation - within 100m of a Vegetation Management Wetland	0.0 ha	0.0 %
9a Legally secured offset areas- offset register areas	0.0 ha	0.0 %
9b Legally secured offset areas- vegetation offsets through a Property Map of Assessable Vegetation	0.0 ha	0.0 %

Additional Information with Respect to MSES Values Present

MSES - State Conservation Areas

1a. Protected Areas - estates

(no results)

1b. Protected Areas - nature refuges

(no results)

2. State Marine Parks - highly protected zones

(no results)

3. Fish habitat areas (A and B areas)

(no results)

Refer to **Map 1 - MSES - State Conservation Areas** for an overview of the relevant MSES.

MSES - Wetlands and Waterways

4. Strategic Environmental Areas (SEA)

(no results)

5. High Ecological Significance wetlands on the Map of Referable Wetlands

(no results)

6a. High Ecological Value (HEV) waters - wetlands

(no results)

6b. High Ecological Value (HEV) waters - waterways

(no results)

Refer to **Map 2 - MSES - Wetlands and Waterways** for an overview of the relevant MSES.

MSES - Species

7. Threatened wildlife and special least concern animal

(no results)

Threatened and special least concern species records

(no results)

Note: The Threatened and Special Least Concern Animal (7) layer originates from the previous MSES version (4.1, dated at 2014). The layer does not represent all currently listed species and is subject to review.

**Nature Conservation Act 1992 (NCA) Status- Endangered (E), Vulnerable (V) or Special Least Concern Animal (SL). Environment Protection and Biodiversity Conservation Act 1999 (EPBC) status: Critically Endangered (CE) Endangered (E), Vulnerable (V)*

To request a species list for an area, or search for a species profile, access Wildlife Online at:
https://www.qld.gov.au/environment/plants-animals/species-list/

Refer to **Map 3 - MSES - Species** for an overview of the relevant MSES.

MSES - Regulated Vegetation

8a. Regulated Vegetation - Endangered/Of concern in Category B (remnant)

Not applicable

8b. Regulated Vegetation - Endangered/Of concern in Category C (regrowth)

Not applicable

For further information relating to regional ecosystems in general, go to:
https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/
For a more detailed description of a particular regional ecosystem, access the regional ecosystem search page at:
https://environment.ehp.qld.gov.au/regional-ecosystems/

8c. Regulated Vegetation - Category R (GBR riverine regrowth)

Not applicable

8d. Regulated Vegetation - Essential habitat

Not applicable

8e. Regulated Vegetation - intersecting a watercourse**

(no results)

8f. Regulated Vegetation - within 100m of a Vegetation Management wetland

Not applicable

Refer to **Map 4 - MSES - Regulated Vegetation** for an overview of the relevant MSES.

MSES - Offsets

9a. Legally secured offset areas - offset register areas

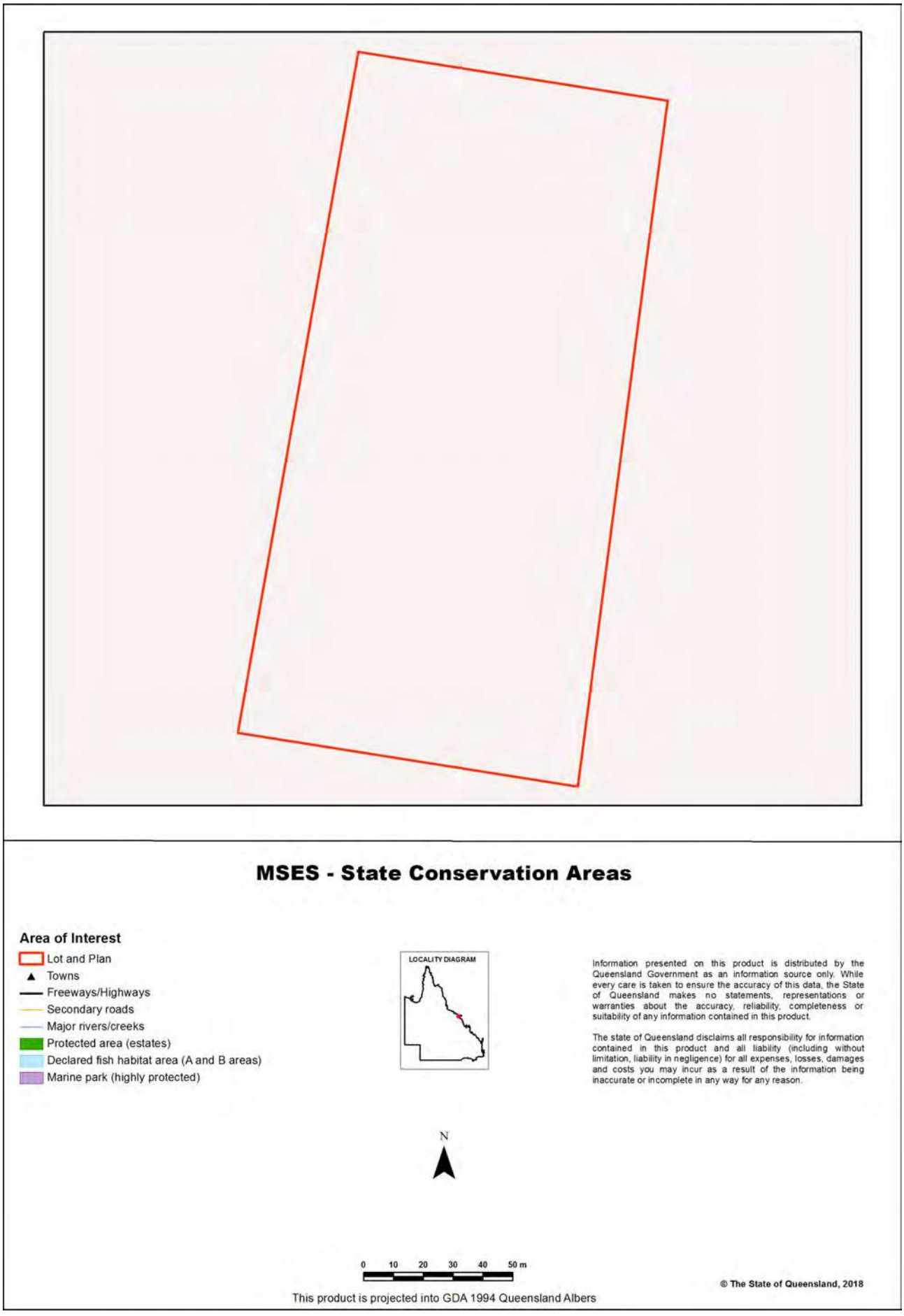
(no results)

9b. Legally secured offset areas - vegetation offsets through a Property Map of Assessable Vegetation

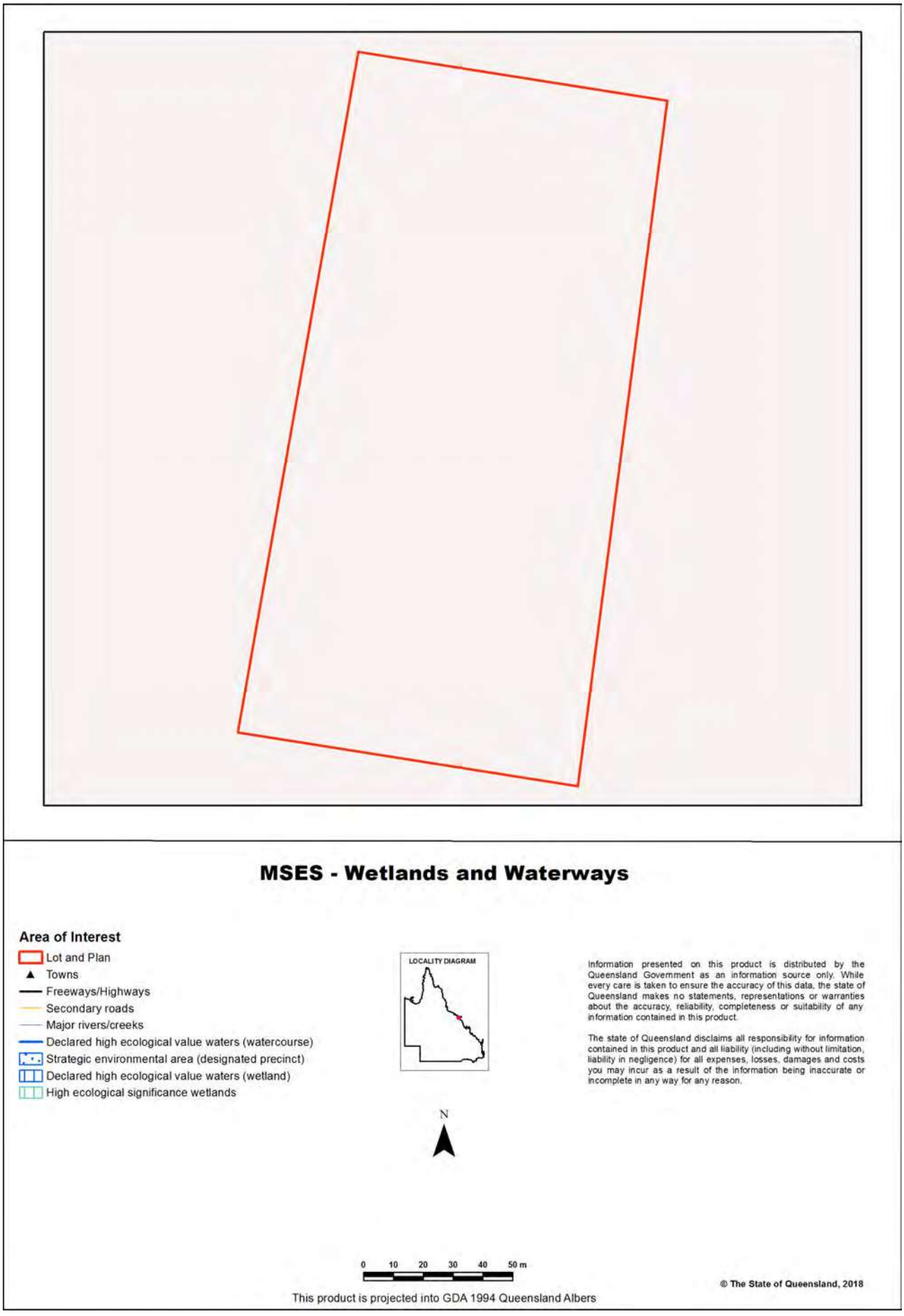
(no results)

Refer to **Map 5 - MSES - Offset Areas** for an overview of the relevant MSES.

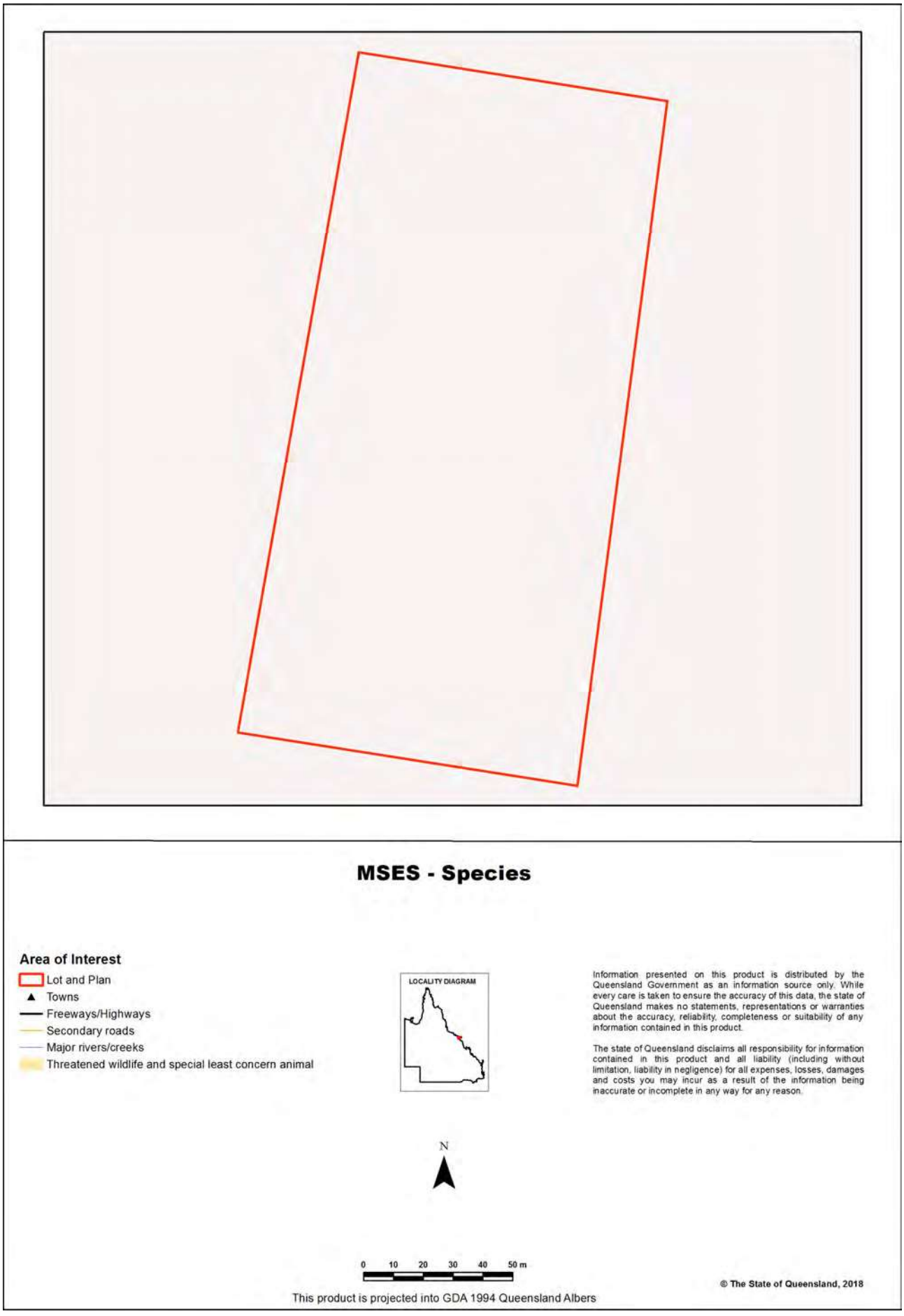
Map 1 - MSES - State Conservation Areas



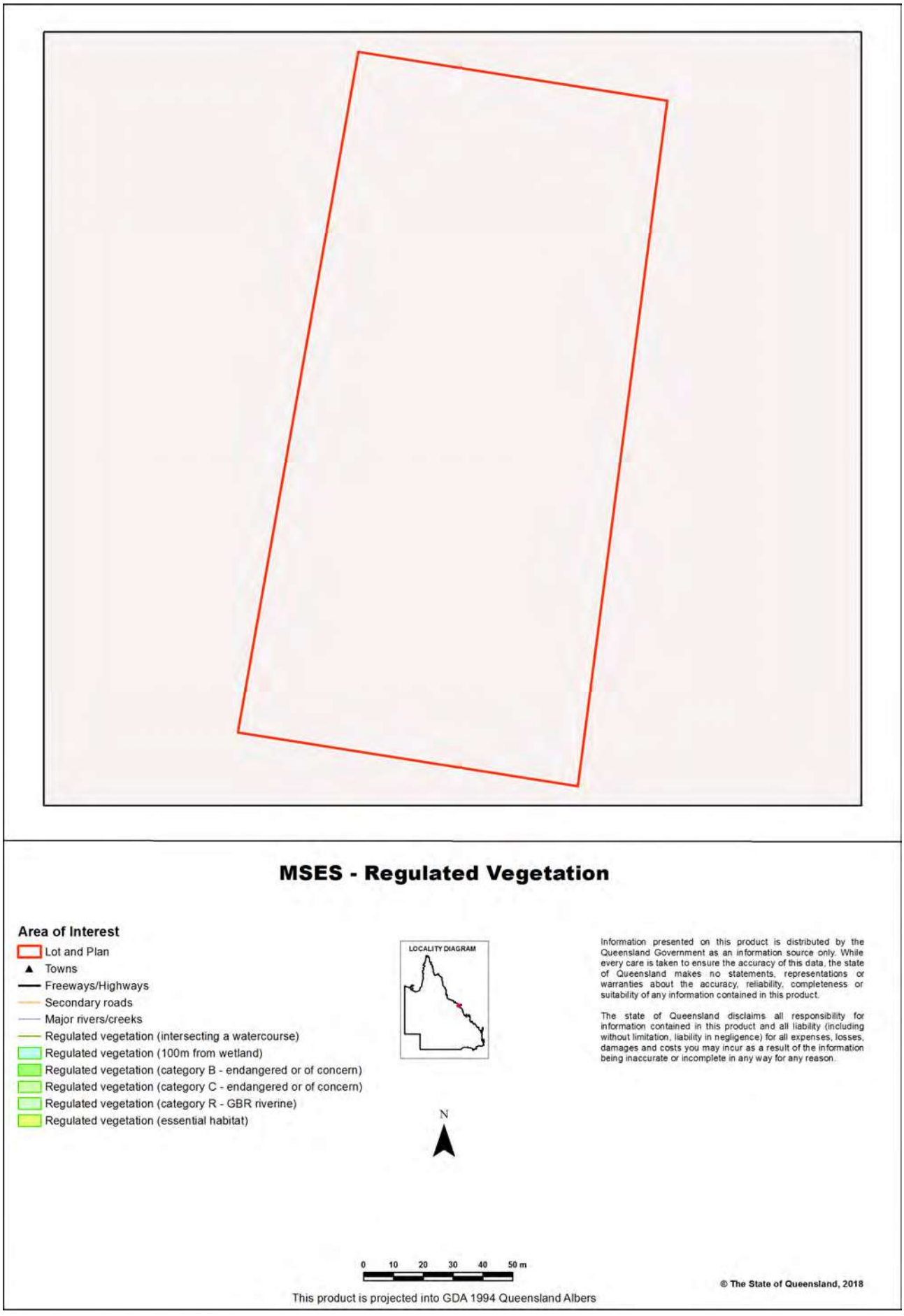
Map 2 - MSES - Wetlands and Waterways



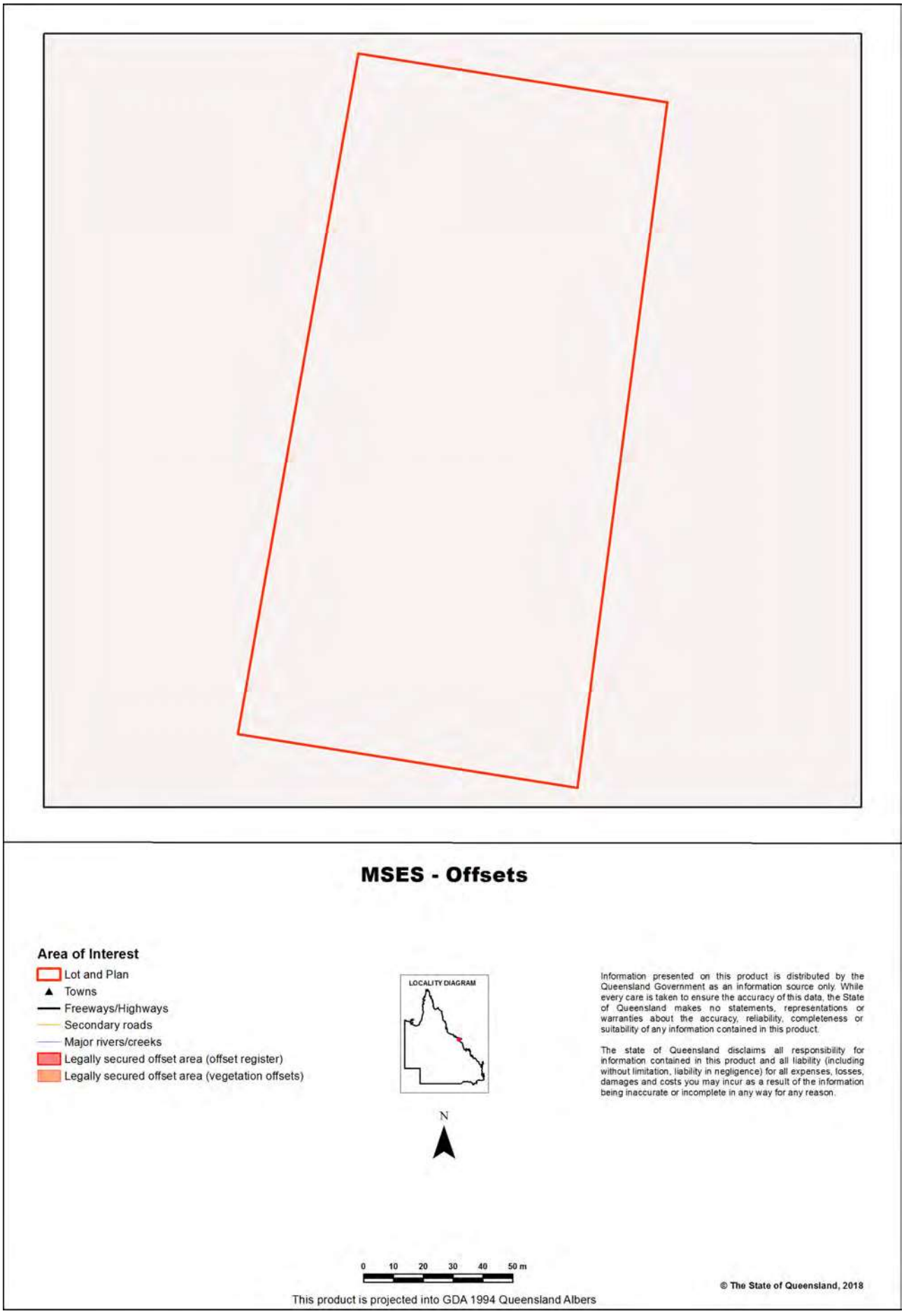
Map 3 - MSES - Species



Map 4 - MSES - Regulated Vegetation



Map 5 - MSES - Offset Areas



Appendices

Appendix 1 - Matters of State Environmental Significance (MSES) methodology

MSES mapping is a regional-scale representation of the definition for MSES under the State Planning Policy (SPP). The compiled MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

The Queensland Government's "Method for mapping - matters of state environmental significance for use in land use planning and development assessment" can be downloaded from:

http://www.ehp.qld.gov.au/land/natural-resource/method-mapping-mses.html .

Appendix 2 - Source Data

The datasets listed below are available on request from:

http://qldspatial.information.qld.gov.au/catalogue/custom/index.page

- Matters of State environmental significance

Note: MSES mapping is not based on new or unique data. The primary mapping product draws data from a number of underlying environment databases and geo-referenced information sources. MSES mapping is a versioned product that is updated generally on a twice-yearly basis to incorporate the changes to underlying data sources. Several components of MSES mapping made for the current version may differ from the current underlying data sources. To ensure accuracy, or proper representation of MSES values, it is strongly recommended that users refer to the underlying data sources and review the current definition of MSES in the State Planning Policy, before applying the MSES mapping.

Individual MSES layers can be attributed to the following source data available at QSpatial:

MSES layers	**current QSpatial data (http://qspatial.ingormation.qld.gov.au)**
Protected Areas-Estates and Nature Refuges	- Protected areas of Queensland - Nature Refuges - Queensland
Marine Park-Highly Protected Zones	Moreton Bay marine park zoning 2008
Fish Habitat Areas	Queensland fish habitat areas
Strategic Environmental Areas-designated	Regional Planning Interests Act - Strategic Environmental Areas
HES wetlands	Map of Referable Wetland - wetland layers: - Wetland management area wetlands - Wetland protection area wetlands
wetlands in HEV waters	HEV waters: - EPP Water (multiple locations) intent for waters Source Wetlands: - Queensland Wetland Mapping (Current version 4, 2015) Source Watercourses: - Vegetation management watercourse and drainage feature map (1:100000 and 1:250000) - latest version 1.4
Wildlife habitat (threatened and special least concern)	-WildNet database species records - habitat suitability models (various)
VMA regulated regional ecosystems	Vegetation management regional ecosystem and remnant map - latest version 8.0
VMA Essential Habitat	Vegetation management - essential habitat map - latest version 4.41
VMA Wetlands	Vegetation management wetlands map - latest version 2.41
Legally secured offsets	Vegetation Management Act property maps of assessable vegetation. For offset register data-contact DES
Regulated Vegetation Map	Vegetation management - regulated vegetation management map - latest version 1.41

Appendix 3 - Acronyms and Abbreviations

AOI	- Area of Interest
DES	- Department of Environment and Science
EP Act	- *Environmental Protection Act 1994*
EPP	- Environmental Protection Policy
GDA94	- Geocentric Datum of Australia 1994
GEM	- General Environmental Matters
GIS	- Geographic Information System
MSES	- Matters of State Environmental Significance
NCA	- *Nature Conservation Act 1992*
RE	- Regional Ecosystem
SPP	- State Planning Policy
VMA	- *Vegetation Management Act 1999*

Queensland Government

Department of Environment and Science

Environmental Reports

Regional Ecosystems

Biodiversity Status

For the selected area of interest
Lot: 299 Plan: SP113325

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the input coordinates.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no matters of interest have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Important Note to User

Information presented in this report is based upon the Queensland Herbarium's Regional Ecosystem framework. The Biodiversity Status has been used to depict the extent of "Endangered", "Of Concern" and "No Concern at Present" regional ecosystems in all cases, rather than the classes used for the purposes of the *Vegetation Management Act 1999* (VMA). Mapping and figures presented in this document reflect the Queensland Herbarium's Remnant and Pre-clearing Regional Ecosystem Datasets, and not the certified mapping used for the purpose of the VMA.

For matters relevant to vegetation management under the VMA, please refer to the Department of Natural Resources, Mines and Energy website

https://www.dnrme.qld.gov.au/

Please direct queries about these reports to: Queensland.Herbarium@dsiti.qld.gov.au

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Summary Information

The following table provides an overview of the AOI with respect to selected topographic and environmental themes. Refer to **Map 1** for locality information.

Table 1: Area of interest details: Lot: 299 Plan: SP113325

Size (ha)	2.56
Local Government(s)	Whitsunday Regional
Bioregion(s)	Central Queensland Coast
Subregion(s)	Proserpine - Sarina Lowlands
Catchment(s)	Proserpine

The table below summarizes the extent of remnant vegetation classed as "Endangered", "Of concern" and "No concern at present" regional ecosystems classified by Biodiversity Status within the area of interest (AOI).

Table 2: Summary table, biodiversity status of regional ecosystems within the AOI

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	0.0	0.0
No concern at present	0.0	0.0
Total remnant vegetation	0.0	0.0

Refer to **Map 2** for further information.

Regional Ecosystems

1. Introduction

Regional ecosystems are vegetation communities in a bioregion that are consistently associated with particular combinations of geology, landform and soil (Sattler and Williams 1999). Descriptions of Queensland's Regional ecosystems are available online from the Regional Ecosystem Description Database (REDD). Descriptions are compiled from a broad range of information sources including vegetation, land system and geology survey and mapping and detailed vegetation site data. The regional ecosystem classification and descriptions are reviewed as new information becomes available. A number of vegetation communities may form a single regional ecosystem and are usually distinguished by differences in dominant species, frequently in the shrub or ground layers and are denoted by a letter following the regional ecosystem code (e.g. a, b, c). Vegetation communities and regional ecosystems are amalgamated into a higher level classification of broad vegetation groups (BVGs).

A published methodology for survey and mapping of regional ecosystems across Queensland (Neldner et al 2017) provides further details on regional ecosystem concepts and terminology.

This report provides information on the type, status, and extent of vegetation communities, regional ecosystems and broad vegetation groups present within a user specified area of interest. Please note, for the purpose of this report, the Biodiversity Status is used. This report has not been developed for application of the *Vegetation Management Act 1999* (VMA). Additionally, information generated in this report has been derived from the Queensland Herbarium's Regional Ecosystem Mapping, and not the regulated mapping certified for the purposes of the VMA. If your interest/matter relates to regional ecosystems and the VMA, users should refer to the Department of Natural Resources, Mines and Energy website.

https://www.dnrme.qld.gov.au/

With respect to the Queensland Biodiversity Status,

"Endangered" regional ecosystems are described as those where:

- remnant vegetation is less than 10 per cent of its pre-clearing extent across the bioregion; or 10-30% of its pre-clearing extent remains and the remnant vegetation is less than 10,000 hectares, or
- less than 10 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss*, or
- 10-30 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 hectares; or
- it is a rare** regional ecosystem subject to a threatening process.***

"Of concern" regional ecosystems are described as those where:

- the degradation criteria listed above for 'Endangered' regional ecosystems are not met and,
- remnant vegetation is 10-30 per cent of its pre-clearing extent across the bioregion; or more than 20 per cent of its pre-clearing extent remains and the remnant extent is less than 10,000 hectares, or
- 10-30 percent of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss.****

and "No concern at present" regional ecosystems are described as those where:

- remnant vegetation is over 30 per cent of its pre-clearing extent across the bioregion, and the remnant area is greater than 10,000 hectares, and
- the degradation criteria listed above for 'Endangered' or 'Of concern' regional ecosystems are not met.

**Severe degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 50 years even with the removal of threatening processes; or soil surface is severely degraded, for example, by loss of A horizon, surface expression of salinity; surface compaction, loss of organic matter or sheet erosion.*

***Rare regional ecosystem: pre-clearing extent (1000 ha); or patch size (100 ha and of limited total extent across its range).*

****Threatening processes are those that are reducing or will reduce the biodiversity and ecological integrity of a regional ecosystem. For example, clearing, weed invasion, fragmentation, inappropriate fire regime or grazing pressure, or infrastructure development.*

*****Moderate degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 20 years even with the removal of threatening processes; or soil surface is moderately degraded.*

2. Remnant Regional Ecosystems

The following table identifies the remnant regional ecosystems and vegetation communities mapped within the AOI and provides their short descriptions, Biodiversity Status, and remnant extent within the selected AOI. Please note, where heterogeneous vegetated patches (mixed patches of remnant vegetation mapped as containing multiple regional ecosystems) occur within the AOI, they have been split and listed as individual regional ecosystems (or vegetation communities where present) for the purposes of the table below. In such instances, associated area figures have been generated based upon the estimated proportion of each regional ecosystem (or vegetation community) predicted to be present within the larger mixed patch.

Table 3: Remnant regional ecosystems, description and status within the AOI

Regional Ecosystem	Short Description	BD Status	Area (Ha)	% of AOI
non-rem	None	None	2.56	100.06

Refer to **Map 2** for further information. **Map 3** also provides a visual estimate of the distribution of regional ecosystems present before clearing.

Table 4 provides further information in regards to the remnant regional ecosystems present within the SOI. Specifically, the extent of remnant vegetation remaining within the bioregion, the 1:1,000,000 broad vegetation group (BVG) classification, whether the regional ecosystem is identified as a wetland, and extent of representation in Queensland's Protected Area Estate. For a description of the vegetation communities within the AOI and classified according to the 1:1,000,000 BVG, refer to **Table 6**.

Table 4: Remnant regional ecosystems within the AOI, additional information

Regional Ecosystem	Remnant Extent	BVG (1 Million)	Wetland	Representation in protected estate
non-rem	None	None	None	None

Representation in Protected Area Estate: High greater than 10% of pre-clearing extent is represented; Medium 4 - 10% is represented; Low less than 4% is represented, No representation.

The distribution of mapped wetland systems within the area of interest is displayed in **Map 6**.

The following table lists known special values associated with a regional ecosystem type.

Table 5: Remnant regional ecosystems within the AOI, special values

Regional Ecosystem	Special Values
non-rem	None

3. Remnant Regional Ecosystems by Broad Vegetation Group

BVGs are a higher-level grouping of vegetation communities. Queensland encompasses a wide variety of landscapes across temperate, wet and dry tropics and semi-arid climatic zones. BVGs provide an overview of vegetation communities across the state or a bioregion and allow comparison with other states. There are three levels of BVGs which reflect the approximate scale at which they are designed to be used: the 1:5,000,000 (national), 1:2,000,000 (state) and 1:1,000,000 (regional) scales.

A comprehensive description of BVGs is available at:

https://publications.qld.gov.au/dataset/redd/resource/

The following table provides a description of the 1:1,000,000 BVGs present and their associated extent within the AOI.

Table 6: Broad vegetation groups (1 million) within the AOI

BVG (1 Million)	Description	Area (Ha)	% of AOI
None	None	2.56	100.06

Refer to **Map 4** for further information. **Map 5** also provides a representation of the distribution of vegetation communities as per the 1:5,000,000 BVG believed to be present prior to European settlement.

4. Technical and BioCondition Benchmark Descriptions

Technical descriptions provide a detailed description of the full range in structure and floristic composition of regional ecosystems (e.g. 11.3.1) and their component vegetation communities (e.g. 11.3.1a, 11.3.1b). See:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

The descriptions are compiled using site survey data from the Queensland Herbarium's CORVEG database. Distribution maps, representative images (if available) and the pre-clearing and remnant extent (hectares) of each vegetation community derived from the regional ecosystem mapping data are included. The technical descriptions should be used in conjunction with the fields from the regional ecosystem description database (REDD) for a full description of the regional ecosystem.

Technical descriptions include data on canopy height, canopy cover and native plant species composition of the predominant layer, which are attributes relevant to assessment of the remnant status of vegetation under the *Vegetation Management Act 1999*. However, as technical descriptions reflect the full range in structure and floristic composition across the climatic, natural disturbance and geographic range of the regional ecosystem, local reference sites should be used for remnant assessment where possible (Neldner et al. 2012 (PDF)* section 3.3.1 of:

https://publications.qld.gov.au/dataset/redd/resource/

The technical descriptions are subject to review and are updated as additional data becomes available.

When conducting a BioCondition assessment, these technical descriptions should be used in conjunction with BioCondition benchmarks for the specific regional ecosystem, or component vegetation community.

http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

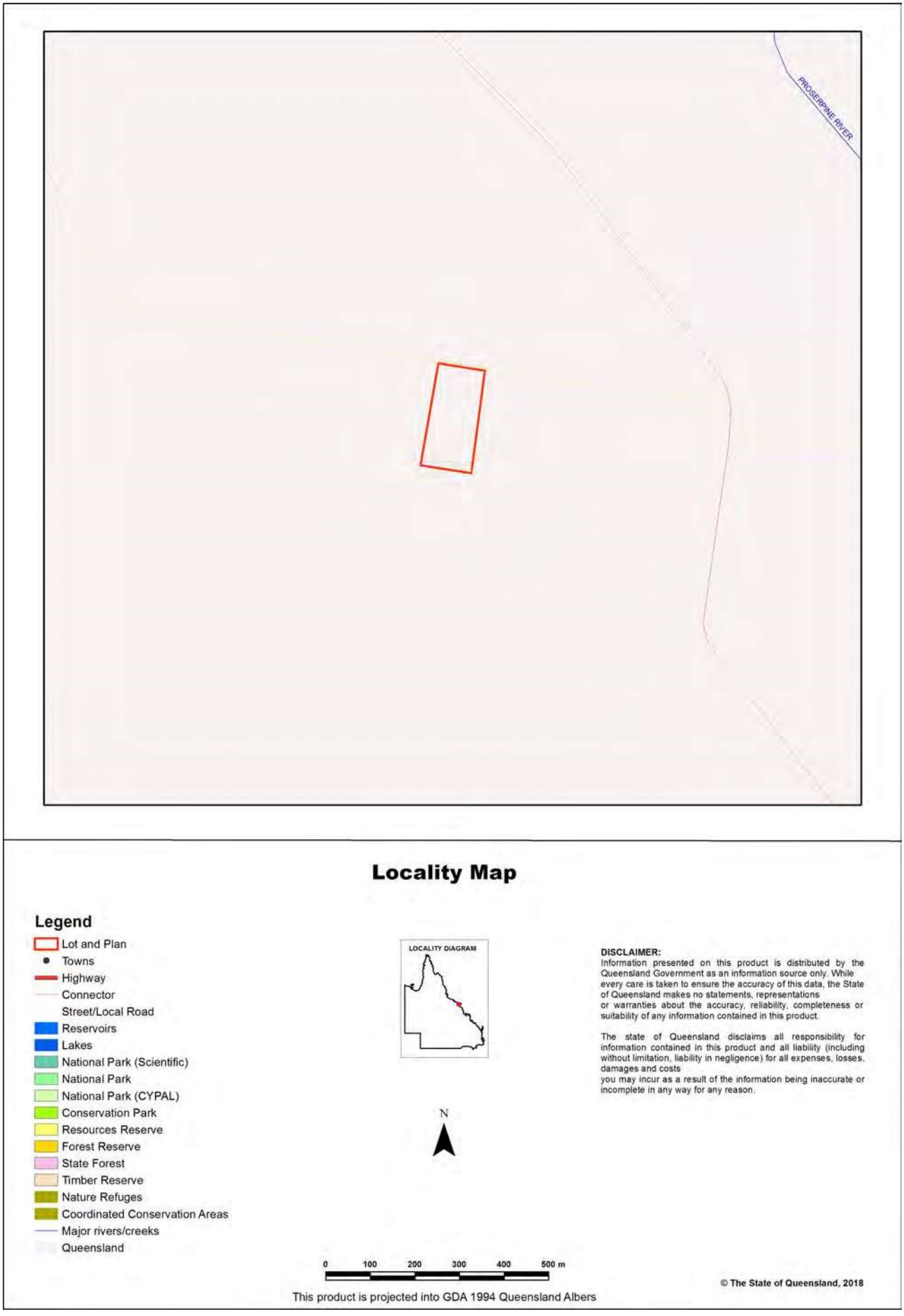
Benchmarks are based on a combination of quantitative and qualitative information and should be used as a guide only. Benchmarks are specific to one regional ecosystem vegetation community, however, the natural variability in structure and floristic composition under a range of climatic and natural disturbance regimes has been considered throughout the geographic extent of the regional ecosystem. Local reference sites should be used for this spatial and temporal (seasonal and annual) variability.

Table 7: List of remnant regional ecosystems within the AOI for which technical and biocondition benchmark descriptions are available

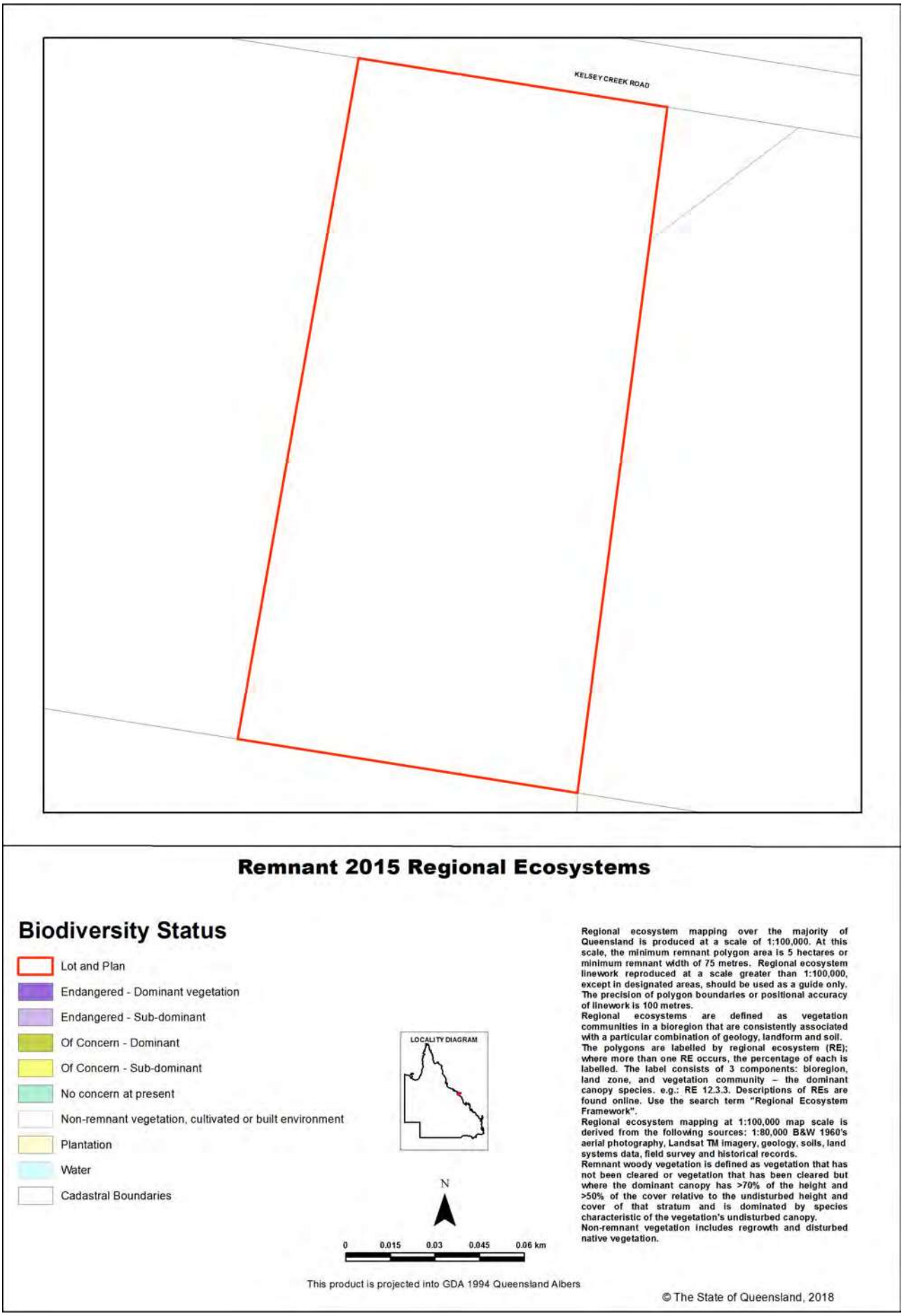
Regional ecosystems mapped as within the AOI	Technical Descriptions	Biocondition Benchmarks
non-rem	Not currently available	Not currently available

Maps

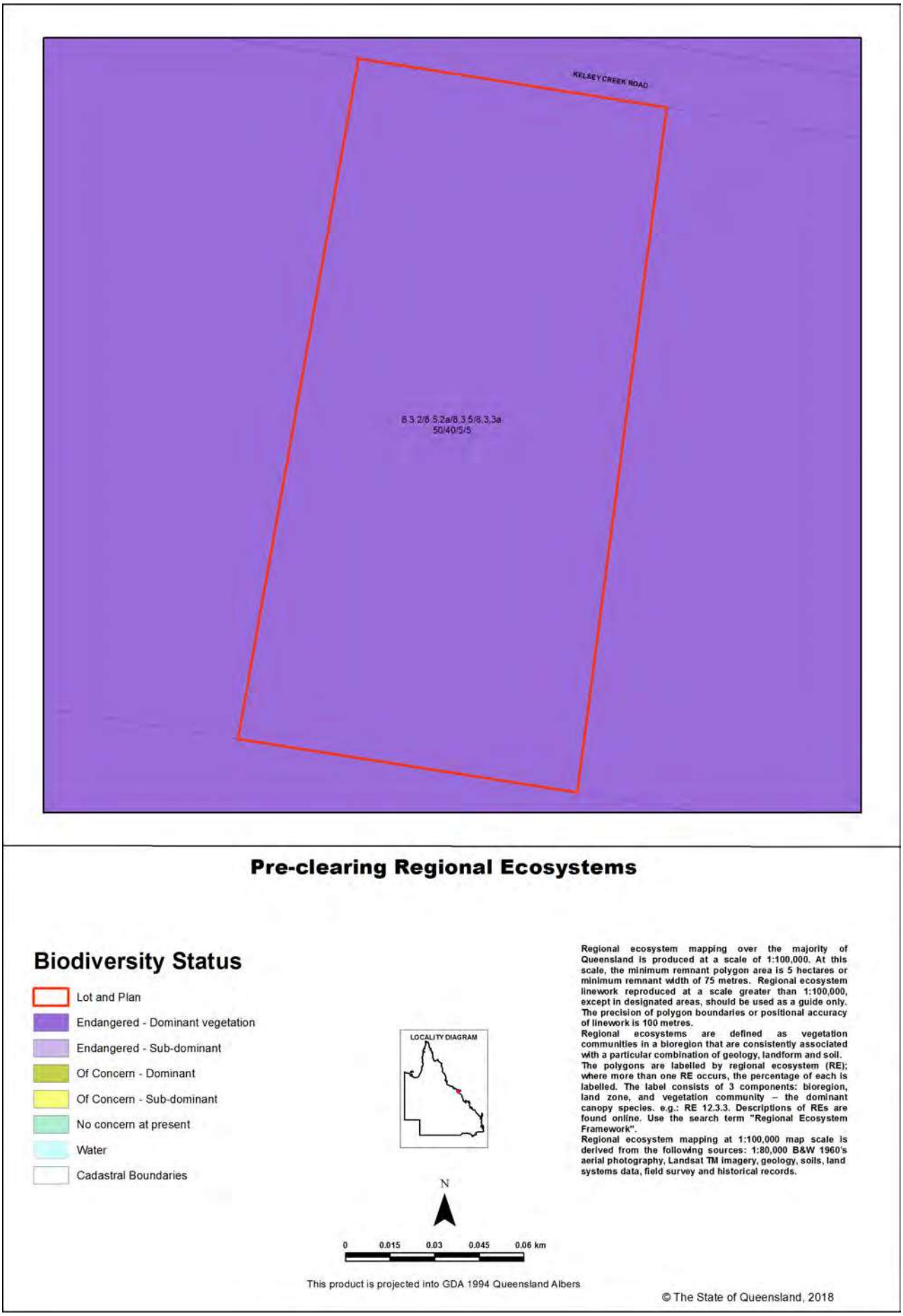
Map 1 - Location



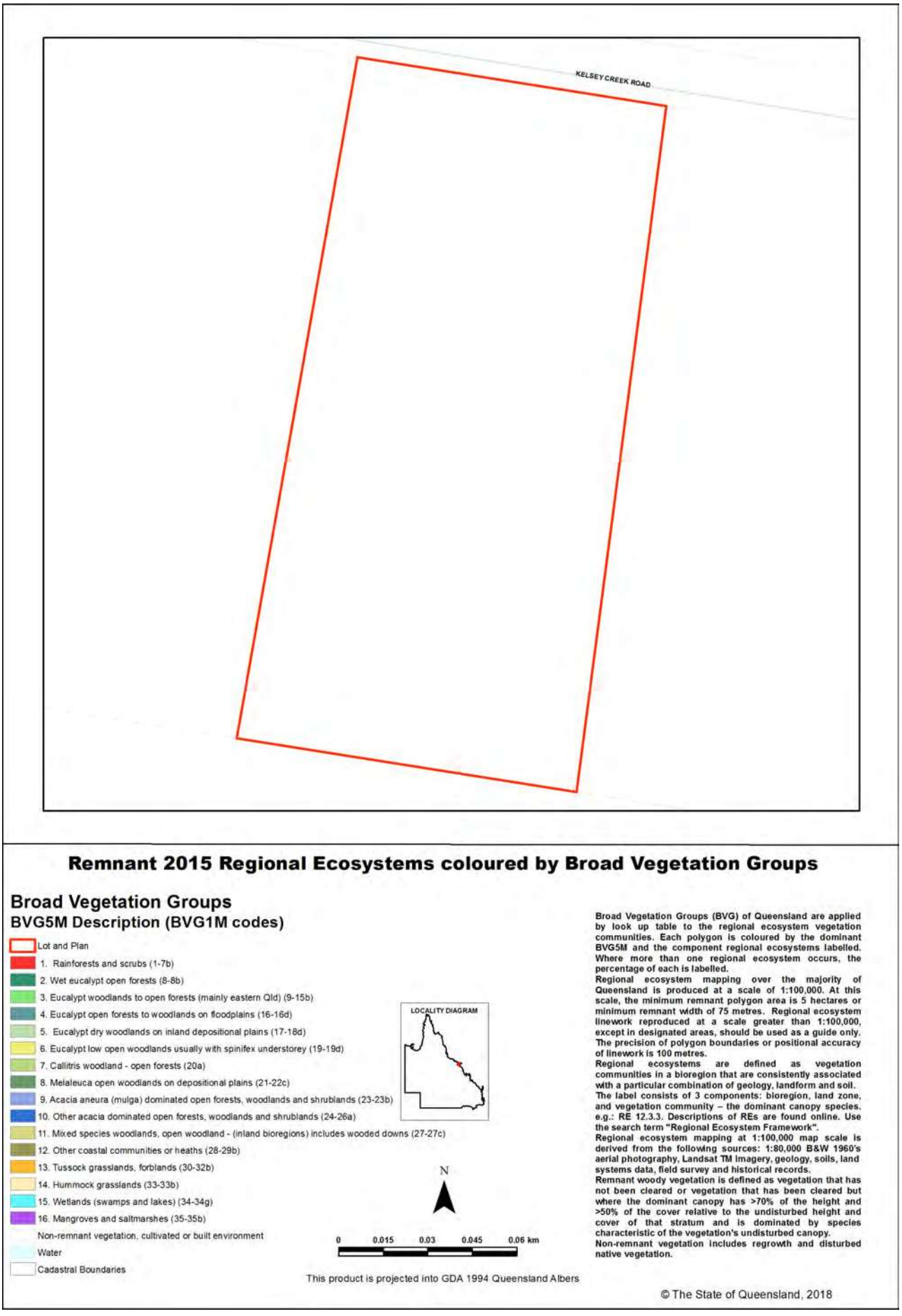
Map 2 - Remnant 2015 regional ecosystems



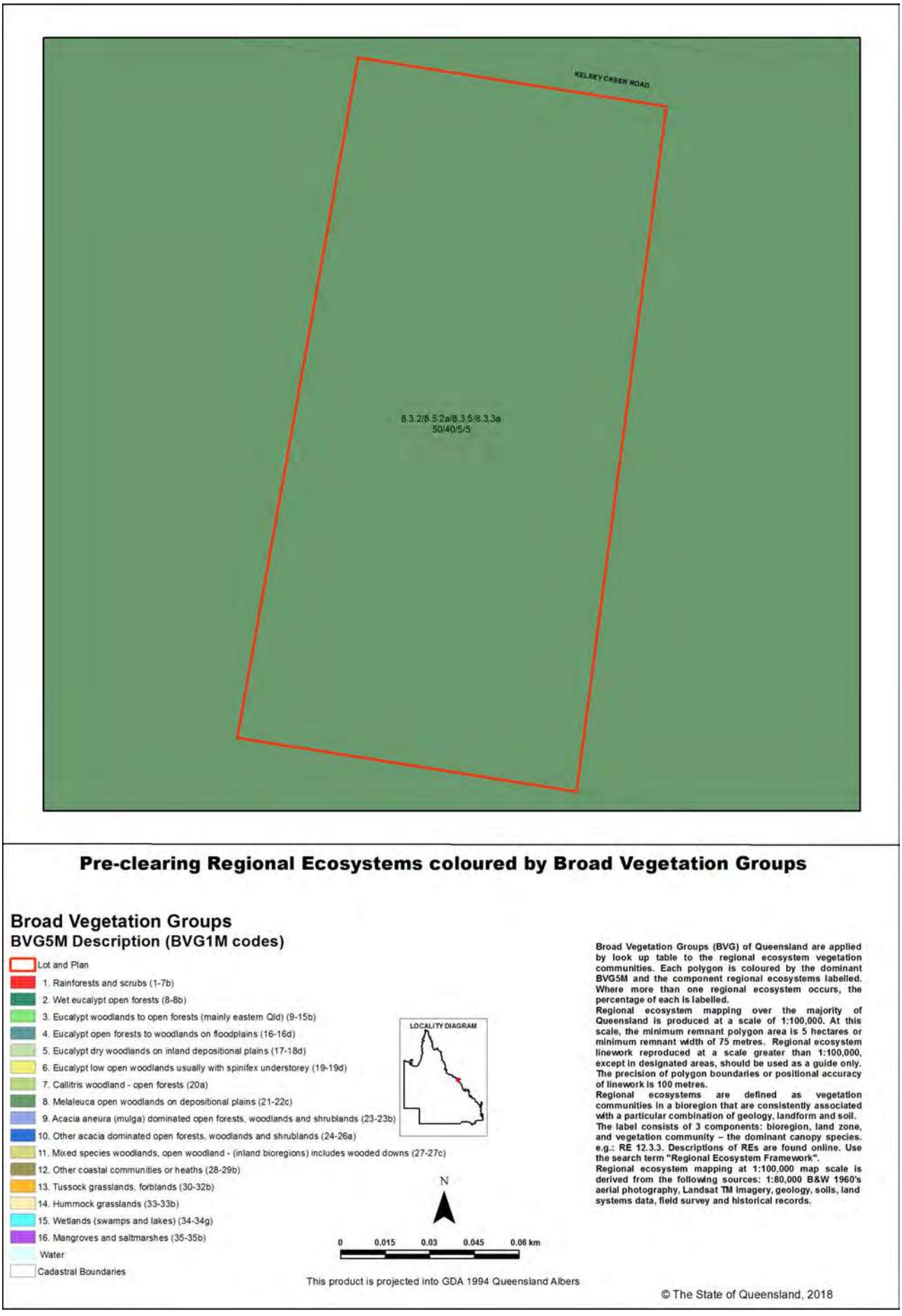
Map 3 - Pre-clearing regional ecosystems



Map 4 - Remnant 2015 regional ecosystems by BVG (5M)



Map 5 - Pre-clearing regional ecosystems by BVG (5M)



Map 6 - Wetlands and waterways



Links and Other Information Sources

The Department of Environment and Science's Website -

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/

provides further information on the regional ecosystem framework, including access to links to the Regional Ecosystem Database, Broad Vegetation Group Definitions, Regional Ecosystem and Land zone descriptions.

Descriptions of the broad vegetation groups of Queensland can be downloaded from:

https://publications.qld.gov.au/dataset/redd/resource/

The methodology for mapping regional ecosystems can be downloaded from:

https://publications.qld.gov.au/dataset/redd/resource/

Technical descriptions for regional ecosystems can be obtained from:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

Benchmarks can be obtained from:

http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

For further information associated with the remnant regional ecosystem dataset used by this report, refer to the metadata associated with the Biodiversity status of pre-clearing and Remnant Regional Ecosystems of Queensland dataset (version listed in **Appendix 1**) which is available through the Queensland Government Information System portal,

http://dds.information.qld.gov.au/dds/

The Queensland Globe is a mapping and data application. As an interactive online tool, Queensland Globe allows you to view and explore Queensland maps, imagery (including up-to-date satellite images) and other spatial data, including regional ecosystem mapping. To further view and explore regional ecosystems over an area of interest, access the Biota Globe (a component of the Queensland Globe). The Queensland Globe can be accessed via the following link:

http://www.dnrm.qld.gov.au/mapping-data/queensland-globe

References

Neldner, V.J., Niehus R.E., Wilson, B.A. McDonald, W.J.F., Ford, A.J. and Accad, A. (2017) The Vegetation of Queensland. Descriptions of Broad Vegetation Groups. Version 3.0. Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts.

(https://publications.qld.gov.au/dataset/redd/resource/78209e74-c7f2-4589-90c1-c33188359086)

Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S. and Butler, D.W. (2017) *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland*. Version 4.0. Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts.

(https://publications.qld.gov.au/dataset/redd/resource/6dee78ab-c12c-4692-9842-b7257c2511e4)

Sattler, P.S. and Williams, R.D. (eds) (1999). *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency, Brisbane.

Appendices

Appendix 1 - Source Data

The dataset listed below is available for download from:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/download/

- Regional Ecosystem Description Database

The datasets listed below are available for download from:

http://dds.information.qld.gov.au/dds/

- Biodiversity status of pre-clearing and 2015 remnant regional ecosystems of Queensland
- Pre-clearing Vegetation Communities and Regional Ecosystems of Queensland
- Queensland Wetland Data Version - Wetland lines
- Queensland Wetland Data Version - Wetland points
- Queensland Wetland Data Version - Wetland areas

Appendix 2 - Acronyms and Abbreviations

AOI	- Area of Interest
GDA94	- Geocentric Datum of Australia 1994
GIS	- Geographic Information System
RE	- Regional Ecosystem
REDD	- Regional Ecosystem Description Database
VMA	- *Vegetation Management Act 1999*

Queensland Government

Department of Environment and Science

Environmental Reports

Biodiversity and Conservation Values

Biodiversity Planning Assessments and Aquatic Conservation Assessments

For the selected area of interest
Lot: 299 Plan: SP113325

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or Area of Interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "Central co-ordinates" option, the resulting assessment area encompasses an area extending from 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Please direct queries about these reports to: biodiversity.planning@des.qld.gov.au

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness, or suitability, for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which the user may incur as a consequence of the information being inaccurate or incomplete in any way and for any reason.



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Summary Information

Tables 1 to 8 provide an overview of the AOI with respect to selected topographic and environmental values.

Table 1: Area of interest details: Lot: 299 Plan: SP113325

Size (ha)	2.56
Local Government(s)	Whitsunday Regional
Bioregion(s)	Central Queensland Coast
Subregion(s)	Proserpine - Sarina Lowlands
Catchment(s)	Proserpine

The following table identifies available Biodiversity Planning Assessments (BPAs) and Aquatic Conservation Assessments (ACAs) with respect to the AOI.

Table 2: Available Biodiversity Planning and Aquatic Conservation Assessments

Assessment Type	Assessment Area and Version
Biodiversity Planning Assessment(s)	Central Queensland Coast v1.3
Aquatic Conservation Assessment(s) (riverine)	Great Barrier Reef Catchments v1.3
Aquatic Conservation Assessment(s) (non-riverine)	Great Barrier Reef Catchments v1.3

Table 3: Remnant regional ecosystems within the AOI as per the Qld Herbarium's 'biodiversity status'

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	0.0	0.0
No concern at present	0.0	0.0

The following table identifies the extent and proportion of the user specified area of interest (AOI) which is mapped as being of "State", "Regional" or "Local" significance via application of the Queensland Department of Environment and Science's *Biodiversity Assessment and Mapping Methodology* (BAMM).

Table 4: Summary table, biodiversity significance

Biodiversity significance	Area (Ha)	% of AOI
(No Records)		

Table 5: Non-riverine wetlands intersecting the AOI

Non-riverine wetland types intersecting the area of interest	#
(No Records)	

NB. The figures presented in the table above are derived from the relevant non-riverine Aquatic Conservation Assessment(s). Later releases of wetland mapping produced via the Queensland Wetland Mapping Program may provide more recent information in regards to wetland extent.

Table 6: Named waterways intersecting the AOI

(no results)

Refer to **Map 1** for general locality information.

The following two tables identify the extent and proportion of the user specified AOI which is mapped as being of "Very High", "High", "Medium", "Low", or "Very Low" aquatic conservation value for riverine and non-riverine wetlands via application of the Queensland Department of Environment and Science's *Aquatic Biodiversity Assessment and Mapping Method* (AquaBAMM).

Table 7: Summary table, aquatic conservation significance (riverine)

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0
High	2.56	100.0
Medium	0.0	0.0
Low	0.0	0.0
Very Low	0.0	0.0

Table 8: Summary table, aquatic conservation significance (non-riverine)

Aquatic conservation significance (non-riverine wetlands)	Area (Ha)	% of AOI
(No Records)		

Biodiversity Planning Assessments

Introduction

The Department of Environment and Science (DES) attributes biodiversity significance on a bioregional scale through a Biodiversity Planning Assessment (BPA). A BPA involves the integration of ecological criteria using the *Biodiversity assessment and Mapping Methodology* (BAMM) and is developed in two stages: 1) **diagnostic criteria**, and 2) **expert panel criteria**. The diagnostic criteria are based on existing data which is reliable and uniformly available across a bioregion, while the expert panel criteria allows for the refinement of the mapped information from the diagnostic output by incorporating local knowledge and expert opinion.

The BAMM methodology has application for identifying areas with various levels of significance solely for biodiversity reasons. These include threatened ecosystems or taxa, large tracts of habitat in good condition, ecosystem diversity, landscape context and connection, and buffers to wetlands or other types of habitat important for the maintenance of biodiversity or ecological processes. While natural resource values such as dryland salinity, soil erosion potential or land capability are not dealt with explicitly, they are included to some extent within the biodiversity status of regional ecosystems recognised by the DES.

Biodiversity Planning Assessments (BPAs) assign three levels of overall biodiversity significance.

- **State significance** - areas assessed as being significant for biodiversity at the bioregional or state scales. They also include areas assessed by other studies/processes as being significant at national or international scales. In addition, areas flagged as being of State significance due to the presence of endangered, vulnerable and/or near threatened taxa, are identified as "State Habitat for EVNT taxa".
- **Regional significance** - areas assessed as being significant for biodiversity at the subregional scale. These areas have lower significance for biodiversity than areas assessed as being of State significance.
- **Local significance and/or other values** - areas assessed as not being significant for biodiversity at state or regional scales. Local values are of significance at the local government scale.

For further information on released BPAs and a copy of the underlying methodology, go to:

http://www.qld.gov.au/environment/plants-animals/biodiversity/planning/

The GIS results can be downloaded from the Queensland Spatial Catalogue at:

http://qspatial.information.qld.gov.au/geoportal/

The following table identifies the extent and proportion of the user specified AOI which is mapped as being of "State", "Regional" or "Local" significance via application of the BAMM.

Table 9: Summary table, biodiversity significance

Biodiversity significance	Area (Ha)	% of AOI
(No Records)		

Refer to **Map 2** for further information.

Diagnostic Criteria

Diagnostic criteria are based on existing data which is reliable and uniformly available across a bioregion. These criteria are diagnostic in that they are used to filter the available data and provide a "first-cut" or initial determination of biodiversity significance. This initial assessment is then combined through a second group of other essential criteria.

A description of the individual diagnostic criteria is provided in the following sections.

Criteria A. Habitat for EVNT taxa: Classifies areas according to their significance based on the presence of endangered, vulnerable and/or rare (EVNT) taxa. EVNT taxa are those scheduled under the *Nature Conservation Act 1992* and/or the *Environment Protection and Biodiversity Conservation Act 1999*. It excludes highly mobile fauna taxa which are instead considered in Criterion H and brings together information on EVNT taxa using buffering of recorded sites or habitat suitability models (HSM) where available.

Criteria B. Ecosystem value: Classifies on the basis of biodiversity status of regional ecosystems, their extent in protected areas (presence of poorly conserved regional ecosystems), the presence of significant wetlands; and areas of national importance such as the presence of Threatened Ecological Communities, World Heritage areas and Ramsar sites. Ecosystem value is applied at a bioregional (**B1**) and regional (**B2**) scale.

Criteria C. Tract size: Measures the relative size of tracts of vegetation in the landscape. The size of any tract is a major indicator of ecological significance, and is also strongly correlated with the long-term viability of biodiversity values. Larger tracts are less susceptible to ecological edge effects and are more likely to sustain viable populations of native flora and fauna than smaller tracts.

Criteria D. Relative size of regional ecosystems: Classifies the relative size of each regional ecosystem unit within its bioregion (**D1**) and its subregion (**D2**). Remnant units are compared with all other occurrences with the same regional ecosystem. Large examples of a regional ecosystem are more significant than smaller examples of the same regional ecosystem because they are more representative of the biodiversity values particular to the regional ecosystem, are more resilient to the effects of disturbance, and constitute a significant proportion of the total area of the regional ecosystem.

Criteria F. Ecosystem diversity: Is an indicator of the number of regional ecosystems occurring within an area. An area with high ecosystem diversity will have many regional ecosystems and ecotones relative to other areas within the bioregion.

Criteria G. Context and connection: Represents the extent to which a remnant unit incorporates, borders or buffers areas such as significant wetlands, endangered ecosystems; and the degree to which it is connected to other vegetation.

A summary of the biodiversity status based upon the diagnostic criteria is provided in the following table.

Table 10: Summary of biodiversity significance based upon diagnostic criteria with respect to the AOI

Biodiversity significance	Description	Area (Ha)	% of AOI
(No Records)			

Assessment of diagnostic criteria with respect to the AOI

The following table reflects an assessment of the individual diagnostic criteria noted above in regards to the AOI.

Table 11: Assessment of individual diagnostic criteria with respect to the AOI

Diagnostic Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
(No Records)								

Other Essential Criteria

Other essential criteria (also known as expert panel criteria) are based on non-uniform information sources and which may rely more upon expert opinion than on quantitative data. These criteria are used to provide a "second-cut" determination of biodiversity significance, which is then combined with the diagnostic criteria for an overall assessment of relative biodiversity significance. A summary of the biodiversity status based upon the other essential criteria is provided in the following table.

Table 12: Summary of biodiversity significance based upon other essential criteria with respect to the AOI

Biodiversity significance	Description	Area (Ha)	% of AOI
(No Records)			

A description of each of the other essential criteria and associated assessment in regards to the AOI is provided in the following sections.

Criteria H. Essential and general habitat for priority taxa: Priority taxa are those which are at risk or of management concern, taxa of scientific interest as relictual (ancient or primitive), endemic taxa or locally significant populations (such as a flying fox camp or heronry), highly specialised taxa whose habitat requirements are complex and distributions are not well correlated with any particular regional ecosystem, taxa important for maintaining genetic diversity (such as complex spatial patterns of genetic variation, geographic range limits, highly disjunct populations), taxa critical for management or monitoring of biodiversity (functionally important or ecological indicators), or economic and culturally important taxa.

Criteria I. Special biodiversity values: areas with special biodiversity values are important because they contain multiple taxa in a unique ecological and often highly biodiverse environment. Areas with special biodiversity values can include the following:

- Ia - centres of endemism - areas where concentrations of taxa are endemic to a bioregion or subregion are found.
- Ib - wildlife refugia (Morton *et al*. 1995), for example, islands, mound springs, caves, wetlands, gorges, mountain ranges and topographic isolates, ecological refuges, refuges from exotic animals, and refuges from clearing. The latter may include large areas that are not suitable for clearing because of land suitability/capability.
- Ic - areas with concentrations of disjunct populations.
- Id - areas with concentrations of taxa at the limits of their geographic ranges.
- Ie - areas with high species richness.
- If - areas with concentrations of relictual populations (ancient and primitive taxa).
- Ig - areas containing REs with distinct variation in species composition associated with geomorphology and other environmental variables.
- Ih - an artificial waterbody or managed/manipulated wetland considered by the panel/s to be of ecological significance.
- Ii - areas with a high density of hollow-bearing trees that provide habitat for animals.

- Ij - breeding or roosting sites used by a significant number of individuals.
- Ik - climate change refuge.

The following table identifies the value and extent area of the Other Essential Criteria H and I within the AOI.

Table 13: Relative importance of expert panel criteria (H and I) used to access overall biodiversity significance with respect to the AOI

Expert Panel	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
(No Records)								

NB. Whilst biodiversity values associated with Criteria I may be present within the site (refer to tables 12 and 15), for the New England Tableland and Central Queensland Coast BPAs, area and % area figures associated with Criteria Ia through to Ij cannot be listed in the table above (due to slight variations in data formats between BPAs).

Criteria J. Corridors: areas identified under this criterion qualify either because they are existing vegetated corridors important for contiguity, or cleared areas that could serve this purpose if revegetated. Some examples of corridors include riparian habitats, transport corridors and "stepping stones".

Bioregional and subregional conservation corridors have been identified in the more developed bioregions of Queensland through the BPAs, using an intensive process involving expert panels. Map 3 displays the location of corridors as identified under the Statewide Corridor network. The Statewide Corridor network incorporates BPA derived corridors and for bioregions where no BPA has been assessed yet, corridors derived under other planning processes. *Note: as a result of updating and developing a statewide network, the alignment of corridors may differ slightly in some instances when compared to those used in individual BPAs.*

The functions of these corridors are:

- **Terrestrial** Bioregional corridors, in conjunction with large tracts of remnant vegetation, maintain ecological and evolutionary processes at a landscape scale, by:
  - Maintaining long term evolutionary/genetic processes that allow the natural change in distributions of species and connectivity between populations of species over long periods of time;
  - Maintaining landscape/ecosystems processes associated with geological, altitudinal and climatic gradients, to allow for ecological responses to climate change;
  - Maintaining large scale seasonal/migratory species processes and movement of fauna;
  - Maximising connectivity between large tracts/patches of remnant vegetation;
  - Identifying key areas for rehabilitation and offsets; and

- **Riparian** Bioregional Corridors also maintain and encourage connectivity of riparian and associated ecosystems.

The location of the corridors is determined by the following principles:

- Terrestrial
  - Complement riparian landscape corridors (i.e. minimise overlap and maximise connectivity);
  - Follow major watershed/catchment and/or coastal boundaries;
  - Incorporate major altitudinal/geological/climatic gradients;
  - Include and maximise connectivity between large tracts/patches of remnant vegetation;
  - Include and maximise connectivity between remnant vegetation in good condition; and

- Riparian
  - Located on the major river or creek systems within the bioregion in question.

The total extent of remnant vegetation triggered as being of "State", "Regional" or "Local" significance due to the presence of an overlying BPA derived terrestrial or riparian corridor within the AOI, is provided in the following table. For further information on how remnant vegetation is triggered due to the presence of an overlying BPA derived corridor, refer to the relevant landscape BPA expert panel report(s).

Table 14: Extent of triggered remnant vegetation due to the presence of BPA derived corridors with respect to the AOI

Biodiversity Significance	Area (Ha)	% of AOI
(No Records)		

NB: area figures associated with the extent of corridor triggered remnant vegetation are only available for those bioregions where a BPA has been undertaken.

Refer to **Map 3** for further information.

Threatening process/condition (Criteria K) - areas identified by experts under this criterion may be used to amend (upgrade or downgrade) biodiversity significance arising from the "first-cut" analysis. The condition of remnant vegetation is affected by threatening processes such as weeds, ferals, grazing and burning regime, selective timber harvesting/removal, salinity, soil erosion, and climate change.

Assessment of Criteria K with respect to the AOI is not currently included in the "Biodiversity and Conservation Values" report, as it has not been applied to the majority of Queensland due to data/information limitations and availability.

Special Area Decisions

Expert panel derived "Special Area Decisions" are used to assign values to Other Essential Criteria. The specific decisions which relate to the AOI in question are listed in the table below.

Table 15: Expert panel decisions for assigning levels of biodiversity significance with respect to the AOI

Decision Number	Description	Panel Recommended Significance	Criteria Values
(No Records)			

Expert panel decision descriptions:

(No Records)

Aquatic Conservation Assessments

Introduction

The Aquatic Biodiversity Assessment and Mapping Method or AquaBAMM (Clayton *et al*. 2006), was developed to assess conservation values of wetlands in queensland, and may also have application in broader geographical contexts. It is a comprehensive method that uses available data, including data resulting from expert opinion, to identify relative wetland conservation/ecological values within a specified study area (usually a catchment). The product of applying this method is an Aquatic Conservation Assessment (ACA) for the study area.

An ACA using AquaBAMM is non-social, non-economic and identifies the conservation/ecological values of wetlands at a user-defined scale. It provides a robust and objective conservation assessment using criteria, indicators and measures that are founded upon a large body of national and international literature. The criteria, each of which may have variable numbers of indicators and measures, are naturalness (aquatic), naturalness (catchment), diversity and richness, threatened species and ecosystems, priority species and ecosystems, special features, connectivity and representativeness. An ACA using AquaBAMM is a powerful decision support tool that is easily updated and simply interrogated through a geographic information system (GIS).

Where they have been conducted, ACAs can provide a source of baseline wetland conservation/ecological information to support natural resource management and planning processes. They are useful as an independent product or as an important foundation upon which a variety of additional environmental and socio-economic elements can be added and considered (i.e. an early input to broader 'triple-bottom-line' decision-making processes). An ACA can have application in:

- determining priorities for protection, regulation or rehabilitation of wetlands and other aquatic ecosystems
- on-ground investment in wetlands and other aquatic ecosystems
- contributing to impact assessment of large-scale development (e.g. dams)
- water resource and strategic regional planning prcesses

For a detailed explanation of the methodology please refer to the summary and expert panel reports relevant to the ACA utilised in this assessment. These reports can be accessed at Wetland *Info*:

http://wetlandinfo.des.qld.gov.au/wetlands/assessment/assessment-methods/aca

The GIS results can be downloaded from the Queensland Spatial Catalogue at:

http://qspatial.information.qld.gov.au/geoportal/

Explanation of Criteria

Under the AquaBAMM, eight criteria are assessed to derive an overall conservation value. Similar to the Biodiversity Assessment and Mapping Methodology, the criteria may be primarily diagnostic (quantitative) or primarily expert opinion (qualitative) in nature. The following sections provide a brief description of each of the 8 criteria.

Criteria 1. Naturalness - Aquatic: This attribute reflects the extent to which a wetland's (riverine, non-riverine, estuarine) aquatic state of naturalness is affected through relevant influencing indicators which include: presence of exotic flora and fauna; presence of aquatic communities; degree of habitat modification and degree of hydrological modification.

Criteria 2. Naturalness - Catchment: The naturalness of the terrestrial systems of a catchment can have an influence on many wetland characteristics including: natural ecological processes e.g. nutrient cycling, riparian vegetation, water chemistry, and flow. The indicators utilised to assess this criterion include: presence of exotic flora and/or fauna; riparian, catchment and flow modification.

Criteria 3. Naturalness - Diversity and Richness: This criterion is common to many ecological assessment methods and can include both physical and biological features. It includes such indicators as species richness, riparian ecosystem richness and geomorphological diversity.

Criteria 4. Threatened Species and Ecosystems: This criterion evaluates ecological rarity characteristics of a wetland. This includes both species rarity and rarity of communities / assemblages. The communities and assemblages are best represented by regional ecosystems. Species rarity is determined by NCA and EPBC status with Endangered, Vulnerable or Near-threatened species being included in the evaluation. Ecosystem rarity is determined by regional ecosystem biodiversity status i.e. Endangered, Of Concern, or Not of Concern.

Criteria 5. Priority Species and Ecosystems: Priority flora and fauna species lists are expert panel derived. These are aquatic, semi-aquatic and riparian species which exhibit at least 1 particular trait in order to be eligible for consideration. For

flora species the traits included:

- It forms significant macrophyte beds (in shallow or deep water).
- It is an important food source.
- It is important/critical habitat.
- It is implicated in spawning or reproduction for other fauna and/or flora species.
- It is at its distributional limit or is a disjunct population.
- It provides stream bank or bed stabilisation or has soil binding properties.
- It is a small population and subject to threatening processes.

Fauna species are included if they meet at least one of the following traits:

- It is endemic to the study area (>75 per cent of its distribution is in the study area/catchment).
- It has experienced, or is suspected of experiencing, a serious population decline.
- It has experienced a significant reduction in its distribution and has a naturally restricted distribution in the study area/catchment.
- It is currently a small population and threatened by loss of habitat.
- It is a significant disjunct population.
- It is a migratory species (other than birds).
- A significant proportion of the breeding population (>one per cent for waterbirds, >75 per cent other species) occurs in the waterbody (see Ramsar criterion 6 for waterbirds).
- Limit of species range.

See the individual expert panel reports for the priority species traits specific to an ACA.

Criteria 6. Special Features: Special features are areas identified by flora, fauna and ecology expert panels which exhibit characteristics beyond those identified in other criteria and which the expert panels consider to be of the highest ecological importance. Special feature traits can relate to, but are not solely restricted to geomorphic features, unique ecological processes, presence of unique or distinct habitat, presence of unique or special hydrological regimes e.g. spring-fed streams. Special features are rated on a 1 - 4 scale (4 being the highest).

Criteria 7. Connectivity: This criterion is based on the concept that appropriately connected aquatic ecosystems are healthy and resilient, with maximum potential biodiversity and delivery of ecosystem services.

Criteria 8. Representativeness: This criterion applies primarily to non-riverine assessments, evaluates the rarity and uniqueness of a wetland type in relation to specific geographic areas. Rarity is determined by the degree of wetland protection within "protected Areas" estate or within an area subject to the *Fisheries Act 1994*, *Coastal Protection and Management Act 1995*, or *Marine Parks Act 2004*. Wetland uniqueness evaluates the relative abundance and size of a wetland or wetland management group within geographic areas such as catchment and subcatchment.

Riverine Wetlands

Riverine wetlands are all wetlands and deepwater habitats within a channel. The channels are naturally or artificially created, periodically or continuously contain moving water, or connecting two bodies of standing water. AquaBAMM, when applied to riverine wetlands uses a discrete spatial unit termed subsections. A subsection can be considered as an area which encompasses discrete homogeneous stream sections in terms of their natural attributes (i.e. physical, chemical, biological and utilitarian values) and natural resources. Thus in an ACA, an aquatic conservation significance score is calculated for each subsection and applies to all streams within a subsection, rather than individual streams as such.

Please note, the area figures provided in Tables 16 and 17, are derived using the extent of riverine subsections within the AOI. Refer to **Map 5** for further information. A summary of the conservation significance of riverine wetlands within the AOI is provided in the following table.

Table 16: Overall level/s of riverine aquatic conservation significance

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
High	2.56	100.0
Medium	0.0	0.0
Low	0.0	0.0
Very Low	0.0	0.0

The individual aquatic conservation criteria ratings for riverine wetlands within the AOI are listed below.

Table 17: Level/s of riverine aquatic conservation significance based on selected criteria

Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
1. Naturalness aquatic							2.56	100.0
2. Naturalness catchment			2.56	100.0				
3. Diversity and richness					2.56	100.0		
4. Threatened species and ecosystems	2.56	100.0						
5. Priority species and ecosystems			2.56	100.0				
6. Special features								
7. Connectivity	2.56	100.0						

The table below lists and describes the relevant expert panel decisions used to assign conservation significance values to riverine wetlands within the AOI.

Table 18: Expert panel decisions for assigning overall levels of riverine aquatic conservation significance

Decision number	Special feature	Catchment	Criteria/Indicator/Measure	Conservation rating (1-4)
(No Records)				

4 is the highest rating/value

Expert panel decision descriptions:

(No Records)

Non-riverine Wetlands

Non-riverine wetlands include both lacustrine and palustrine wetlands, however, do not currently incorporate estuarine, marine or subterranean wetland types. A summary of the conservation significance of non-riverine wetlands within the AOI is provided in the following table. Refer to **Map 6** for further information.

Table 19: Overall level/s of non-riverine aquatic conservation significance

Aquatic conservation significance (non-riverine wetlands)	Area (Ha)	% of AOI
(No Records)		

The following table provides an assessment of non-riverine wetlands within the AOI and associated aquatic conservation criteria values.

Table 20: Level/s of non-riverine aquatic conservation significance based on selected criteria

Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
(No Records)								

The table below lists and describes the relevant expert panel decisions used to assign conservation significance values to non-riverine wetlands within the AOI.

Table 21: Expert panel decisions for assigning overall levels of non-riverine aquatic conservation significance.

Decision number	Special feature	Catchment	Criteria/Indicator/Measure	Conservation rating (1-4)
(No Records)				

4 is the highest rating/value

Expert panel decision descriptions:

(No Records)

Threatened and Priority Species

Introduction

This chapter contains a list of threatened and priority flora and/or fauna species that have been recorded on, or within 4km of the Assessment Area.

The information presented in this chapter with respect to species presence is derived from compiled databases developed primarily for the purpose of BPAs and ACAs. Data is collated from a number of sources and is updated periodically.

It is important to note that the list of species provided in this report, may differ when compared to other reports generated from other sources such as the State government's WildNet, Herbrecs or the federal government's EPBC database for a number of reasons.

Records for threatened and priority species are filtered and checked based on a number of rules including:

- Taxonomic nomenclature - current scientific names and status,
- Location - cross-check co-ordinates with location description,
- Taxon by location - requires good knowledge of the taxon and history of the record,
- Duplicate records - identify and remove,
- Expert panels - check records and provide new records,
- Flora cultivated records excluded,
- Use precise records less than or equal to 2000m,
- Use recent records greater than or equal to 1975 animals, greater than or equal to 1950 plants.

Threatened Species

Threatened species are those species classified as "Endangered" or "Vulnerable" under the *Environment Protection and Biodiversity Conservation Act 1999* or "Endangered", "Vulnerable" or "Near threatened" under the *Nature Conservation Act 1992*.

The following threatened species have been recorded on, or within approximately 4km of the AOI.

Table 22: Threatened species recorded on, or within 4km of the AOI

Species	Common name	NCA status	EPBC status	Back on Track rank	Migratory species*	Wetland species**	Identified flora/fauna
Crocodylus porosus	Estuarine Crocodile	V		Low	Y	Y	FA
Dasyurus hallucatus	Northern Quoll		E	Medium			FA
Petrogale persephone	Proserpine Rock-wallaby	E	E	Critical			FA

NB. Please note that the threatened species listed in this section are based upon the most recently compiled DES internal state-wide threatened species dataset. This dataset may contain additional records that were not originally available for inclusion in the relevant individual BPAs and ACAs.

**JAMBA - Japan-Australia Migratory Bird Agreement; CAMBA - China-Australia Migratory Bird Agreement; ROKAMBA - Republic of Korea-Australia Migratory Bird Agreement; CMS - Convention on the Conservation of Migratory Species.*

***Y - wetland indicator species.*

BPA Priority Species

A list of BPA priority species that have been recorded on, or within approximately 4km of the AOI is contained in the following table.

Table 23: Priority species recorded on, or within 4km of the AOI

(no results)

NB. Please note that the list of priority species is based on those species identified in the BPAs, however records for these species may be more recent than the originals used. furthermore, the BPA priority species databases are updated from time to time. At each update, the taxonomic details for all species are amended as necessary to reflect current taxonomic name and/or status changes.

ACA Priority Species

A list of ACA priority species used in riverine and non-riverine ACAs that have been recorded on, or within approximately 4km of the AOI are contained in the following tables.

Table 24: Priority species recorded on, or within 4 km of the AOI - riverine

Species	Common name	Back on Track rank	Identified flora/fauna
Ardea modesta	Eastern Great Egret	Low	FA

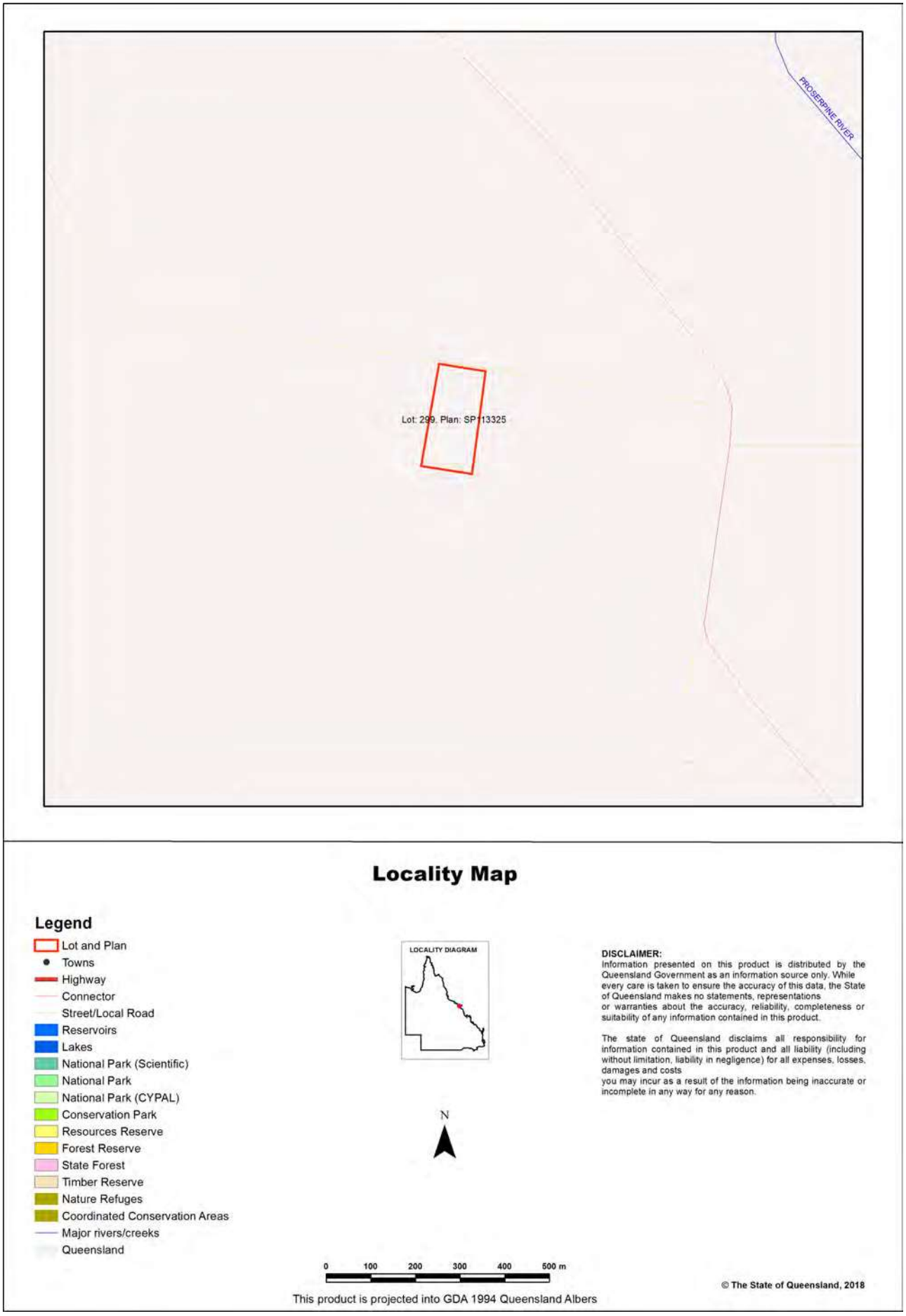
Table 25: Priority species recorded on, or within 4 km of the AOI - non-riverine

Species	Common name	Back on Track rank	Identified flora/fauna
Ardea ibis	Cattle Egret	Low	FA
Ardea modesta	Eastern Great Egret	Low	FA

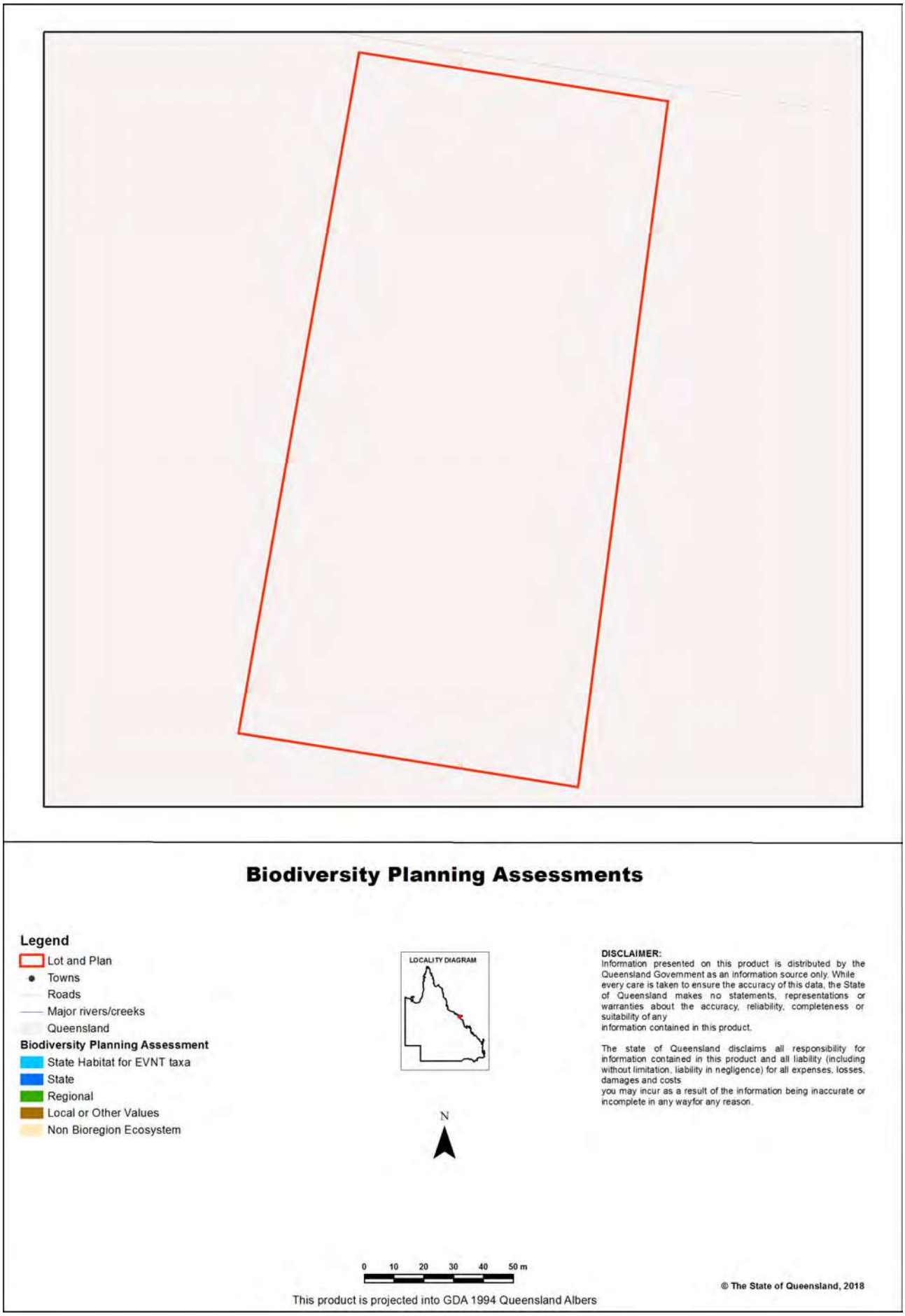
NB. Please note that the priority species records used in the above two tables are comprised of those adopted for the released individual ACAs. The ACA riverine and non-riverine priority species databases are updated from time to time to reflect new release of ACAs. At each update, the taxonomic details for all ACAs records are amended as necessary to reflect current taxonomic name and/or status changes.

Maps

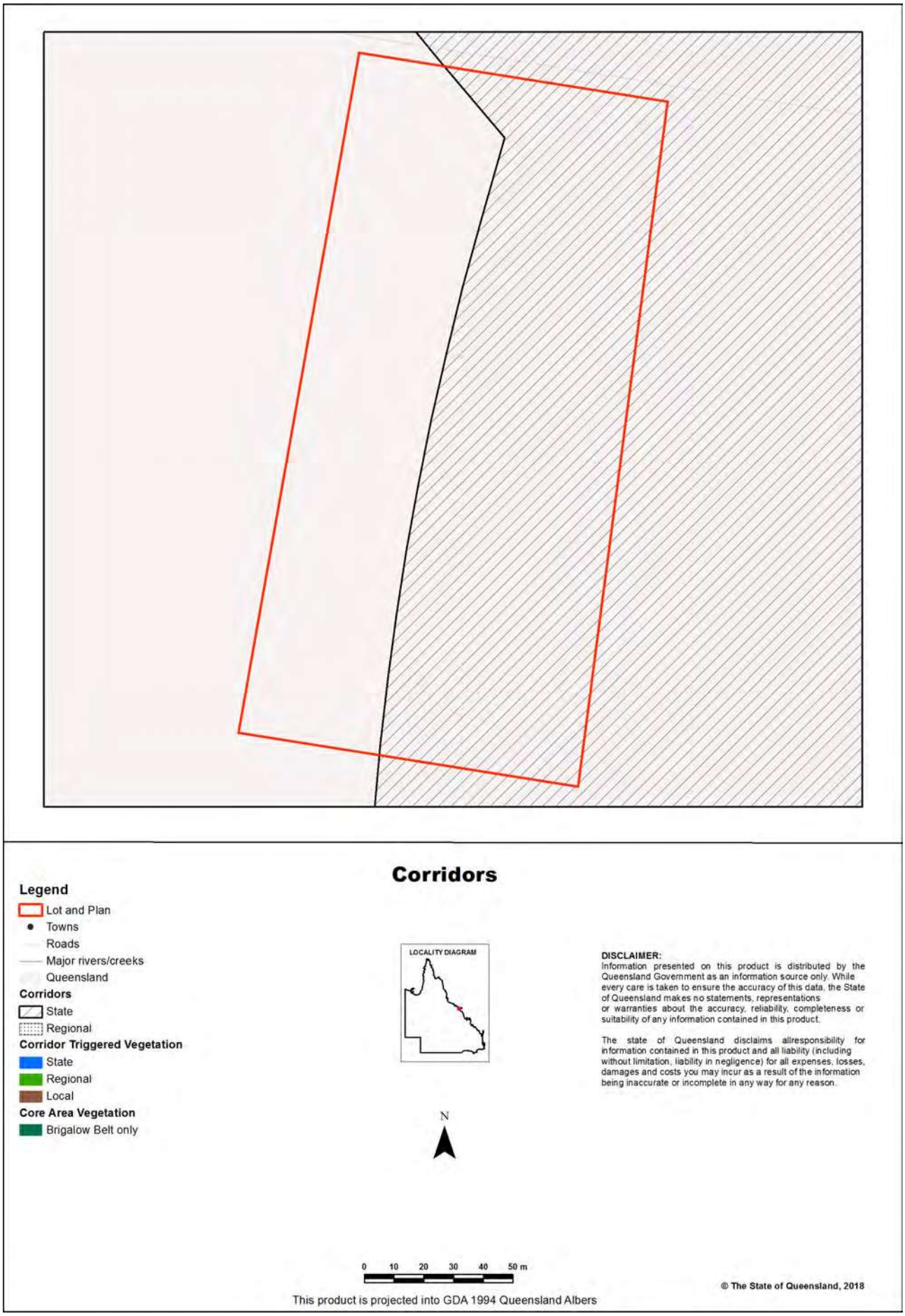
Map 1 - Locality Map



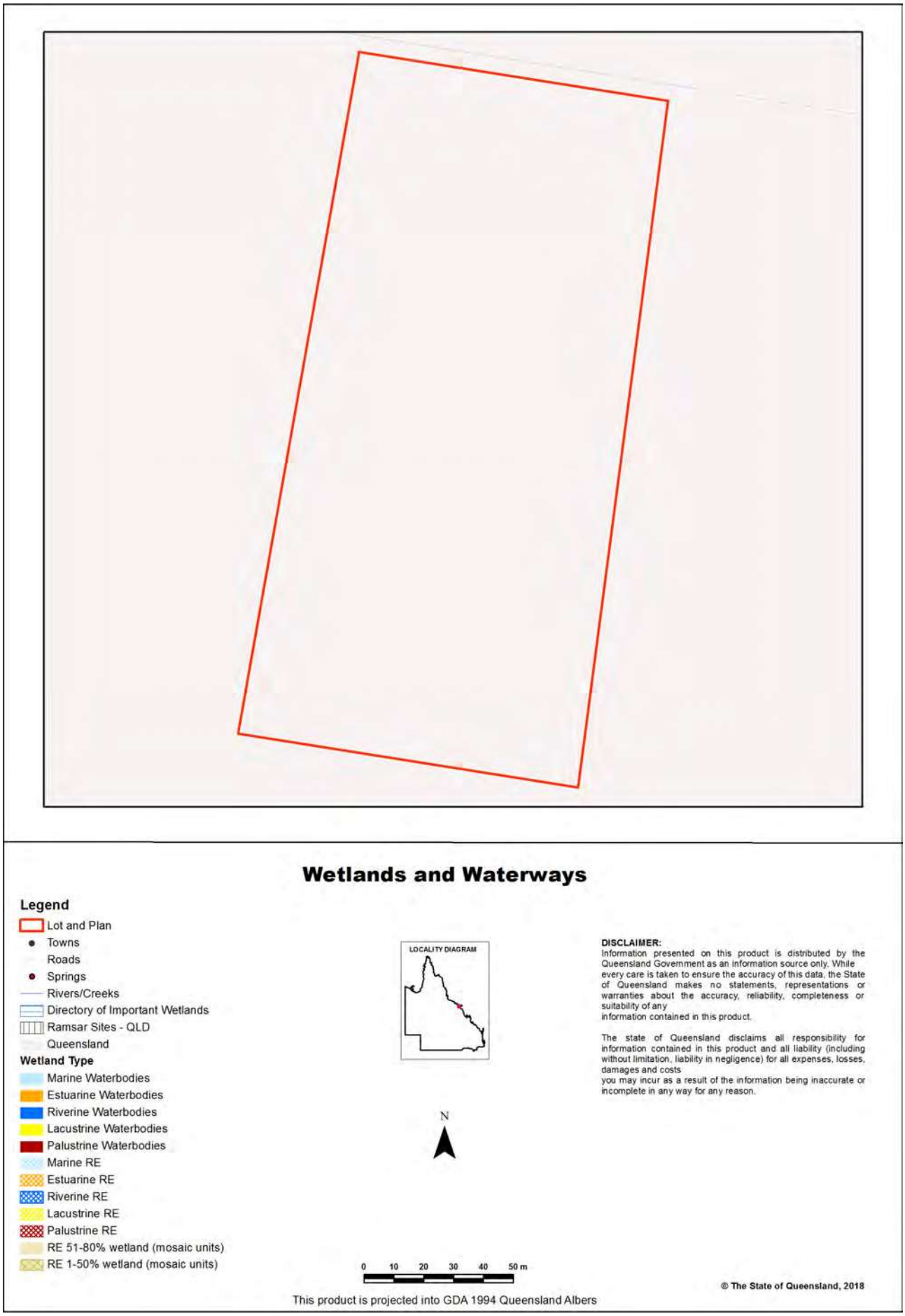
Map 2 - Biodiversity Planning Assessment (BPA)



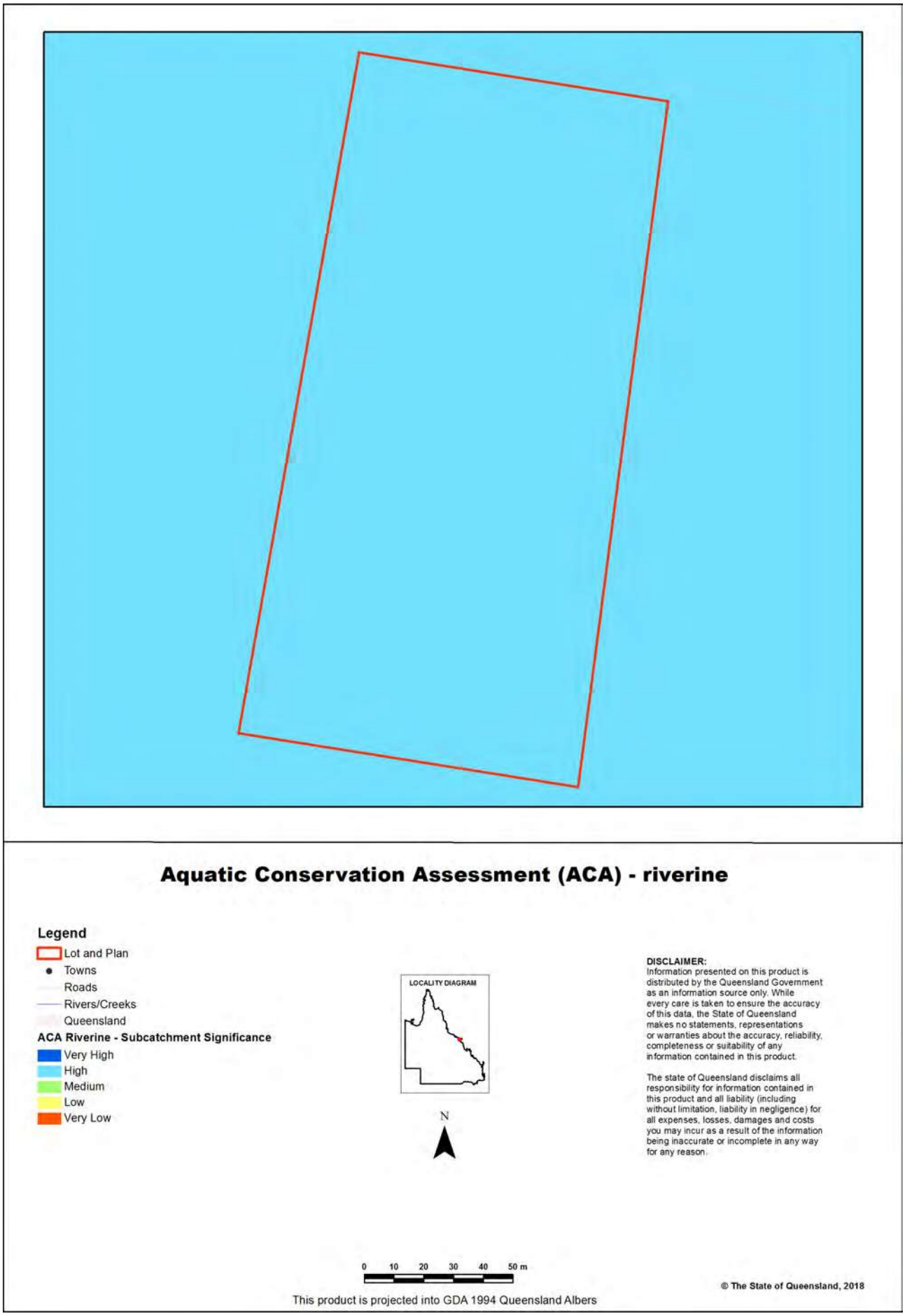
Map 3 - Corridors



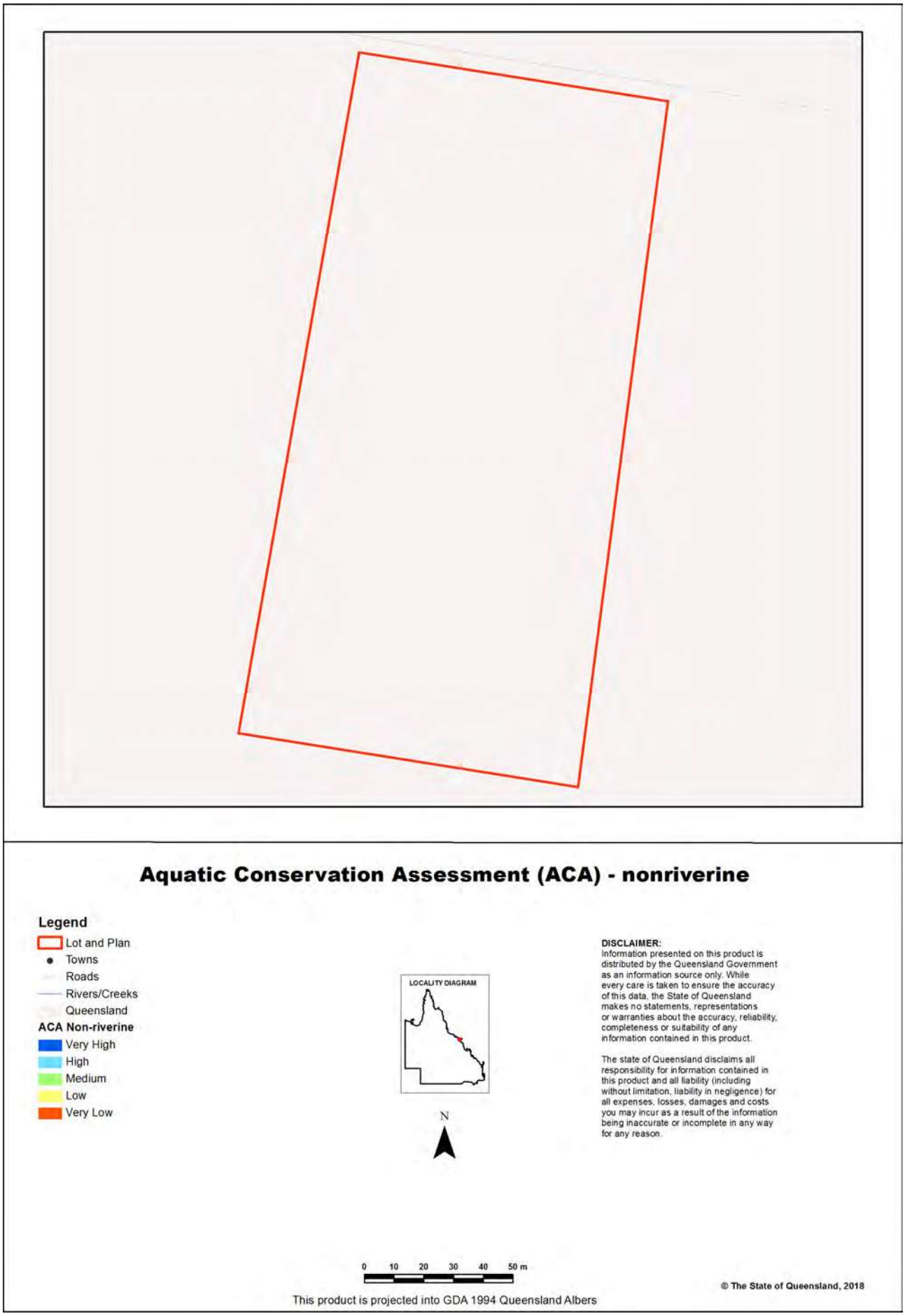
Map 4 - Wetlands and waterways



Map 5 - Aquatic Conservation Assessment (ACA) - riverine



Map 6 - Aquatic Conservation Assessment (ACA) - non-riverine



References

Clayton, P.D., Fielder, D.F., Howell, S. and Hill, C.J. (2006) *Aquatic biodiversity assessment and mapping method (AquaBAMM): a conservation values assessment tool for wetlands with trial application in the Burnett River catchment.* Published by the Environmental Protection Agency, Brisbane. ISBN 1-90928-07-3. Available at

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Morton, S. R., Short, J. and Barker, R. D. with an Appendix by G.F. Griffin and G. Pearce (1995). *Refugia for Biological Diversity in Arid and Semi-arid Australia. Biodiversity Series* , Paper No. 4, Biodiversity Unit, Environment Australia.

Sattler, P.S. and Williams, R.D. (eds) (1999). *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency, Brisbane.

Appendices

Appendix 1 - Source Data

Theme	Datasets
Aquatic Conservation Assessments Non-riverine*	Combination of the following datasets: Cape York Peninsula Non-riverine v1.1 Great Barrier Reef Catchment Non-riverine v1.3 Lake Eyre and Bulloo Basins v1.1 QMDB Non-riverine ACA v1.4 Southeast Queensland ACA v1.1 WBB Non-riverine ACA v1.1
Aquatic Conservation Assessments Riverine*	Combination of the following datasets: Cape York Peninsula Riverine v1.1 Great Barrier Reef Catchment Riverine v1.1 Lake Eyre and Bulloo Basins v1.1 QMDB Riverine ACA v1.4 Southeast Queensland ACA v1.1 WBB Riverine ACA v1.1
Biodiversity Planning Assessments*	Combination of the following datasets: Brigalow Belt BPA v2.1 Cape York Peninsula BPA v1.1 Central Queensland Coast BPA v1.3 Channel Country BPA v1.1 Desert Uplands BPA v1.3 Einasleigh Uplands BPA v1.1 Gulf Plains BPA v1.1 Mitchell Grass Downs BPA v1.1 Mulga Lands BPA v1.4 New England Tableland v2.3 Southeast Queensland v4.1
Statewide BPA Corridors*	Statewide corridors v1.4
Threatened Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.
BPA Priority Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.
ACA Priority Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.

***These datasets are available at:**

http://dds.information.qld.gov.au/DDS

Appendix 2 - Acronyms and Abbreviations

AOI	- Area of Interest
ACA	- Aquatic Conservation Assessment
AQUABAMM	- Aquatic Biodiversity Assessment and Mapping Methodology
BAMM	- Biodiversity Assessment and Mapping Methodology
BoT	- Back on Track
BPA	- Biodiversity Planning Assessment
CAMBA	- China-Australia Migratory Bird Agreement
DES	- Department of Environment and Science
EPBC	- *Environment Protection and Biodiversity Conservation Act 1999*
EVNT	- Endangered, Vulnerable, Near Threatened
GDA94	- Geocentric Datum of Australia 1994
GIS	- Geographic Information System
JAMBA	- Japan-Australia Migratory Bird Agreement
NCA	- *Nature Conservation Act 1992*
RE	- Regional Ecosystem
REDD	- Regional Ecosystem Description Database
ROKAMBA	- Republic of Korea-Australia Migratory Bird Agreement

Queensland Government

Department of Environment and Science

Environmental Reports

Matters of State Environmental Significance

For the selected area of interest
Lot: 277 Plan: SP113325

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Please direct queries about these reports to: Planning.Support@des.qld.gov.au

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness, or suitability, for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which the user may incur as a consequence of the information being inaccurate or incomplete in any way and for any reason.



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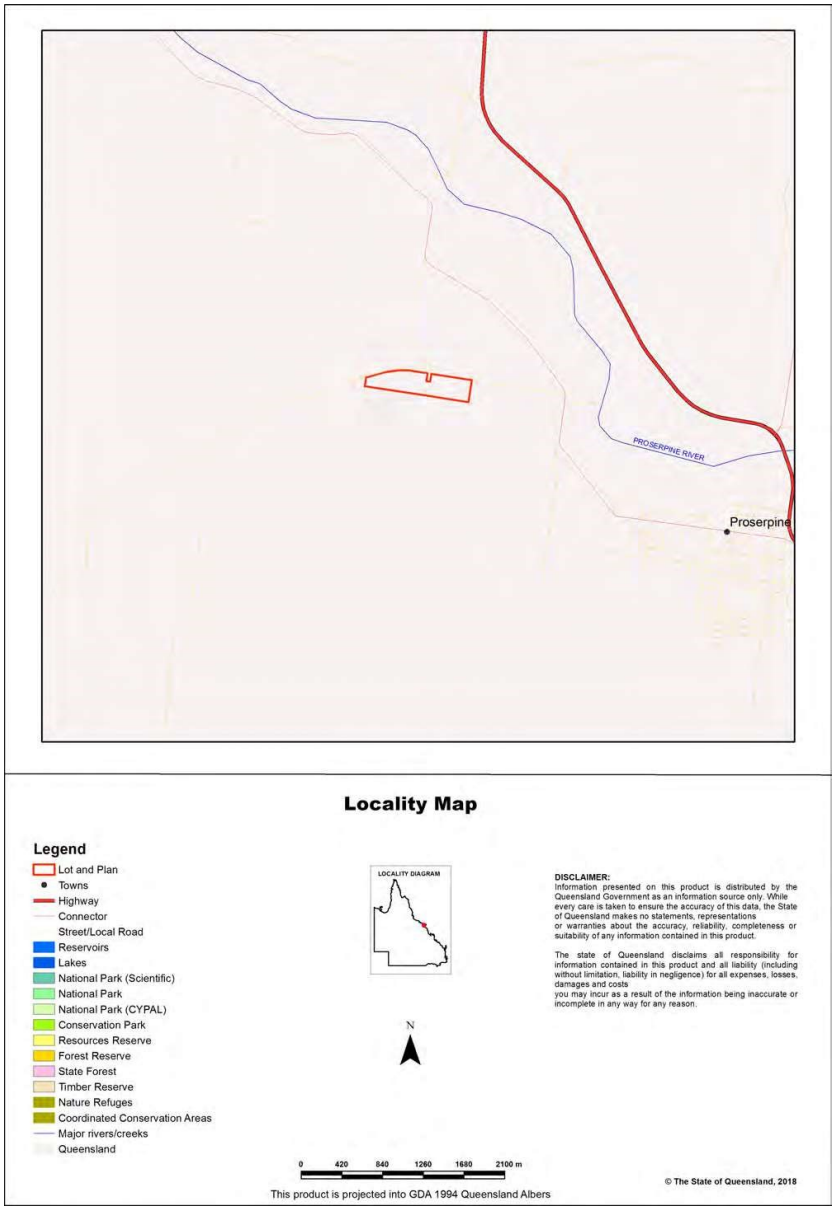
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Assessment Area Details

The following table provides an overview of the area of interest (AOI) with respect to selected topographic and environmental values.

Table 1: Summary table, details for AOI Lot: 277 Plan: SP113325

Size (ha)	22.23
Local Government(s)	Whitsunday Regional
Bioregion(s)	Central Queensland Coast
Subregion(s)	Proserpine - Sarina Lowlands
Catchment(s)	Proserpine



Matters of State Environmental Significance (MSES)

MSES Categories

Queensland's State Planning Policy (SPP) includes a biodiversity State interest that states:

'The sustainable, long-term conservation of biodiversity is supported. Significant impacts on matters of national or state environmental significance are avoided, or where this cannot be reasonably achieved; impacts are minimised and residual impacts offset.'

The MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

The SPP defines matters of state environmental significance as:

- Protected areas (including all classes of protected area except coordinated conservation areas) under the *Nature Conservation Act 1992* ;

- Marine parks and land within a 'marine national park', 'conservation park', 'scientific research', 'preservation' or 'buffer' zone under the *Marine Parks Act 2004* ;

- Areas within declared fish habitat areas that are management A areas or management B areas under the Fisheries Regulation 2008;

- Threatened wildlife under the *Nature Conservation Act 1992* and special least concern animals under the Nature Conservation (Wildlife) Regulation 2006;

- Regulated vegetation under the *Vegetation Management Act 1999* that is:

    • Category B areas on the regulated vegetation management map, that are 'endangered' or 'of concern' regional ecosystems;

    • Category C areas on the regulated vegetation management map that are 'endangered' or 'of concern' regional ecosystems;

    • Category R areas on the regulated vegetation management map;

    • Regional ecosystems that intersect with watercourses identified on the vegetation management watercourse and drainage feature map;

    • Regional ecosystems that intersect with wetlands identified on the vegetation management wetlands map;

- Strategic Environmental Areas under the *Regional Planning Interests Act 2014* ;

- Wetlands in a wetland protection area of wetlands of high ecological significance shown on the Map of Referable Wetlands under the Environmental Protection Regulation 2008;

- Wetlands and watercourses in high ecological value waters defined in the Environmental Protection (Water) Policy 2009, schedule 2;

- Legally secured offset areas.

MSES Values Present

The MSES values that are present in the area of interest are summarised in the table below:

Table 2: Summary of MSES present within the AOI

1a Protected Areas- estates	0.0 ha	0.0 %
1b Protected Areas- nature refuges	0.0 ha	0.0 %
2 State Marine Parks- highly protected zones	0.0 ha	0.0 %
3 Fish habitat areas (A and B areas)	0.0 ha	0.0 %
4 Strategic Environmental Areas (SEA)	0.0 ha	0.0 %
5 High Ecological Significance wetlands on the map of Referable Wetlands	0.0 ha	0.0 %
6a High Ecological Value (HEV) wetlands	0.0 ha	0.0 %
6b High Ecological Value (HEV) waterways **	0.0 km	Not applicable
7 Threatened species and Iconic species	0.0 ha	0.0 %
8a Regulated Vegetation - Endangered/Of concern in Category B (remnant)	0.0 ha	0.0 %
8b Regulated Vegetation - Endangered/Of concern in Category C (regrowth)	0.0 ha	0.0 %
8c Regulated Vegetation - Category R (GBR riverine regrowth)	1.69 ha	7.6%
8d Regulated Vegetation - Essential habitat	0.0 ha	0.0 %
8e Regulated Vegetation - intersecting a watercourse **	0.2 km	Not applicable
8f Regulated Vegetation - within 100m of a Vegetation Management Wetland	0.0 ha	0.0 %
9a Legally secured offset areas- offset register areas	0.0 ha	0.0 %
9b Legally secured offset areas- vegetation offsets through a Property Map of Assessable Vegetation	0.0 ha	0.0 %

Additional Information with Respect to MSES Values Present

MSES - State Conservation Areas

1a. Protected Areas - estates

(no results)

1b. Protected Areas - nature refuges

(no results)

2. State Marine Parks - highly protected zones

(no results)

3. Fish habitat areas (A and B areas)

(no results)

Refer to **Map 1 - MSES - State Conservation Areas** for an overview of the relevant MSES.

MSES - Wetlands and Waterways

4. Strategic Environmental Areas (SEA)

(no results)

5. High Ecological Significance wetlands on the Map of Referable Wetlands

(no results)

6a. High Ecological Value (HEV) waters - wetlands

(no results)

6b. High Ecological Value (HEV) waters - waterways

(no results)

Refer to **Map 2 - MSES - Wetlands and Waterways** for an overview of the relevant MSES.

MSES - Species

7. Threatened wildlife and special least concern animal

(no results)

Threatened and special least concern species records

(no results)

Note: The Threatened and Special Least Concern Animal (7) layer originates from the previous MSES version (4.1, dated at 2014). The layer does not represent all currently listed species and is subject to review.

**Nature Conservation Act 1992 (NCA) Status- Endangered (E), Vulnerable (V) or Special Least Concern Animal (SL). Environment Protection and Biodiversity Conservation Act 1999 (EPBC) status: Critically Endangered (CE) Endangered (E), Vulnerable (V)*

To request a species list for an area, or search for a species profile, access Wildlife Online at:
https://www.qld.gov.au/environment/plants-animals/species-list/

Refer to **Map 3 - MSES - Species** for an overview of the relevant MSES.

MSES - Regulated Vegetation

8a. Regulated Vegetation - Endangered/Of concern in Category B (remnant)

Not applicable

8b. Regulated Vegetation - Endangered/Of concern in Category C (regrowth)

Not applicable

For further information relating to regional ecosystems in general, go to:
https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/
For a more detailed description of a particular regional ecosystem, access the regional ecosystem search page at:
https://environment.ehp.qld.gov.au/regional-ecosystems/

8c. Regulated Vegetation - Category R (GBR riverine regrowth)

Regulated vegetation map category	Map number	RVM rule
R	8657	4

8d. Regulated Vegetation - Essential habitat

Not applicable

8e. Regulated Vegetation - intersecting a watercourse**

A vegetation management watercourse is mapped as present

8f. Regulated Vegetation - within 100m of a Vegetation Management wetland

Not applicable

Refer to **Map 4 - MSES - Regulated Vegetation** for an overview of the relevant MSES.

MSES - Offsets

9a. Legally secured offset areas - offset register areas

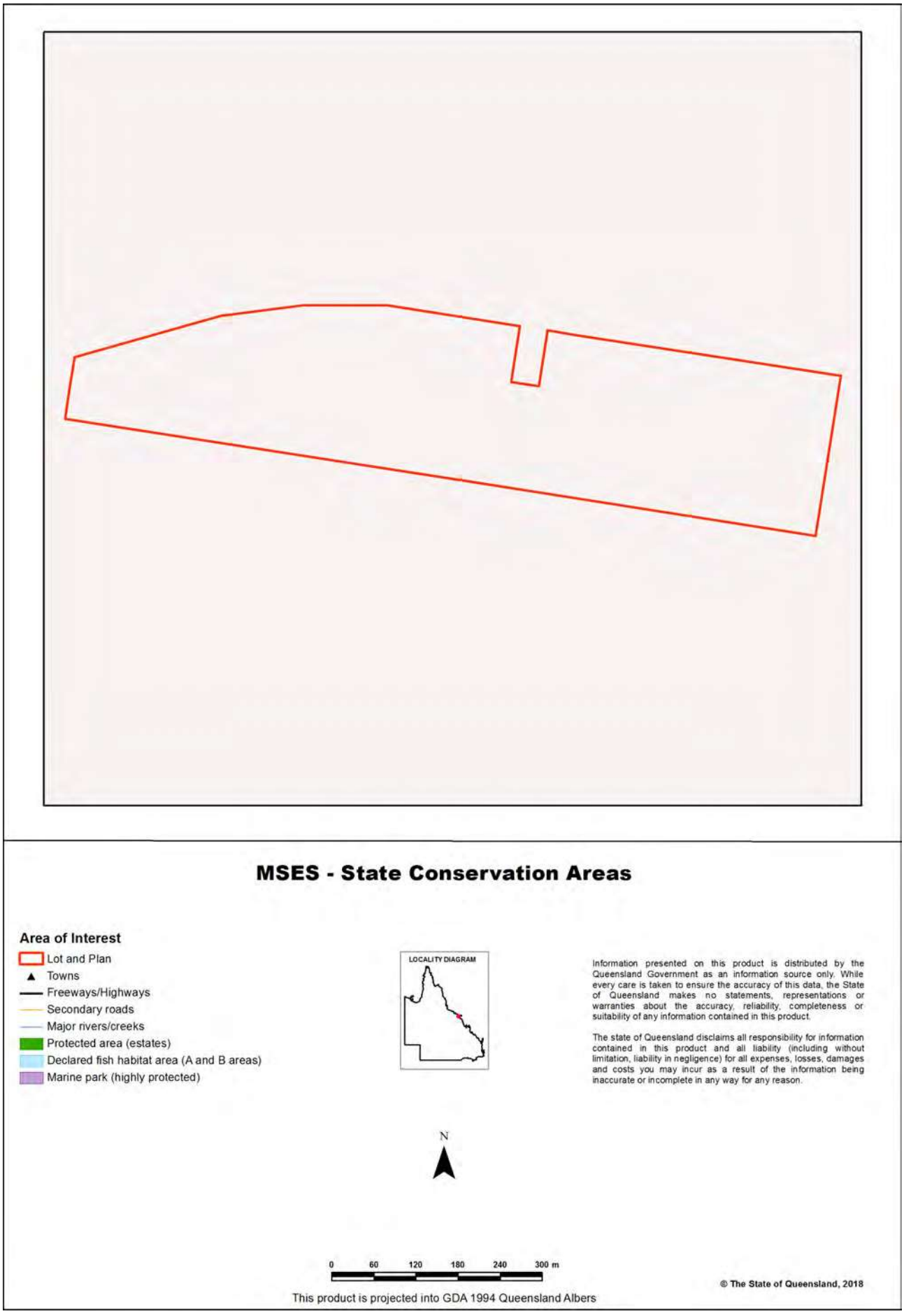
(no results)

9b. Legally secured offset areas - vegetation offsets through a Property Map of Assessable Vegetation

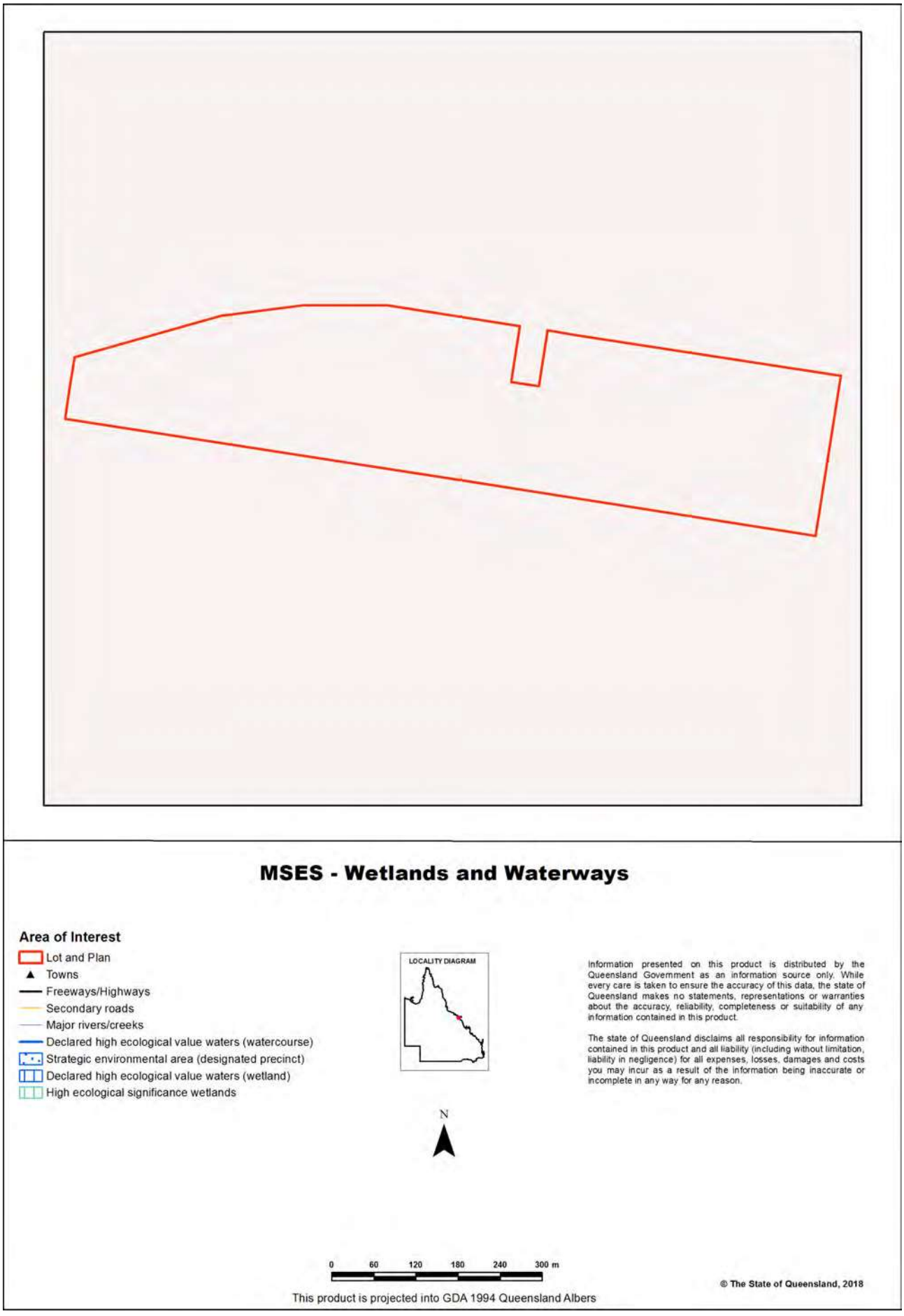
(no results)

Refer to **Map 5 - MSES - Offset Areas** for an overview of the relevant MSES.

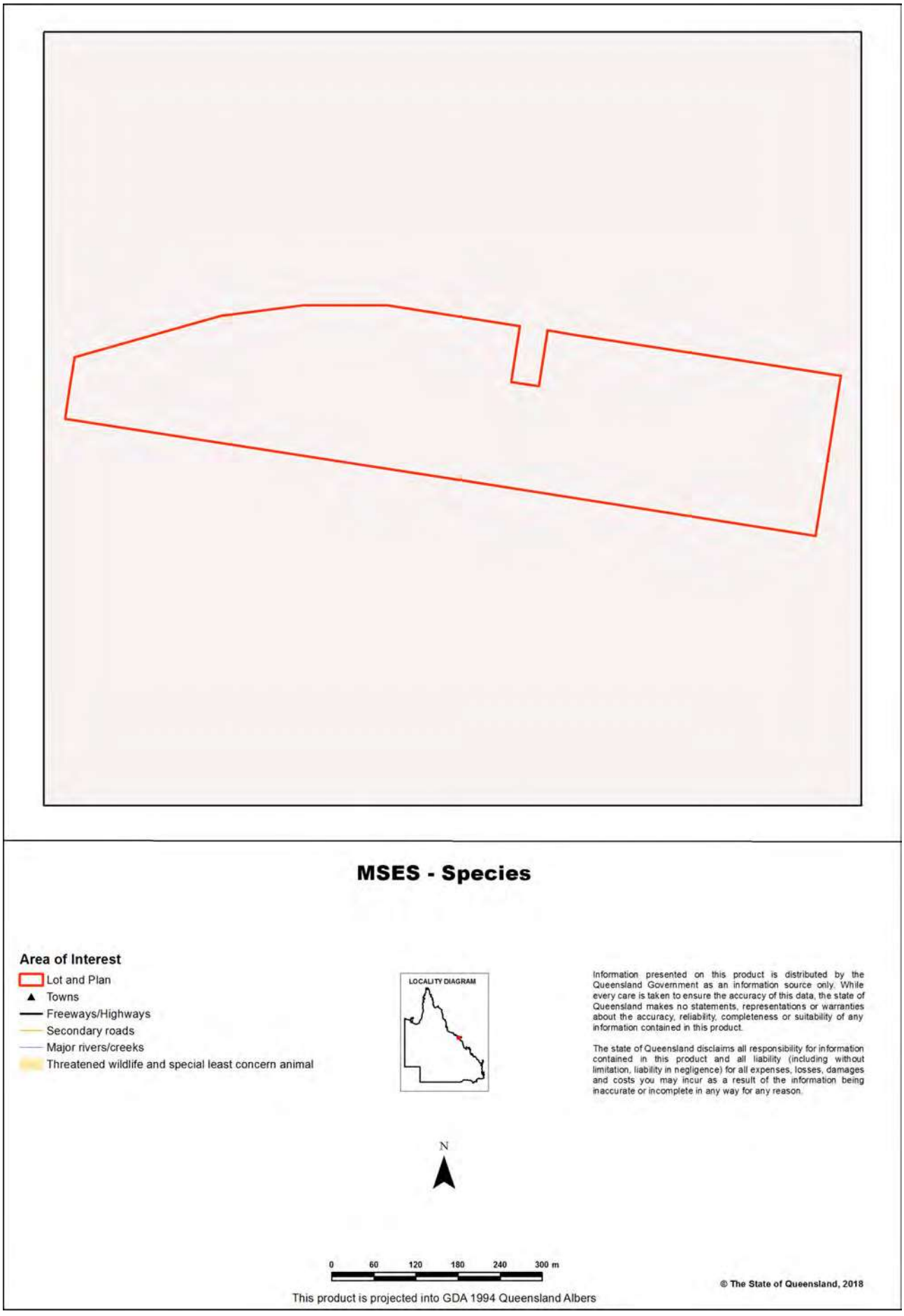
Map 1 - MSES - State Conservation Areas



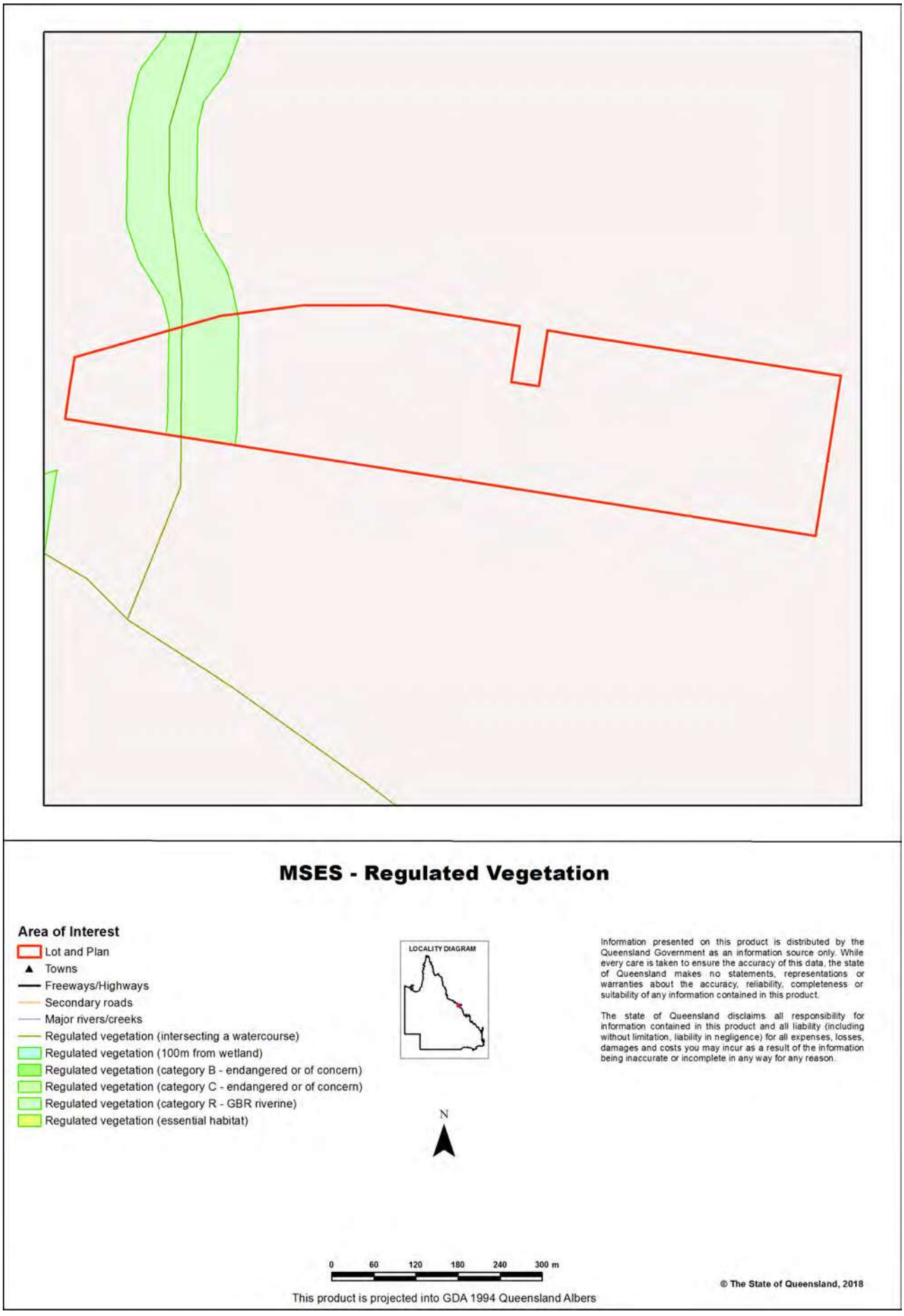
Map 2 - MSES - Wetlands and Waterways



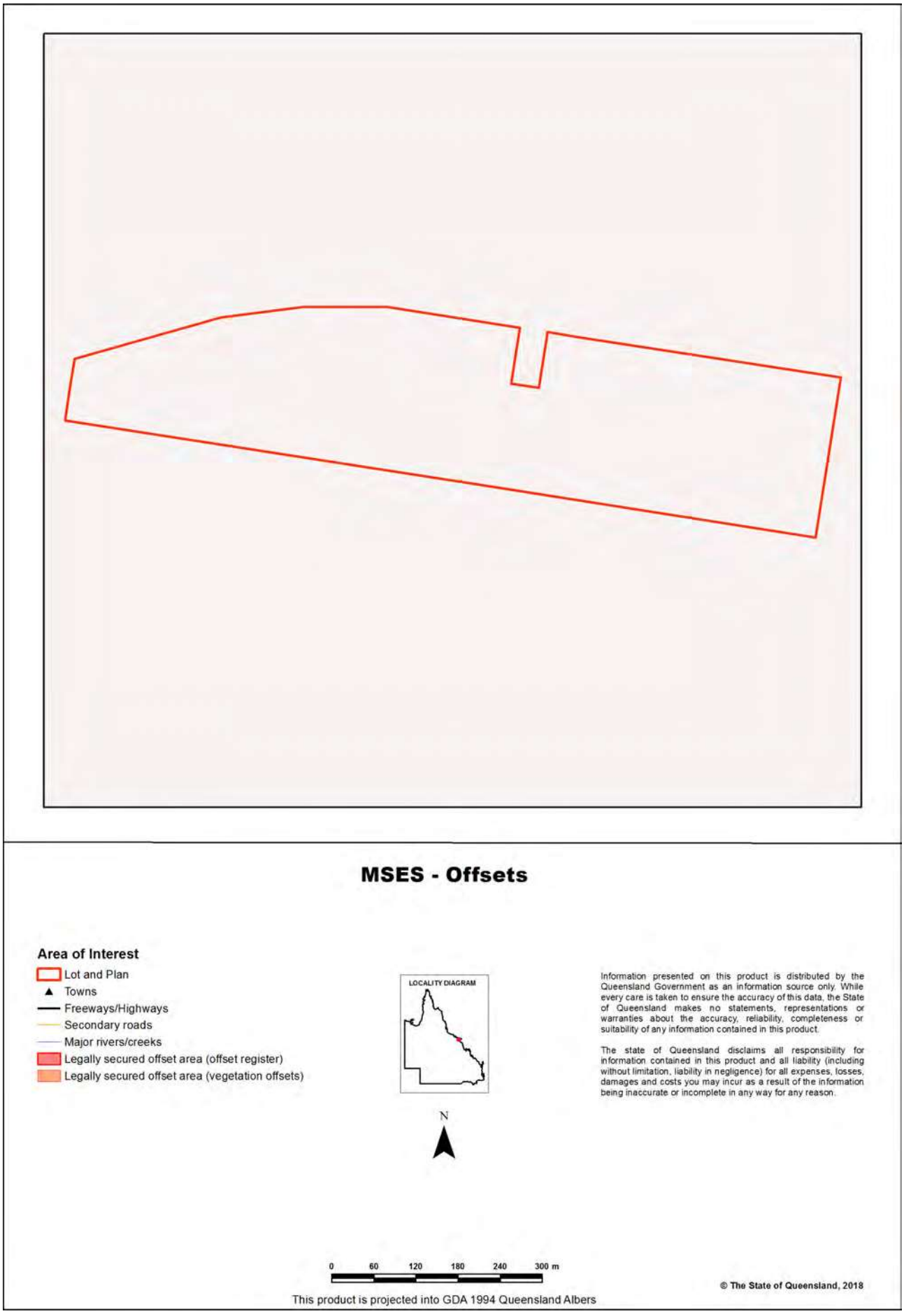
Map 3 - MSES - Species



Map 4 - MSES - Regulated Vegetation



Map 5 - MSES - Offset Areas



Appendices

Appendix 1 - Matters of State Environmental Significance (MSES) methodology

MSES mapping is a regional-scale representation of the definition for MSES under the State Planning Policy (SPP). The compiled MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

The Queensland Government's "Method for mapping - matters of state environmental significance for use in land use planning and development assessment" can be downloaded from:

http://www.ehp.qld.gov.au/land/natural-resource/method-mapping-mses.html .

Appendix 2 - Source Data

The datasets listed below are available on request from:

http://qldspatial.information.qld.gov.au/catalogue/custom/index.page

- Matters of State environmental significance

Note: MSES mapping is not based on new or unique data. The primary mapping product draws data from a number of underlying environment databases and geo-referenced information sources. MSES mapping is a versioned product that is updated generally on a twice-yearly basis to incorporate the changes to underlying data sources. Several components of MSES mapping made for the current version may differ from the current underlying data sources. To ensure accuracy, or proper representation of MSES values, it is strongly recommended that users refer to the underlying data sources and review the current definition of MSES in the State Planning Policy, before applying the MSES mapping.

Individual MSES layers can be attributed to the following source data available at QSpatial:

MSES layers	**current QSpatial data (http://qspatial.ingormation.qld.gov.au)**
Protected Areas-Estates and Nature Refuges	- Protected areas of Queensland - Nature Refuges - Queensland
Marine Park-Highly Protected Zones	Moreton Bay marine park zoning 2008
Fish Habitat Areas	Queensland fish habitat areas
Strategic Environmental Areas-designated	Regional Planning Interests Act - Strategic Environmental Areas
HES wetlands	Map of Referable Wetland - wetland layers: - Wetland management area wetlands - Wetland protection area wetlands
wetlands in HEV waters	HEV waters: - EPP Water (multiple locations) intent for waters Source Wetlands: - Queensland Wetland Mapping (Current version 4, 2015) Source Watercourses: - Vegetation management watercourse and drainage feature map (1:100000 and 1:250000) - latest version 1.4
Wildlife habitat (threatened and special least concern)	-WildNet database species records - habitat suitability models (various)
VMA regulated regional ecosystems	Vegetation management regional ecosystem and remnant map - latest version 8.0
VMA Essential Habitat	Vegetation management - essential habitat map - latest version 4.41
VMA Wetlands	Vegetation management wetlands map - latest version 2.41
Legally secured offsets	Vegetation Management Act property maps of assessable vegetation. For offset register data-contact DES
Regulated Vegetation Map	Vegetation management - regulated vegetation management map - latest version 1.41

Appendix 3 - Acronyms and Abbreviations

AOI	- Area of Interest
DES	- Department of Environment and Science
EP Act	- *Environmental Protection Act 1994*
EPP	- Environmental Protection Policy
GDA94	- Geocentric Datum of Australia 1994
GEM	- General Environmental Matters
GIS	- Geographic Information System
MSES	- Matters of State Environmental Significance
NCA	- *Nature Conservation Act 1992*
RE	- Regional Ecosystem
SPP	- State Planning Policy
VMA	- *Vegetation Management Act 1999*

Queensland Government

Department of Environment and Science

Environmental Reports

Regional Ecosystems

Biodiversity Status

For the selected area of interest
Lot: 277 Plan: SP113325

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the input coordinates.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no matters of interest have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Important Note to User

Information presented in this report is based upon the Queensland Herbarium's Regional Ecosystem framework. The Biodiversity Status has been used to depict the extent of "Endangered", "Of Concern" and "No Concern at Present" regional ecosystems in all cases, rather than the classes used for the purposes of the *Vegetation Management Act 1999* (VMA). Mapping and figures presented in this document reflect the Queensland Herbarium's Remnant and Pre-clearing Regional Ecosystem Datasets, and not the certified mapping used for the purpose of the VMA.

For matters relevant to vegetation management under the VMA, please refer to the Department of Natural Resources, Mines and Energy website

https://www.dnrme.qld.gov.au/

Please direct queries about these reports to: Queensland.Herbarium@dsiti.qld.gov.au

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness, or suitability, for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which the user may incur as a consequence of the information being inaccurate or incomplete in any way and for any reason.



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Summary Information

The following table provides an overview of the AOI with respect to selected topographic and environmental themes. Refer to **Map 1** for locality information.

Table 1: Area of interest details: Lot: 277 Plan: SP113325

Size (ha)	22.23
Local Government(s)	Whitsunday Regional
Bioregion(s)	Central Queensland Coast
Subregion(s)	Proserpine - Sarina Lowlands
Catchment(s)	Proserpine

The table below summarizes the extent of remnant vegetation classed as "Endangered", "Of concern" and "No concern at present" regional ecosystems classified by Biodiversity Status within the area of interest (AOI).

Table 2: Summary table, biodiversity status of regional ecosystems within the AOI

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	0.0	0.0
No concern at present	0.0	0.0
Total remnant vegetation	0.0	0.0

Refer to **Map 2** for further information.

Regional Ecosystems

1. Introduction

Regional ecosystems are vegetation communities in a bioregion that are consistently associated with particular combinations of geology, landform and soil (Sattler and Williams 1999). Descriptions of Queensland's Regional ecosystems are available online from the Regional Ecosystem Description Database (REDD). Descriptions are compiled from a broad range of information sources including vegetation, land system and geology survey and mapping and detailed vegetation site data. The regional ecosystem classification and descriptions are reviewed as new information becomes available. A number of vegetation communities may form a single regional ecosystem and are usually distinguished by differences in dominant species, frequently in the shrub or ground layers and are denoted by a letter following the regional ecosystem code (e.g. a, b, c). Vegetation communities and regional ecosystems are amalgamated into a higher level classification of broad vegetation groups (BVGs).

A published methodology for survey and mapping of regional ecosystems across Queensland (Neldner et al 2017) provides further details on regional ecosystem concepts and terminology.

This report provides information on the type, status, and extent of vegetation communities, regional ecosystems and broad vegetation groups present within a user specified area of interest. Please note, for the purpose of this report, the Biodiversity Status is used. This report has not been developed for application of the *Vegetation Management Act 1999* (VMA). Additionally, information generated in this report has been derived from the Queensland Herbarium's Regional Ecosystem Mapping, and not the regulated mapping certified for the purposes of the VMA. If your interest/matter relates to regional ecosystems and the VMA, users should refer to the Department of Natural Resources, Mines and Energy website.

https://www.dnrme.qld.gov.au/

With respect to the Queensland Biodiversity Status,

"Endangered" regional ecosystems are described as those where:

- remnant vegetation is less than 10 per cent of its pre-clearing extent across the bioregion; or 10-30% of its pre-clearing extent remains and the remnant vegetation is less than 10,000 hectares, or
- less than 10 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss*, or
- 10-30 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 hectares; or
- it is a rare** regional ecosystem subject to a threatening process.***

"Of concern" regional ecosystems are described as those where:

- the degradation criteria listed above for 'Endangered' regional ecosystems are not met and,
- remnant vegetation is 10-30 per cent of its pre-clearing extent across the bioregion; or more than 20 per cent of its pre-clearing extent remains and the remnant extent is less than 10,000 hectares, or
- 10-30 percent of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss.****

and "No concern at present" regional ecosystems are described as those where:

- remnant vegetation is over 30 per cent of its pre-clearing extent across the bioregion, and the remnant area is greater than 10,000 hectares, and
- the degradation criteria listed above for 'Endangered' or 'Of concern' regional ecosystems are not met.

**Severe degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 50 years even with the removal of threatening processes; or soil surface is severely degraded, for example, by loss of A horizon, surface expression of salinity; surface compaction, loss of organic matter or sheet erosion.*

***Rare regional ecosystem: pre-clearing extent (1000 ha); or patch size (100 ha and of limited total extent across its range).*

****Threatening processes are those that are reducing or will reduce the biodiversity and ecological integrity of a regional ecosystem. For example, clearing, weed invasion, fragmentation, inappropriate fire regime or grazing pressure, or infrastructure development.*

*****Moderate degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 20 years even with the removal of threatening processes; or soil surface is moderately degraded.*

2. Remnant Regional Ecosystems

The following table identifies the remnant regional ecosystems and vegetation communities mapped within the AOI and provides their short descriptions, Biodiversity Status, and remnant extent within the selected AOI. Please note, where heterogeneous vegetated patches (mixed patches of remnant vegetation mapped as containing multiple regional ecosystems) occur within the AOI, they have been split and listed as individual regional ecosystems (or vegetation communities where present) for the purposes of the table below. In such instances, associated area figures have been generated based upon the estimated proportion of each regional ecosystem (or vegetation community) predicted to be present within the larger mixed patch.

Table 3: Remnant regional ecosystems, description and status within the AOI

Regional Ecosystem	Short Description	BD Status	Area (Ha)	% of AOI
non-rem	None	None	22.23	99.99

Refer to **Map 2** for further information. **Map 3** also provides a visual estimate of the distribution of regional ecosystems present before clearing.

Table 4 provides further information in regards to the remnant regional ecosystems present within the SOI. Specifically, the extent of remnant vegetation remaining within the bioregion, the 1:1,000,000 broad vegetation group (BVG) classification, whether the regional ecosystem is identified as a wetland, and extent of representation in Queensland's Protected Area Estate. For a description of the vegetation communities within the AOI and classified according to the 1:1,000,000 BVG, refer to **Table 6**.

Table 4: Remnant regional ecosystems within the AOI, additional information

Regional Ecosystem	Remnant Extent	BVG (1 Million)	Wetland	Representation in protected estate
non-rem	None	None	None	None

Representation in Protected Area Estate: High greater than 10% of pre-clearing extent is represented; Medium 4 - 10% is represented; Low less than 4% is represented, No representation.

The distribution of mapped wetland systems within the area of interest is displayed in **Map 6**.

The following table lists known special values associated with a regional ecosystem type.

Table 5: Remnant regional ecosystems within the AOI, special values

Regional Ecosystem	Special Values
non-rem	None

3. Remnant Regional Ecosystems by Broad Vegetation Group

BVGs are a higher-level grouping of vegetation communities. Queensland encompasses a wide variety of landscapes across temperate, wet and dry tropics and semi-arid climatic zones. BVGs provide an overview of vegetation communities across the state or a bioregion and allow comparison with other states. There are three levels of BVGs which reflect the approximate scale at which they are designed to be used: the 1:5,000,000 (national), 1:2,000,000 (state) and 1:1,000,000 (regional) scales.

A comprehensive description of BVGs is available at:

https://publications.qld.gov.au/dataset/redd/resource/

The following table provides a description of the 1:1,000,000 BVGs present and their associated extent within the AOI.

Table 6: Broad vegetation groups (1 million) within the AOI

BVG (1 Million)	Description	Area (Ha)	% of AOI
None	None	22.23	99.99

Refer to **Map 4** for further information. **Map 5** also provides a representation of the distribution of vegetation communities as per the 1:5,000,000 BVG believed to be present prior to European settlement.

4. Technical and BioCondition Benchmark Descriptions

Technical descriptions provide a detailed description of the full range in structure and floristic composition of regional ecosystems (e.g. 11.3.1) and their component vegetation communities (e.g. 11.3.1a, 11.3.1b). See:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

The descriptions are compiled using site survey data from the Queensland Herbarium's CORVEG database. Distribution maps, representative images (if available) and the pre-clearing and remnant extent (hectares) of each vegetation community derived from the regional ecosystem mapping data are included. The technical descriptions should be used in conjunction with the fields from the regional ecosystem description database (REDD) for a full description of the regional ecosystem.

Technical descriptions include data on canopy height, canopy cover and native plant species composition of the predominant layer, which are attributes relevant to assessment of the remnant status of vegetation under the *Vegetation Management Act 1999*. However, as technical descriptions reflect the full range in structure and floristic composition across the climatic, natural disturbance and geographic range of the regional ecosystem, local reference sites should be used for remnant assessment where possible (Neldner et al. 2012 (PDF)* section 3.3.1 of:

https://publications.qld.gov.au/dataset/redd/resource/

The technical descriptions are subject to review and are updated as additional data becomes available.

When conducting a BioCondition assessment, these technical descriptions should be used in conjunction with BioCondition benchmarks for the specific regional ecosystem, or component vegetation community.

http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

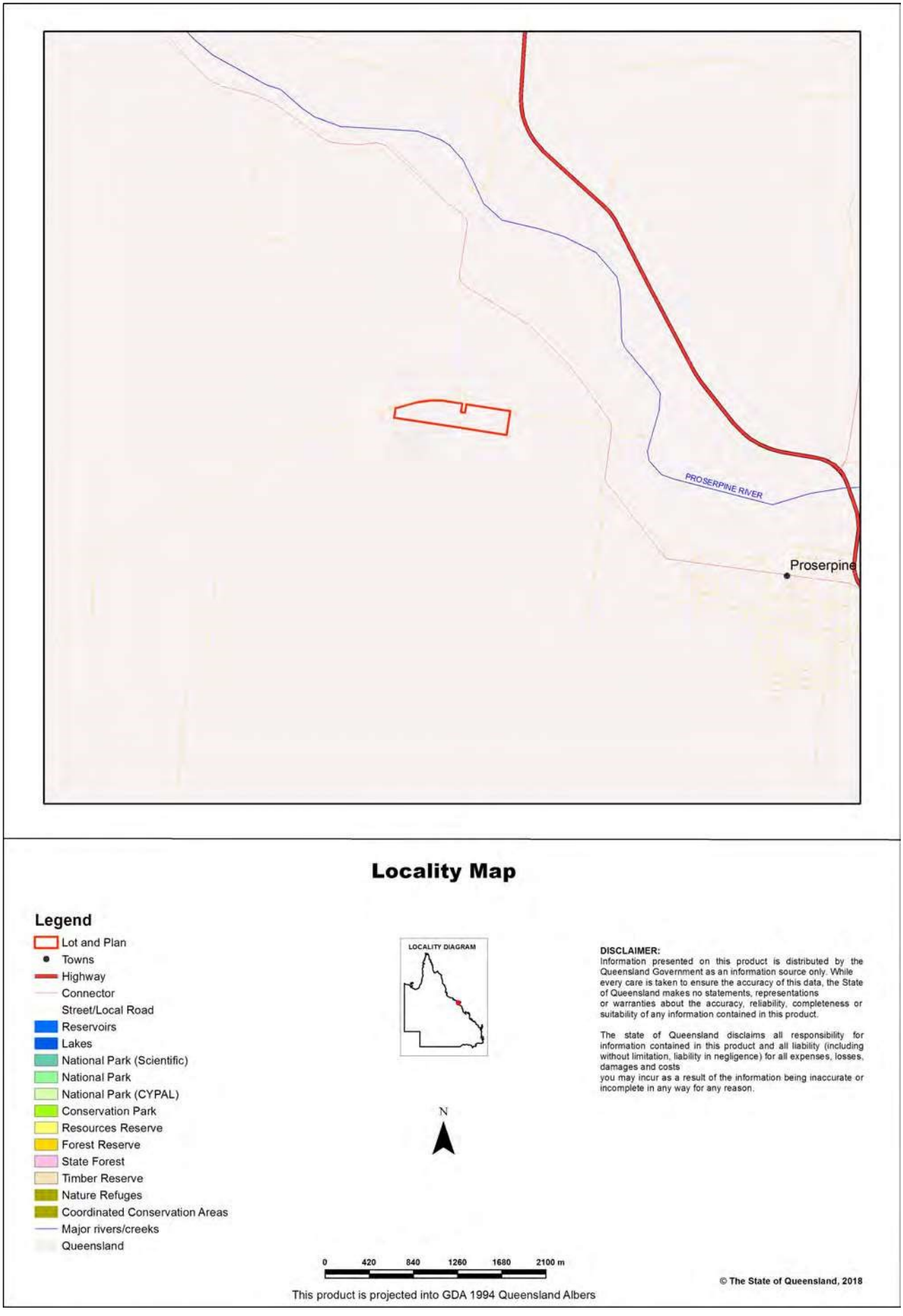
Benchmarks are based on a combination of quantitative and qualitative information and should be used as a guide only. Benchmarks are specific to one regional ecosystem vegetation community, however, the natural variability in structure and floristic composition under a range of climatic and natural disturbance regimes has been considered throughout the geographic extent of the regional ecosystem. Local reference sites should be used for this spatial and temporal (seasonal and annual) variability.

Table 7: List of remnant regional ecosystems within the AOI for which technical and biocondition benchmark descriptions are available

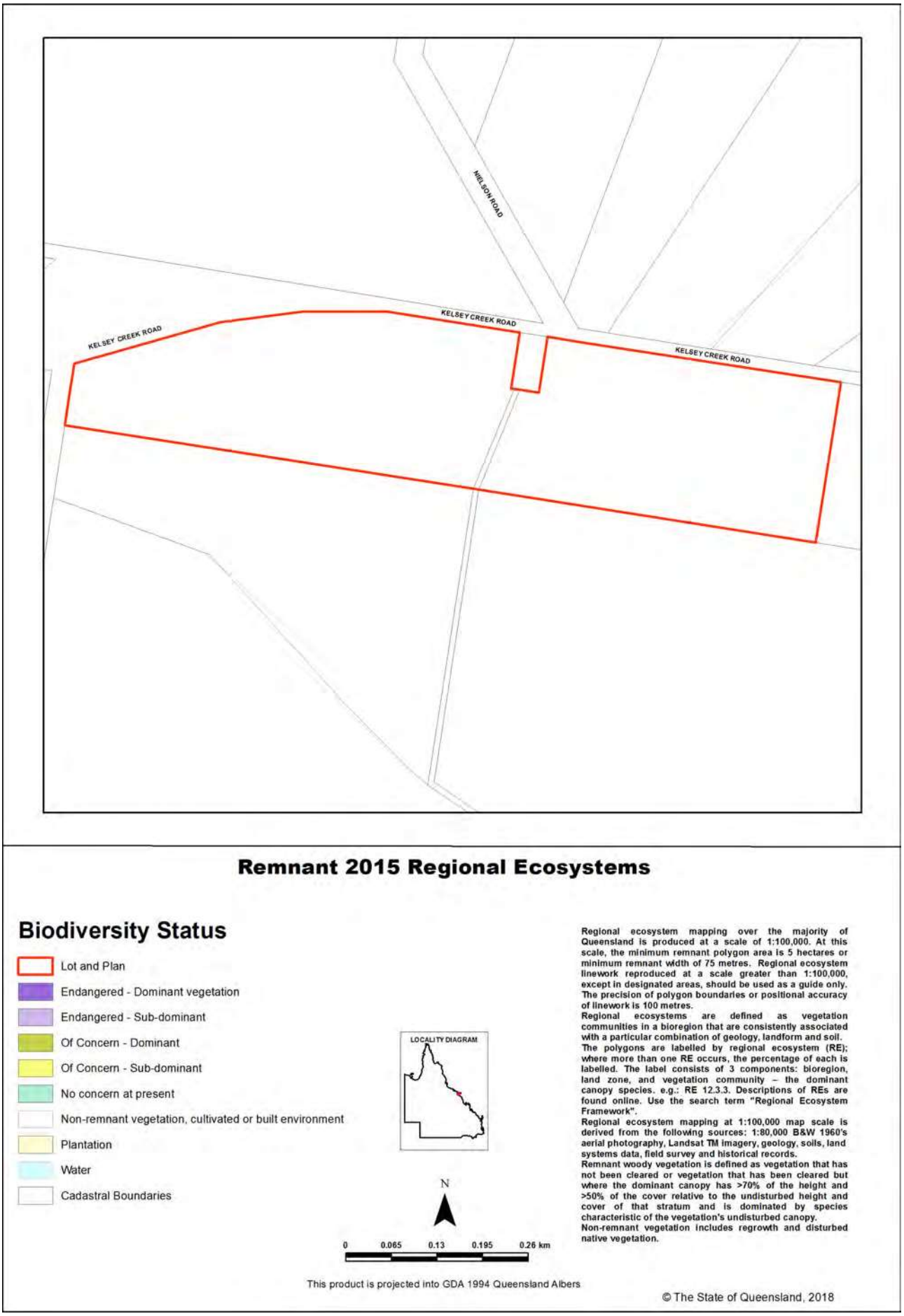
Regional ecosystems mapped as within the AOI	Technical Descriptions	Biocondition Benchmarks
non-rem	Not currently available	Not currently available

Maps

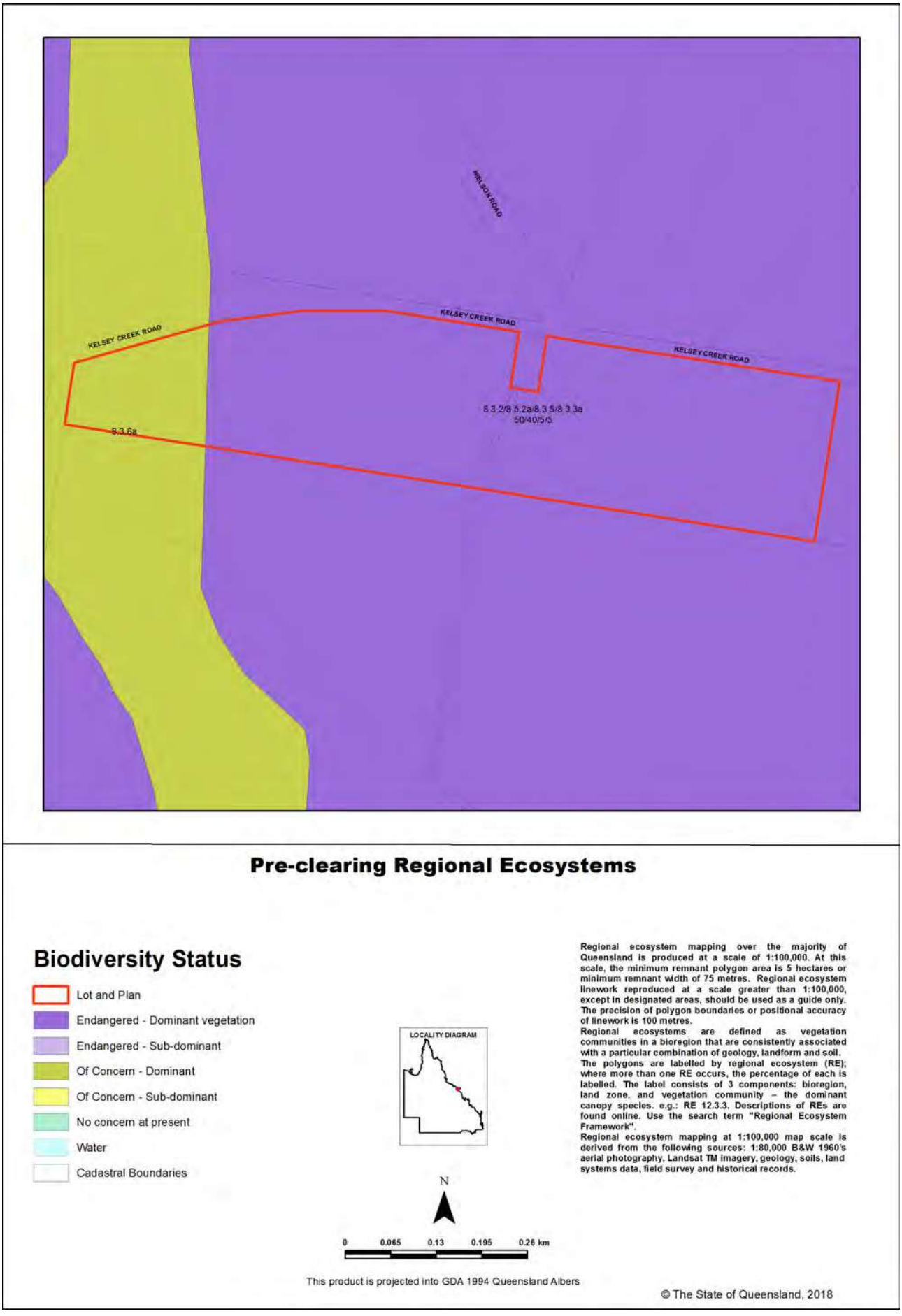
Map 1 - Location



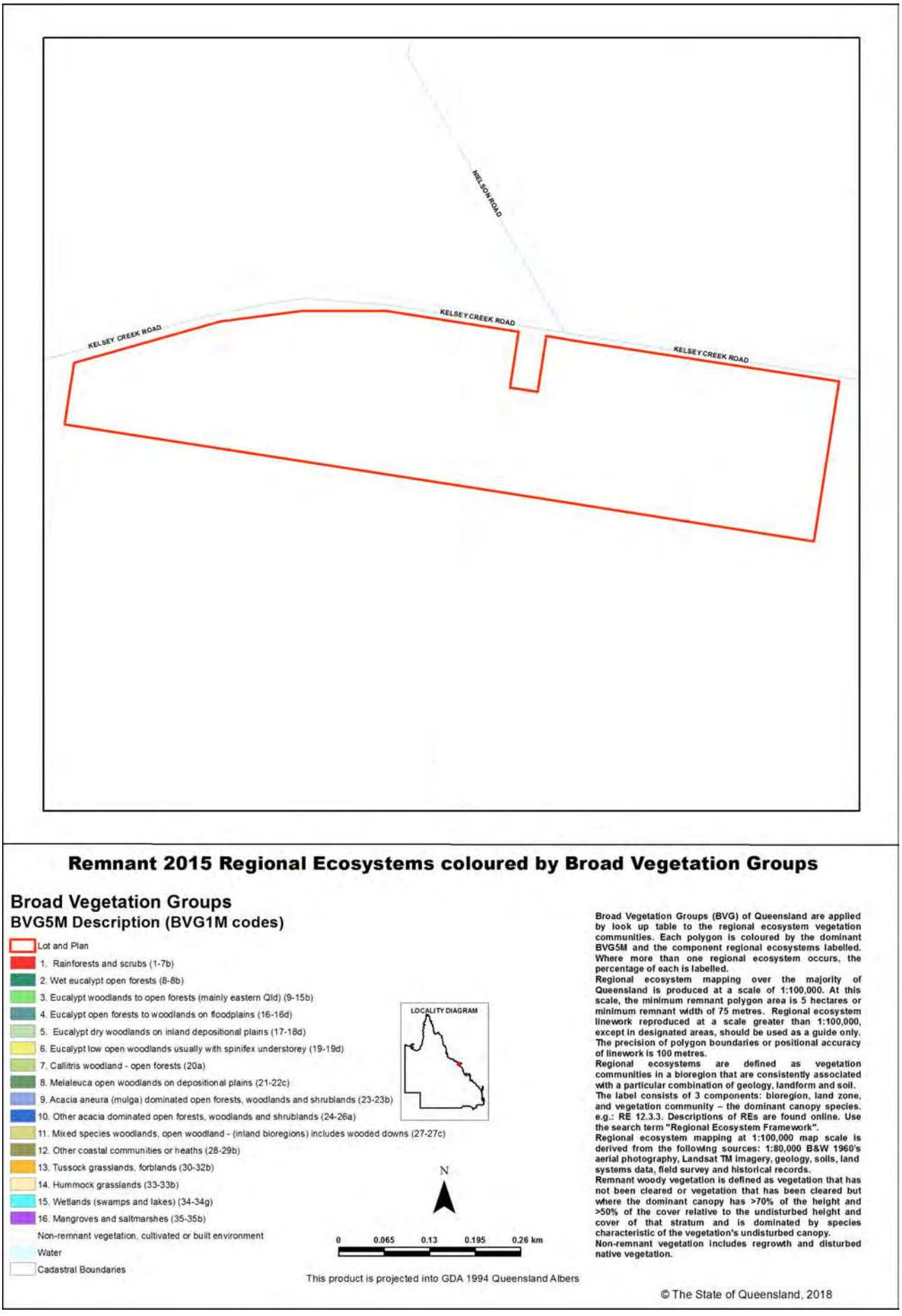
Map 2 - Remnant 2015 regional ecosystems



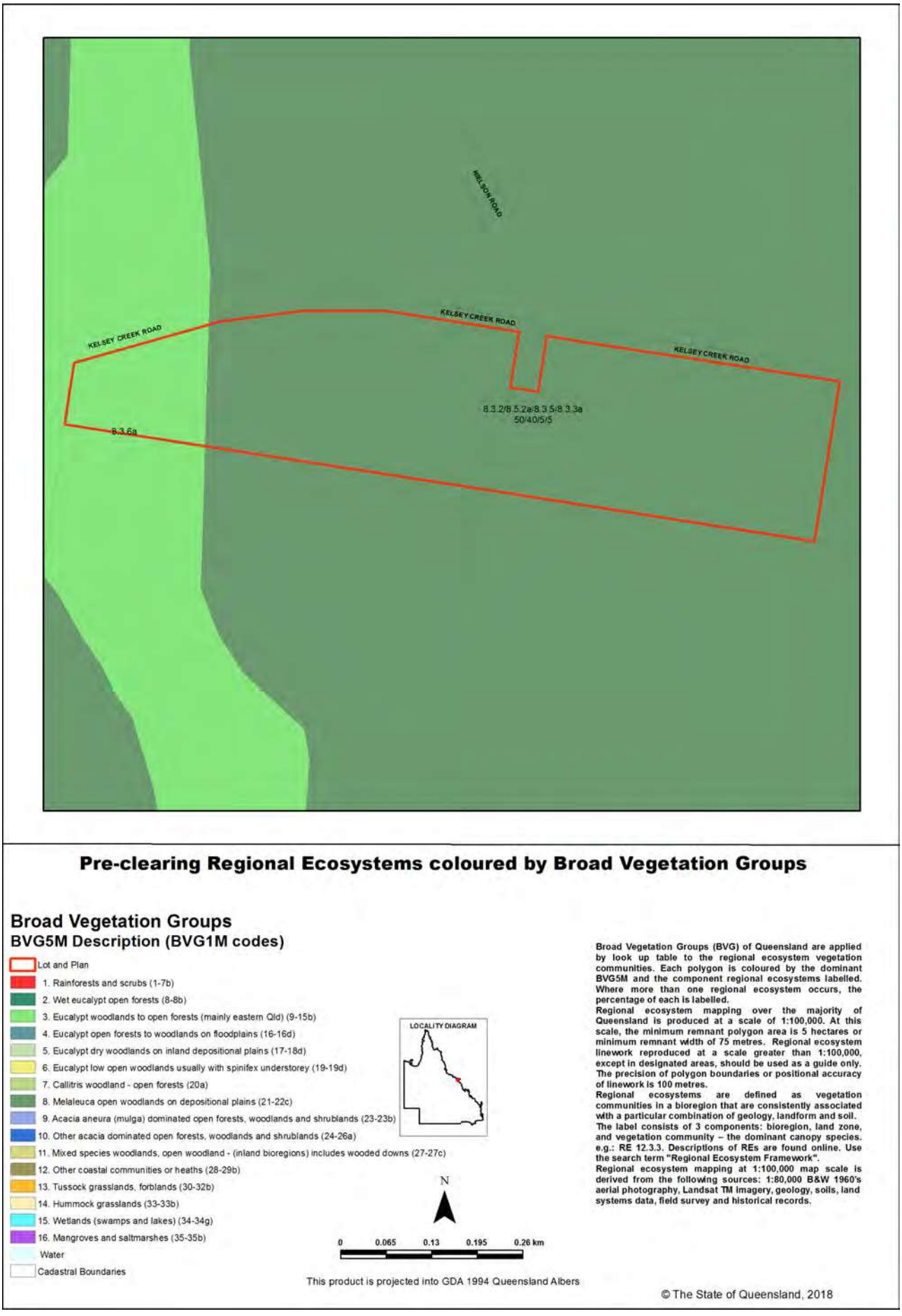
Map 3 - Pre-clearing regional ecosystems



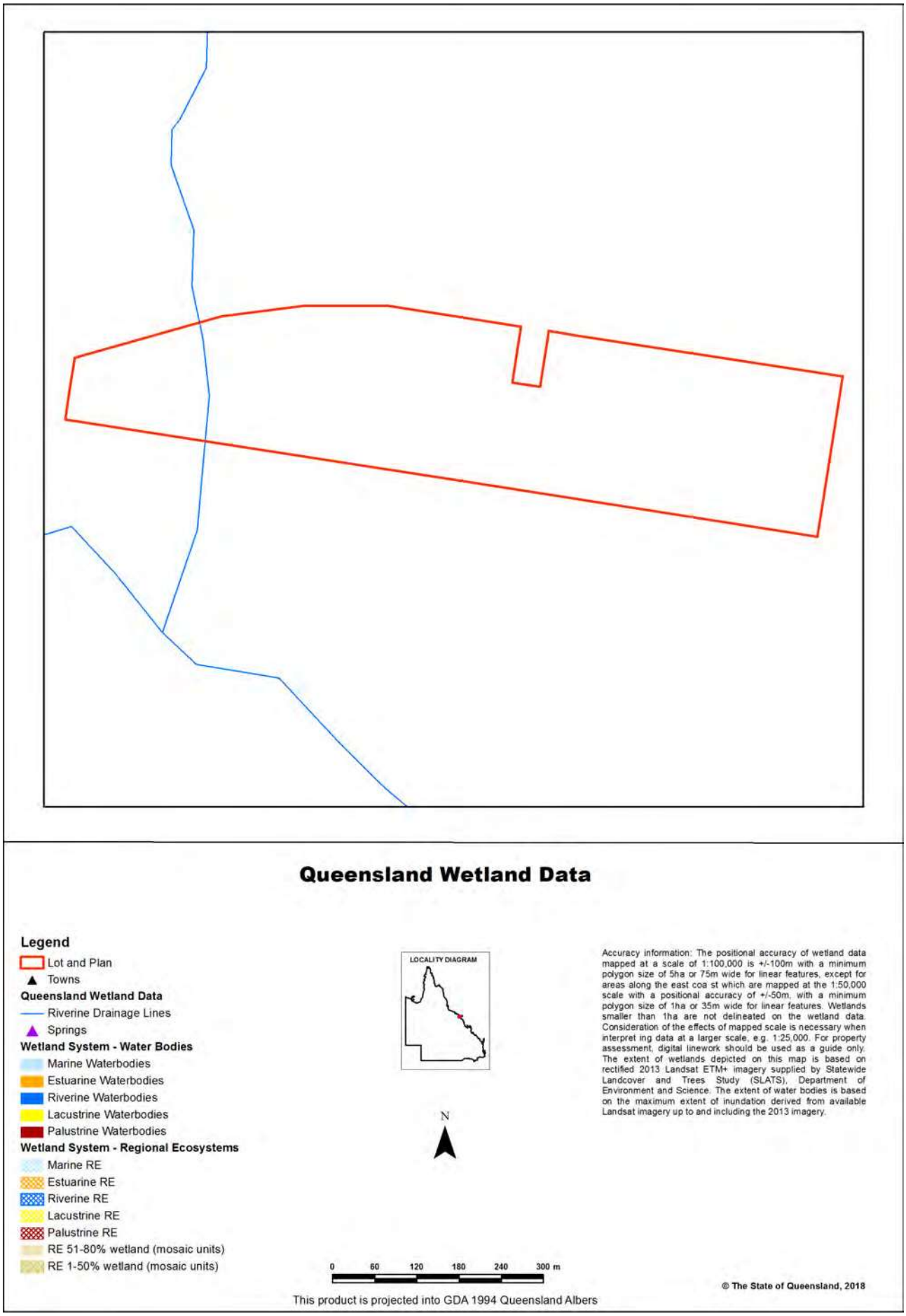
Map 4 - Remnant 2015 regional ecosystems by BVG (5M)



Map 5 - Pre-clearing regional ecosystems by BVG (5M)



Map 6 - Wetlands and waterways



Links and Other Information Sources

The Department of Environment and Science's Website -

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/

provides further information on the regional ecosystem framework, including access to links to the Regional Ecosystem Database, Broad Vegetation Group Definitions, Regional Ecosystem and Land zone descriptions.

Descriptions of the broad vegetation groups of Queensland can be downloaded from:

https://publications.qld.gov.au/dataset/redd/resource/

The methodology for mapping regional ecosystems can be downloaded from:

https://publications.qld.gov.au/dataset/redd/resource/

Technical descriptions for regional ecosystems can be obtained from:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

Benchmarks can be obtained from:

http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

For further information associated with the remnant regional ecosystem dataset used by this report, refer to the metadata associated with the Biodiversity status of pre-clearing and Remnant Regional Ecosystems of Queensland dataset (version listed in **Appendix 1**) which is available through the Queensland Government Information System portal,

http://dds.information.qld.gov.au/dds/

The Queensland Globe is a mapping and data application. As an interactive online tool, Queensland Globe allows you to view and explore Queensland maps, imagery (including up-to-date satellite images) and other spatial data, including regional ecosystem mapping. To further view and explore regional ecosystems over an area of interest, access the Biota Globe (a component of the Queensland Globe). The Queensland Globe can be accessed via the following link:

http://www.dnrm.qld.gov.au/mapping-data/queensland-globe

References

Neldner, V.J., Niehus R.E., Wilson, B.A. McDonald, W.J.F., Ford, A.J. and Accad, A. (2017) The Vegetation of Queensland. Descriptions of Broad Vegetation Groups. Version 3.0. Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts.

(https://publications.qld.gov.au/dataset/redd/resource/78209e74-c7f2-4589-90c1-c33188359086)

Neldner, V.J., Wilson, B.A., Dillewaard, H.A., Ryan, T.S. and Butler, D.W. (2017) *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland*. Version 4.0. Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts.

(https://publications.qld.gov.au/dataset/redd/resource/6dee78ab-c12c-4692-9842-b7257c2511e4)

Sattler, P.S. and Williams, R.D. (eds) (1999). *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency, Brisbane.

Appendices

Appendix 1 - Source Data

The dataset listed below is available for download from:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/download/

- Regional Ecosystem Description Database

The datasets listed below are available for download from:

http://dds.information.qld.gov.au/dds/

- Biodiversity status of pre-clearing and 2015 remnant regional ecosystems of Queensland
- Pre-clearing Vegetation Communities and Regional Ecosystems of Queensland
- Queensland Wetland Data Version - Wetland lines
- Queensland Wetland Data Version - Wetland points
- Queensland Wetland Data Version - Wetland areas

Appendix 2 - Acronyms and Abbreviations

AOI	- Area of Interest
GDA94	- Geocentric Datum of Australia 1994
GIS	- Geographic Information System
RE	- Regional Ecosystem
REDD	- Regional Ecosystem Description Database
VMA	- *Vegetation Management Act 1999*

Queensland Government

Department of Environment and Science

Environmental Reports

Biodiversity and Conservation Values

Biodiversity Planning Assessments and Aquatic Conservation Assessments

For the selected area of interest
Lot: 277 Plan: SP113325

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or Area of Interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "Central co-ordinates" option, the resulting assessment area encompasses an area extending from 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Please direct queries about these reports to: biodiversity.planning@des.qld.gov.au

Disclaimer

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Summary Information

Tables 1 to 8 provide an overview of the AOI with respect to selected topographic and environmental values.

Table 1: Area of interest details: Lot: 277 Plan: SP113325

Size (ha)	22.23
Local Government(s)	Whitsunday Regional
Bioregion(s)	Central Queensland Coast
Subregion(s)	Proserpine - Sarina Lowlands
Catchment(s)	Proserpine

The following table identifies available Biodiversity Planning Assessments (BPAs) and Aquatic Conservation Assessments (ACAs) with respect to the AOI.

Table 2: Available Biodiversity Planning and Aquatic Conservation Assessments

Assessment Type	Assessment Area and Version
Biodiversity Planning Assessment(s)	Central Queensland Coast v1.3
Aquatic Conservation Assessment(s) (riverine)	Great Barrier Reef Catchments v1.3
Aquatic Conservation Assessment(s) (non-riverine)	Great Barrier Reef Catchments v1.3

Table 3: Remnant regional ecosystems within the AOI as per the Qld Herbarium's 'biodiversity status'

Biodiversity Status	Area (Ha)	% of AOI
Endangered	0.0	0.0
Of concern	0.0	0.0
No concern at present	0.0	0.0

The following table identifies the extent and proportion of the user specified area of interest (AOI) which is mapped as being of "State", "Regional" or "Local" significance via application of the Queensland Department of Environment and Science's *Biodiversity Assessment and Mapping Methodology* (BAMM).

Table 4: Summary table, biodiversity significance

Biodiversity significance	Area (Ha)	% of AOI
(No Records)		

Table 5: Non-riverine wetlands intersecting the AOI

Non-riverine wetland types intersecting the area of interest	#
(No Records)	

NB. The figures presented in the table above are derived from the relevant non-riverine Aquatic Conservation Assessment(s). Later releases of wetland mapping produced via the Queensland Wetland Mapping Program may provide more recent information in regards to wetland extent.

Table 6: Named waterways intersecting the AOI

(no results)

Refer to **Map 1** for general locality information.

The following two tables identify the extent and proportion of the user specified AOI which is mapped as being of "Very High", "High", "Medium", "Low", or "Very Low" aquatic conservation value for riverine and non-riverine wetlands via application of the Queensland Department of Environment and Science's *Aquatic Biodiversity Assessment and Mapping Method* (AquaBAMM).

Table 7: Summary table, aquatic conservation significance (riverine)

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0
High	22.23	100.0
Medium	0.0	0.0
Low	0.0	0.0
Very Low	0.0	0.0

Table 8: Summary table, aquatic conservation significance (non-riverine)

Aquatic conservation significance (non-riverine wetlands)	Area (Ha)	% of AOI
(No Records)		

Biodiversity Planning Assessments

Introduction

The Department of Environment and Science (DES) attributes biodiversity significance on a bioregional scale through a Biodiversity Planning Assessment (BPA). A BPA involves the integration of ecological criteria using the *Biodiversity assessment and Mapping Methodology* (BAMM) and is developed in two stages: 1) **diagnostic criteria**, and 2) **expert panel criteria**. The diagnostic criteria are based on existing data which is reliable and uniformly available across a bioregion, while the expert panel criteria allows for the refinement of the mapped information from the diagnostic output by incorporating local knowledge and expert opinion.

The BAMM methodology has application for identifying areas with various levels of significance solely for biodiversity reasons. These include threatened ecosystems or taxa, large tracts of habitat in good condition, ecosystem diversity, landscape context and connection, and buffers to wetlands or other types of habitat important for the maintenance of biodiversity or ecological processes. While natural resource values such as dryland salinity, soil erosion potential or land capability are not dealt with explicitly, they are included to some extent within the biodiversity status of regional ecosystems recognised by the DES.

Biodiversity Planning Assessments (BPAs) assign three levels of overall biodiversity significance.

- **State significance** - areas assessed as being significant for biodiversity at the bioregional or state scales. They also include areas assessed by other studies/processes as being significant at national or international scales. In addition, areas flagged as being of State significance due to the presence of endangered, vulnerable and/or near threatened taxa, are identified as "State Habitat for EVNT taxa".
- **Regional significance** - areas assessed as being significant for biodiversity at the subregional scale. These areas have lower significance for biodiversity than areas assessed as being of State significance.
- **Local significance and/or other values** - areas assessed as not being significant for biodiversity at state or regional scales. Local values are of significance at the local government scale.

For further information on released BPAs and a copy of the underlying methodology, go to:

http://www.qld.gov.au/environment/plants-animals/biodiversity/planning/

The GIS results can be downloaded from the Queensland Spatial Catalogue at:

http://qspatial.information.qld.gov.au/geoportal/

The following table identifies the extent and proportion of the user specified AOI which is mapped as being of "State", "Regional" or "Local" significance via application of the BAMM.

Table 9: Summary table, biodiversity significance

Biodiversity significance	Area (Ha)	% of AOI
(No Records)		

Refer to **Map 2** for further information.

Diagnostic Criteria

Diagnostic criteria are based on existing data which is reliable and uniformly available across a bioregion. These criteria are diagnostic in that they are used to filter the available data and provide a "first-cut" or initial determination of biodiversity significance. This initial assessment is then combined through a second group of other essential criteria.

A description of the individual diagnostic criteria is provided in the following sections.

Criteria A. Habitat for EVNT taxa: Classifies areas according to their significance based on the presence of endangered, vulnerable and/or rare (EVNT) taxa. EVNT taxa are those scheduled under the *Nature Conservation Act 1992* and/or the *Environment Protection and Biodiversity Conservation Act 1999*. It excludes highly mobile fauna taxa which are instead considered in Criterion H and brings together information on EVNT taxa using buffering of recorded sites or habitat suitability models (HSM) where available.

Criteria B. Ecosystem value: Classifies on the basis of biodiversity status of regional ecosystems, their extent in protected areas (presence of poorly conserved regional ecosystems), the presence of significant wetlands; and areas of national importance such as the presence of Threatened Ecological Communities, World Heritage areas and Ramsar sites. Ecosystem value is applied at a bioregional (**B1**) and regional (**B2**) scale.

Criteria C. Tract size: Measures the relative size of tracts of vegetation in the landscape. The size of any tract is a major indicator of ecological significance, and is also strongly correlated with the long-term viability of biodiversity values. Larger tracts are less susceptible to ecological edge effects and are more likely to sustain viable populations of native flora and fauna than smaller tracts.

Criteria D. Relative size of regional ecosystems: Classifies the relative size of each regional ecosystem unit within its bioregion (**D1**) and its subregion (**D2**). Remnant units are compared with all other occurrences with the same regional ecosystem. Large examples of a regional ecosystem are more significant than smaller examples of the same regional ecosystem because they are more representative of the biodiversity values particular to the regional ecosystem, are more resilient to the effects of disturbance, and constitute a significant proportion of the total area of the regional ecosystem.

Criteria F. Ecosystem diversity: Is an indicator of the number of regional ecosystems occurring within an area. An area with high ecosystem diversity will have many regional ecosystems and ecotones relative to other areas within the bioregion.

Criteria G. Context and connection: Represents the extent to which a remnant unit incorporates, borders or buffers areas such as significant wetlands, endangered ecosystems; and the degree to which it is connected to other vegetation.

A summary of the biodiversity status based upon the diagnostic criteria is provided in the following table.

Table 10: Summary of biodiversity significance based upon diagnostic criteria with respect to the AOI

Biodiversity significance	Description	Area (Ha)	% of AOI
(No Records)			

Assessment of diagnostic criteria with respect to the AOI

The following table reflects an assessment of the individual diagnostic criteria noted above in regards to the AOI.

Table 11: Assessment of individual diagnostic criteria with respect to the AOI

Diagnostic Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
(No Records)								

Other Essential Criteria

Other essential criteria (also known as expert panel criteria) are based on non-uniform information sources and which may rely more upon expert opinion than on quantitative data. These criteria are used to provide a "second-cut" determination of biodiversity significance, which is then combined with the diagnostic criteria for an overall assessment of relative biodiversity significance. A summary of the biodiversity status based upon the other essential criteria is provided in the following table.

Table 12: Summary of biodiversity significance based upon other essential criteria with respect to the AOI

Biodiversity significance	Description	Area (Ha)	% of AOI
(No Records)			

A description of each of the other essential criteria and associated assessment in regards to the AOI is provided in the following sections.

Criteria H. Essential and general habitat for priority taxa: Priority taxa are those which are at risk or of management concern, taxa of scientific interest as relictual (ancient or primitive), endemic taxa or locally significant populations (such as a flying fox camp or heronry), highly specialised taxa whose habitat requirements are complex and distributions are not well correlated with any particular regional ecosystem, taxa important for maintaining genetic diversity (such as complex spatial patterns of genetic variation, geographic range limits, highly disjunct populations), taxa critical for management or monitoring of biodiversity (functionally important or ecological indicators), or economic and culturally important taxa.

Criteria I. Special biodiversity values: areas with special biodiversity values are important because they contain multiple taxa in a unique ecological and often highly biodiverse environment. Areas with special biodiversity values can include the following:

- Ia - centres of endemism - areas where concentrations of taxa are endemic to a bioregion or subregion are found.
- Ib - wildlife refugia (Morton *et al*. 1995), for example, islands, mound springs, caves, wetlands, gorges, mountain ranges and topographic isolates, ecological refuges, refuges from exotic animals, and refuges from clearing. The latter may include large areas that are not suitable for clearing because of land suitability/capability.
- Ic - areas with concentrations of disjunct populations.
- Id - areas with concentrations of taxa at the limits of their geographic ranges.
- Ie - areas with high species richness.
- If - areas with concentrations of relictual populations (ancient and primitive taxa).
- Ig - areas containing REs with distinct variation in species composition associated with geomorphology and other environmental variables.
- Ih - an artificial waterbody or managed/manipulated wetland considered by the panel/s to be of ecological significance.
- Ii - areas with a high density of hollow-bearing trees that provide habitat for animals.

- Ij - breeding or roosting sites used by a significant number of individuals.
- Ik - climate change refuge.

The following table identifies the value and extent area of the Other Essential Criteria H and I within the AOI.

Table 13: Relative importance of expert panel criteria (H and I) used to access overall biodiversity significance with respect to the AOI

Expert Panel	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
(No Records)								

NB. Whilst biodiversity values associated with Criteria I may be present within the site (refer to tables 12 and 15), for the New England Tableland and Central Queensland Coast BPAs, area and % area figures associated with Criteria Ia through to Ij cannot be listed in the table above (due to slight variations in data formats between BPAs).

Criteria J. Corridors: areas identified under this criterion qualify either because they are existing vegetated corridors important for contiguity, or cleared areas that could serve this purpose if revegetated. Some examples of corridors include riparian habitats, transport corridors and "stepping stones".

Bioregional and subregional conservation corridors have been identified in the more developed bioregions of Queensland through the BPAs, using an intensive process involving expert panels. Map 3 displays the location of corridors as identified under the Statewide Corridor network. The Statewide Corridor network incorporates BPA derived corridors and for bioregions where no BPA has been assessed yet, corridors derived under other planning processes. *Note: as a result of updating and developing a statewide network, the alignment of corridors may differ slightly in some instances when compared to those used in individual BPAs.*

The functions of these corridors are:

- **Terrestrial** Bioregional corridors, in conjunction with large tracts of remnant vegetation, maintain ecological and evolutionary processes at a landscape scale, by:
  - Maintaining long term evolutionary/genetic processes that allow the natural change in distributions of species and connectivity between populations of species over long periods of time;
  - Maintaining landscape/ecosystems processes associated with geological, altitudinal and climatic gradients, to allow for ecological responses to climate change;
  - Maintaining large scale seasonal/migratory species processes and movement of fauna;
  - Maximising connectivity between large tracts/patches of remnant vegetation;
  - Identifying key areas for rehabilitation and offsets; and

- **Riparian** Bioregional Corridors also maintain and encourage connectivity of riparian and associated ecosystems.

The location of the corridors is determined by the following principles:

- Terrestrial
  - Complement riparian landscape corridors (i.e. minimise overlap and maximise connectivity);
  - Follow major watershed/catchment and/or coastal boundaries;
  - Incorporate major altitudinal/geological/climatic gradients;
  - Include and maximise connectivity between large tracts/patches of remnant vegetation;
  - Include and maximise connectivity between remnant vegetation in good condition; and

- Riparian
  - Located on the major river or creek systems within the bioregion in question.

The total extent of remnant vegetation triggered as being of "State", "Regional" or "Local" significance due to the presence of an overlying BPA derived terrestrial or riparian corridor within the AOI, is provided in the following table. For further information on how remnant vegetation is triggered due to the presence of an overlying BPA derived corridor, refer to the relevant landscape BPA expert panel report(s).

Table 14: Extent of triggered remnant vegetation due to the presence of BPA derived corridors with respect to the AOI

Biodiversity Significance	Area (Ha)	% of AOI
(No Records)		

NB: area figures associated with the extent of corridor triggered remnant vegetation are only available for those bioregions where a BPA has been undertaken.

Refer to **Map 3** for further information.

Threatening process/condition (Criteria K) - areas identified by experts under this criterion may be used to amend (upgrade or downgrade) biodiversity significance arising from the "first-cut" analysis. The condition of remnant vegetation is affected by threatening processes such as weeds, ferals, grazing and burning regime, selective timber harvesting/removal, salinity, soil erosion, and climate change.

Assessment of Criteria K with respect to the AOI is not currently included in the "Biodiversity and Conservation Values" report, as it has not been applied to the majority of Queensland due to data/information limitations and availability.

Special Area Decisions

Expert panel derived "Special Area Decisions" are used to assign values to Other Essential Criteria. The specific decisions which relate to the AOI in question are listed in the table below.

Table 15: Expert panel decisions for assigning levels of biodiversity significance with respect to the AOI

Decision Number	Description	Panel Recommended Significance	Criteria Values
(No Records)			

Expert panel decision descriptions:

(No Records)

Aquatic Conservation Assessments

Introduction

The Aquatic Biodiversity Assessment and Mapping Method or AquaBAMM (Clayton *et al*. 2006), was developed to assess conservation values of wetlands in queensland, and may also have application in broader geographical contexts. It is a comprehensive method that uses available data, including data resulting from expert opinion, to identify relative wetland conservation/ecological values within a specified study area (usually a catchment). The product of applying this method is an Aquatic Conservation Assessment (ACA) for the study area.

An ACA using AquaBAMM is non-social, non-economic and identifies the conservation/ecological values of wetlands at a user-defined scale. It provides a robust and objective conservation assessment using criteria, indicators and measures that are founded upon a large body of national and international literature. The criteria, each of which may have variable numbers of indicators and measures, are naturalness (aquatic), naturalness (catchment), diversity and richness, threatened species and ecosystems, priority species and ecosystems, special features, connectivity and representativeness. An ACA using AquaBAMM is a powerful decision support tool that is easily updated and simply interrogated through a geographic information system (GIS).

Where they have been conducted, ACAs can provide a source of baseline wetland conservation/ecological information to support natural resource management and planning processes. They are useful as an independent product or as an important foundation upon which a variety of additional environmental and socio-economic elements can be added and considered (i.e. an early input to broader 'triple-bottom-line' decision-making processes). An ACA can have application in:

- determining priorities for protection, regulation or rehabilitation of wetlands and other aquatic ecosystems
- on-ground investment in wetlands and other aquatic ecosystems
- contributing to impact assessment of large-scale development (e.g. dams)
- water resource and strategic regional planning prcesses

For a detailed explanation of the methodology please refer to the summary and expert panel reports relevant to the ACA utilised in this assessment. These reports can be accessed at Wetland *Info*:

http://wetlandinfo.des.qld.gov.au/wetlands/assessment/assessment-methods/aca

The GIS results can be downloaded from the Queensland Spatial Catalogue at:

http://qspatial.information.qld.gov.au/geoportal/

Explanation of Criteria

Under the AquaBAMM, eight criteria are assessed to derive an overall conservation value. Similar to the Biodiversity Assessment and Mapping Methodology, the criteria may be primarily diagnostic (quantitative) or primarily expert opinion (qualitative) in nature. The following sections provide a brief description of each of the 8 criteria.

Criteria 1. Naturalness - Aquatic: This attribute reflects the extent to which a wetland's (riverine, non-riverine, estuarine) aquatic state of naturalness is affected through relevant influencing indicators which include: presence of exotic flora and fauna; presence of aquatic communities; degree of habitat modification and degree of hydrological modification.

Criteria 2. Naturalness - Catchment: The naturalness of the terrestrial systems of a catchment can have an influence on many wetland characteristics including: natural ecological processes e.g. nutrient cycling, riparian vegetation, water chemistry, and flow. The indicators utilised to assess this criterion include: presence of exotic flora and/or fauna; riparian, catchment and flow modification.

Criteria 3. Naturalness - Diversity and Richness: This criterion is common to many ecological assessment methods and can include both physical and biological features. It includes such indicators as species richness, riparian ecosystem richness and geomorphological diversity.

Criteria 4. Threatened Species and Ecosystems: This criterion evaluates ecological rarity characteristics of a wetland. This includes both species rarity and rarity of communities / assemblages. The communities and assemblages are best represented by regional ecosystems. Species rarity is determined by NCA and EPBC status with Endangered, Vulnerable or Near-threatened species being included in the evaluation. Ecosystem rarity is determined by regional ecosystem biodiversity status i.e. Endangered, Of Concern, or Not of Concern.

Criteria 5. Priority Species and Ecosystems: Priority flora and fauna species lists are expert panel derived. These are aquatic, semi-aquatic and riparian species which exhibit at least 1 particular trait in order to be eligible for consideration. For

flora species the traits included:

- It forms significant macrophyte beds (in shallow or deep water).
- It is an important food source.
- It is important/critical habitat.
- It is implicated in spawning or reproduction for other fauna and/or flora species.
- It is at its distributional limit or is a disjunct population.
- It provides stream bank or bed stabilisation or has soil binding properties.
- It is a small population and subject to threatening processes.

Fauna species are included if they meet at least one of the following traits:

- It is endemic to the study area (>75 per cent of its distribution is in the study area/catchment).
- It has experienced, or is suspected of experiencing, a serious population decline.
- It has experienced a significant reduction in its distribution and has a naturally restricted distribution in the study area/catchment.
- It is currently a small population and threatened by loss of habitat.
- It is a significant disjunct population.
- It is a migratory species (other than birds).
- A significant proportion of the breeding population (>one per cent for waterbirds, >75 per cent other species) occurs in the waterbody (see Ramsar criterion 6 for waterbirds).
- Limit of species range.

See the individual expert panel reports for the priority species traits specific to an ACA.

Criteria 6. Special Features: Special features are areas identified by flora, fauna and ecology expert panels which exhibit characteristics beyond those identified in other criteria and which the expert panels consider to be of the highest ecological importance. Special feature traits can relate to, but are not solely restricted to geomorphic features, unique ecological processes, presence of unique or distinct habitat, presence of unique or special hydrological regimes e.g. spring-fed streams. Special features are rated on a 1 - 4 scale (4 being the highest).

Criteria 7. Connectivity: This criterion is based on the concept that appropriately connected aquatic ecosystems are healthy and resilient, with maximum potential biodiversity and delivery of ecosystem services.

Criteria 8. Representativeness: This criterion applies primarily to non-riverine assessments, evaluates the rarity and uniqueness of a wetland type in relation to specific geographic areas. Rarity is determined by the degree of wetland protection within "protected Areas" estate or within an area subject to the *Fisheries Act 1994*, *Coastal Protection and Management Act 1995*, or *Marine Parks Act 2004*. Wetland uniqueness evaluates the relative abundance and size of a wetland or wetland management group within geographic areas such as catchment and subcatchment.

Riverine Wetlands

Riverine wetlands are all wetlands and deepwater habitats within a channel. The channels are naturally or artificially created, periodically or continuously contain moving water, or connecting two bodies of standing water. AquaBAMM, when applied to riverine wetlands uses a discrete spatial unit termed subsections. A subsection can be considered as an area which encompasses discrete homogeneous stream sections in terms of their natural attributes (i.e. physical, chemical, biological and utilitarian values) and natural resources. Thus in an ACA, an aquatic conservation significance score is calculated for each subsection and applies to all streams within a subsection, rather than individual streams as such.

Please note, the area figures provided in Tables 16 and 17, are derived using the extent of riverine subsections within the AOI. Refer to **Map 5** for further information. A summary of the conservation significance of riverine wetlands within the AOI is provided in the following table.

Table 16: Overall level/s of riverine aquatic conservation significance

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
High	22.23	100.0
Medium	0.0	0.0
Low	0.0	0.0
Very Low	0.0	0.0

The individual aquatic conservation criteria ratings for riverine wetlands within the AOI are listed below.

Table 17: Level/s of riverine aquatic conservation significance based on selected criteria

Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
1. Naturalness aquatic							22.23	100.0
2. Naturalness catchment			22.23	100.0				
3. Diversity and richness					22.23	100.0		
4. Threatened species and ecosystems	22.23	100.0						
5. Priority species and ecosystems			22.23	100.0				
6. Special features								
7. Connectivity	22.23	100.0						

The table below lists and describes the relevant expert panel decisions used to assign conservation significance values to riverine wetlands within the AOI.

Table 18: Expert panel decisions for assigning overall levels of riverine aquatic conservation significance

Decision number	Special feature	Catchment	Criteria/Indicator/Measure	Conservation rating (1-4)
(No Records)				

4 is the highest rating/value

Expert panel decision descriptions:

(No Records)

Non-riverine Wetlands

Non-riverine wetlands include both lacustrine and palustrine wetlands, however, do not currently incorporate estuarine, marine or subterranean wetland types. A summary of the conservation significance of non-riverine wetlands within the AOI is provided in the following table. Refer to **Map 6** for further information.

Table 19: Overall level/s of non-riverine aquatic conservation significance

Aquatic conservation significance (non-riverine wetlands)	Area (Ha)	% of AOI
(No Records)		

The following table provides an assessment of non-riverine wetlands within the AOI and associated aquatic conservation criteria values.

Table 20: Level/s of non-riverine aquatic conservation significance based on selected criteria

Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
(No Records)								

The table below lists and describes the relevant expert panel decisions used to assign conservation significance values to non-riverine wetlands within the AOI.

Table 21: Expert panel decisions for assigning overall levels of non-riverine aquatic conservation significance.

Decision number	Special feature	Catchment	Criteria/Indicator/Measure	Conservation rating (1-4)
(No Records)				

4 is the highest rating/value

Expert panel decision descriptions:

(No Records)

Threatened and Priority Species

Introduction

This chapter contains a list of threatened and priority flora and/or fauna species that have been recorded on, or within 4km of the Assessment Area.

The information presented in this chapter with respect to species presence is derived from compiled databases developed primarily for the purpose of BPAs and ACAs. Data is collated from a number of sources and is updated periodically.

It is important to note that the list of species provided in this report, may differ when compared to other reports generated from other sources such as the State government's WildNet, Herbrecs or the federal government's EPBC database for a number of reasons.

Records for threatened and priority species are filtered and checked based on a number of rules including:

- Taxonomic nomenclature - current scientific names and status,
- Location - cross-check co-ordinates with location description,
- Taxon by location - requires good knowledge of the taxon and history of the record,
- Duplicate records - identify and remove,
- Expert panels - check records and provide new records,
- Flora cultivated records excluded,
- Use precise records less than or equal to 2000m,
- Use recent records greater than or equal to 1975 animals, greater than or equal to 1950 plants.

Threatened Species

Threatened species are those species classified as "Endangered" or "Vulnerable" under the *Environment Protection and Biodiversity Conservation Act 1999* or "Endangered", "Vulnerable" or "Near threatened" under the *Nature Conservation Act 1992*.

The following threatened species have been recorded on, or within approximately 4km of the AOI.

Table 22: Threatened species recorded on, or within 4km of the AOI

Species	Common name	NCA status	EPBC status	Back on Track rank	Migratory species*	Wetland species**	Identified flora/fauna
Crocodylus porosus	Estuarine Crocodile	V		Low	Y	Y	FA
Dasyurus hallucatus	Northern Quoll		E	Medium			FA
Petrogale persephone	Proserpine Rock-wallaby	E	E	Critical			FA

NB. Please note that the threatened species listed in this section are based upon the most recently compiled DES internal state-wide threatened species dataset. This dataset may contain additional records that were not originally available for inclusion in the relevant individual BPAs and ACAs.

**JAMBA - Japan-Australia Migratory Bird Agreement; CAMBA - China-Australia Migratory Bird Agreement; ROKAMBA - Republic of Korea-Australia Migratory Bird Agreement; CMS - Convention on the Conservation of Migratory Species.*

***Y - wetland indicator species.*

BPA Priority Species

A list of BPA priority species that have been recorded on, or within approximately 4km of the AOI is contained in the following table.

Table 23: Priority species recorded on, or within 4km of the AOI

(no results)

NB. Please note that the list of priority species is based on those species identified in the BPAs, however records for these species may be more recent than the originals used. furthermore, the BPA priority species databases are updated from time to time. At each update, the taxonomic details for all species are amended as necessary to reflect current taxonomic name and/or status changes.

ACA Priority Species

A list of ACA priority species used in riverine and non-riverine ACAs that have been recorded on, or within approximately 4km of the AOI are contained in the following tables.

Table 24: Priority species recorded on, or within 4 km of the AOI - riverine

Species	Common name	Back on Track rank	Identified flora/fauna
Ardea modesta	Eastern Great Egret	Low	FA
Myriophyllum verrucosum	water milfoil		FL

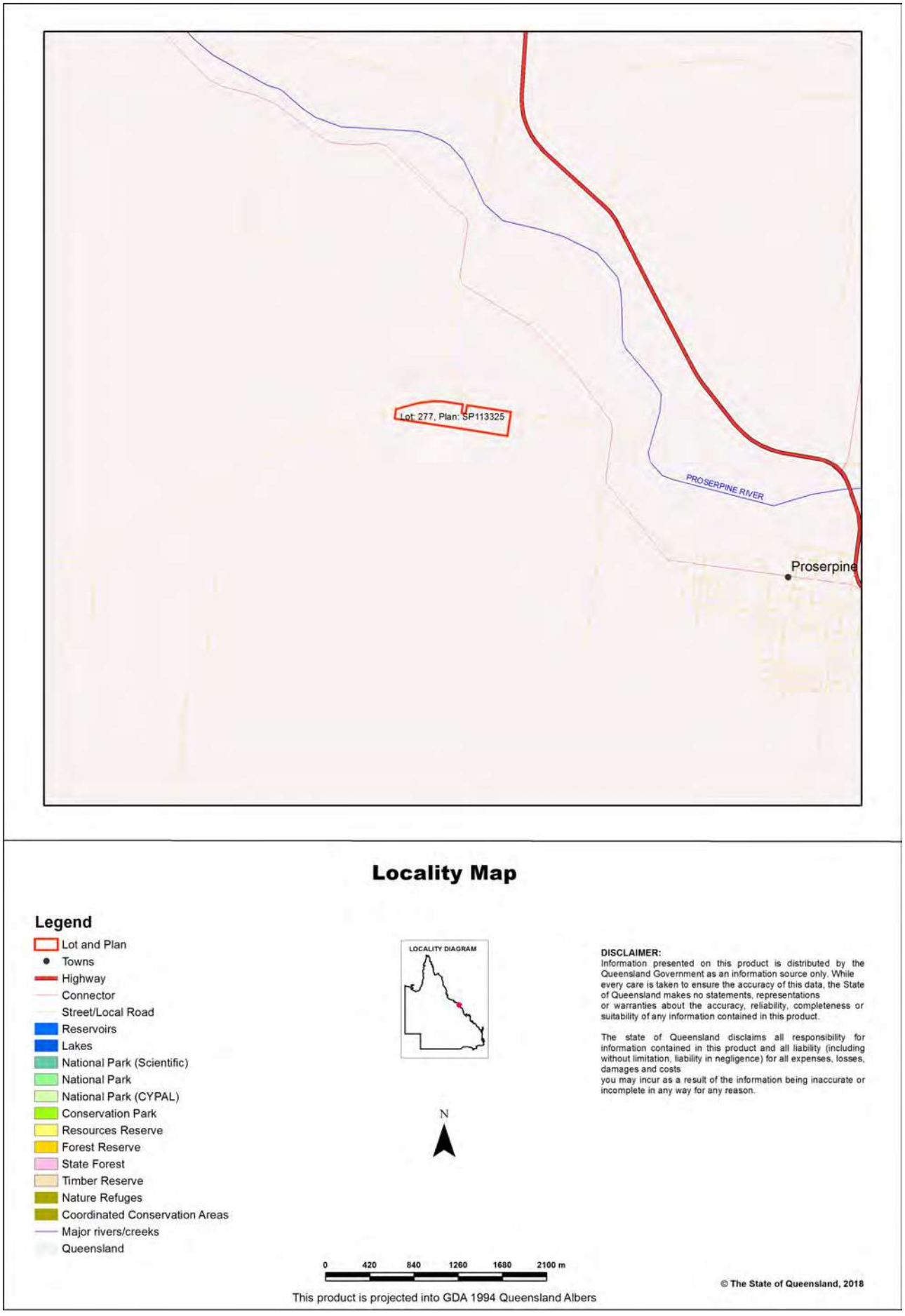
Table 25: Priority species recorded on, or within 4 km of the AOI - non-riverine

Species	Common name	Back on Track rank	Identified flora/fauna
Ardea ibis	Cattle Egret	Low	FA
Ardea modesta	Eastern Great Egret	Low	FA
Myriophyllum verrucosum	water milfoil		FL

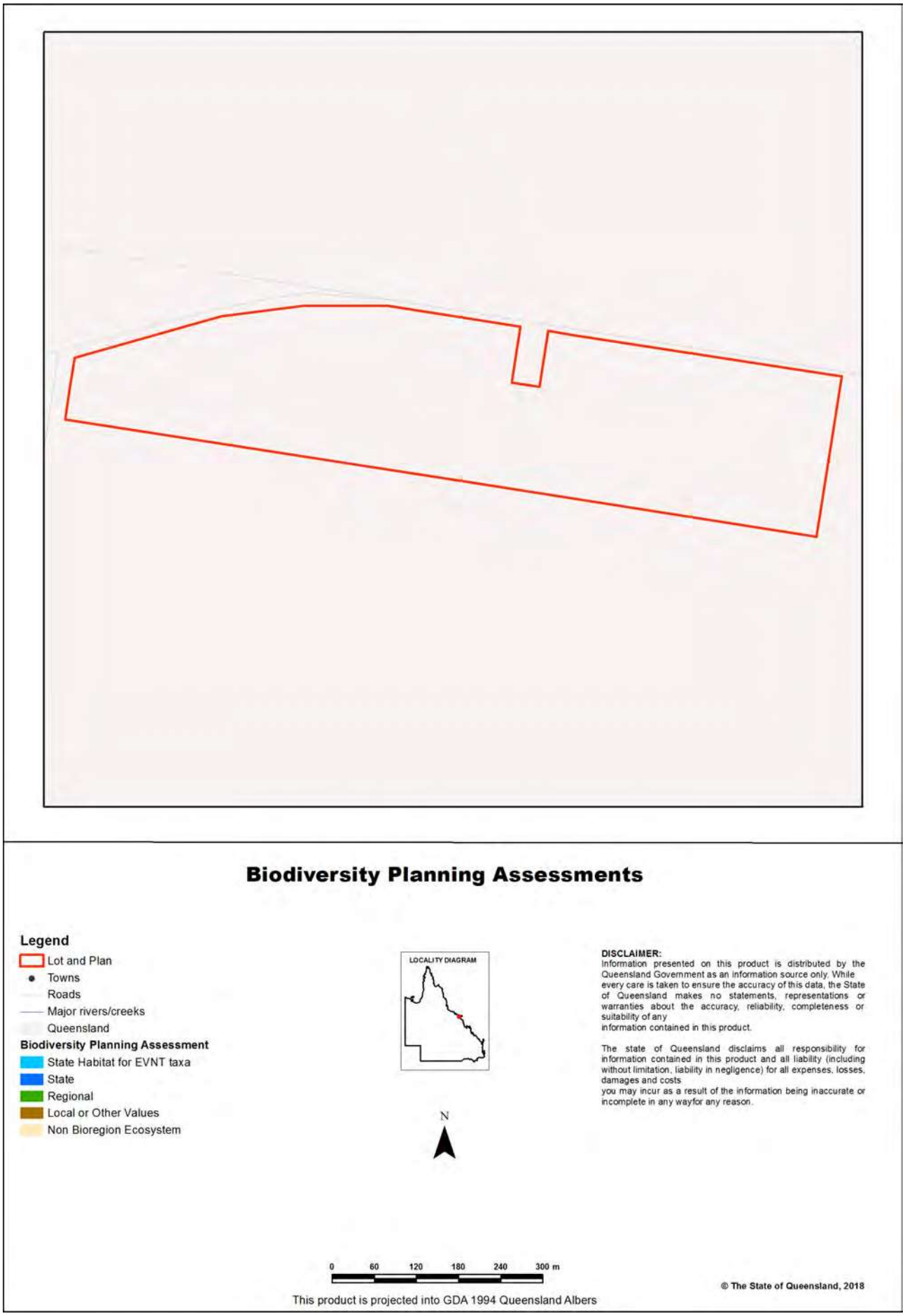
NB. Please note that the priority species records used in the above two tables are comprised of those adopted for the released individual ACAs. The ACA riverine and non-riverine priority species databases are updated from time to time to reflect new release of ACAs. At each update, the taxonomic details for all ACAs records are amended as necessary to reflect current taxonomic name and/or status changes.

Maps

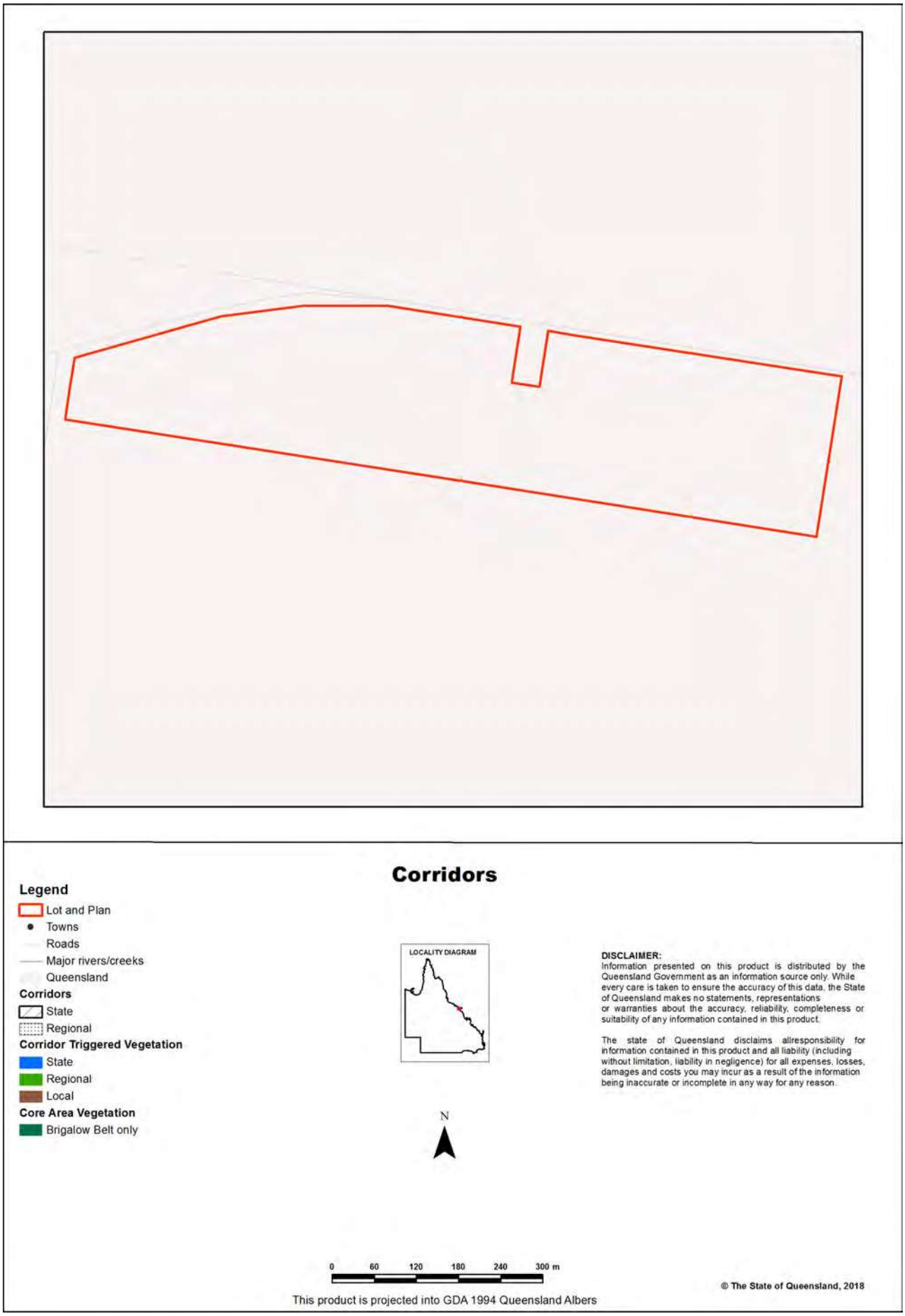
Map 1 - Locality Map



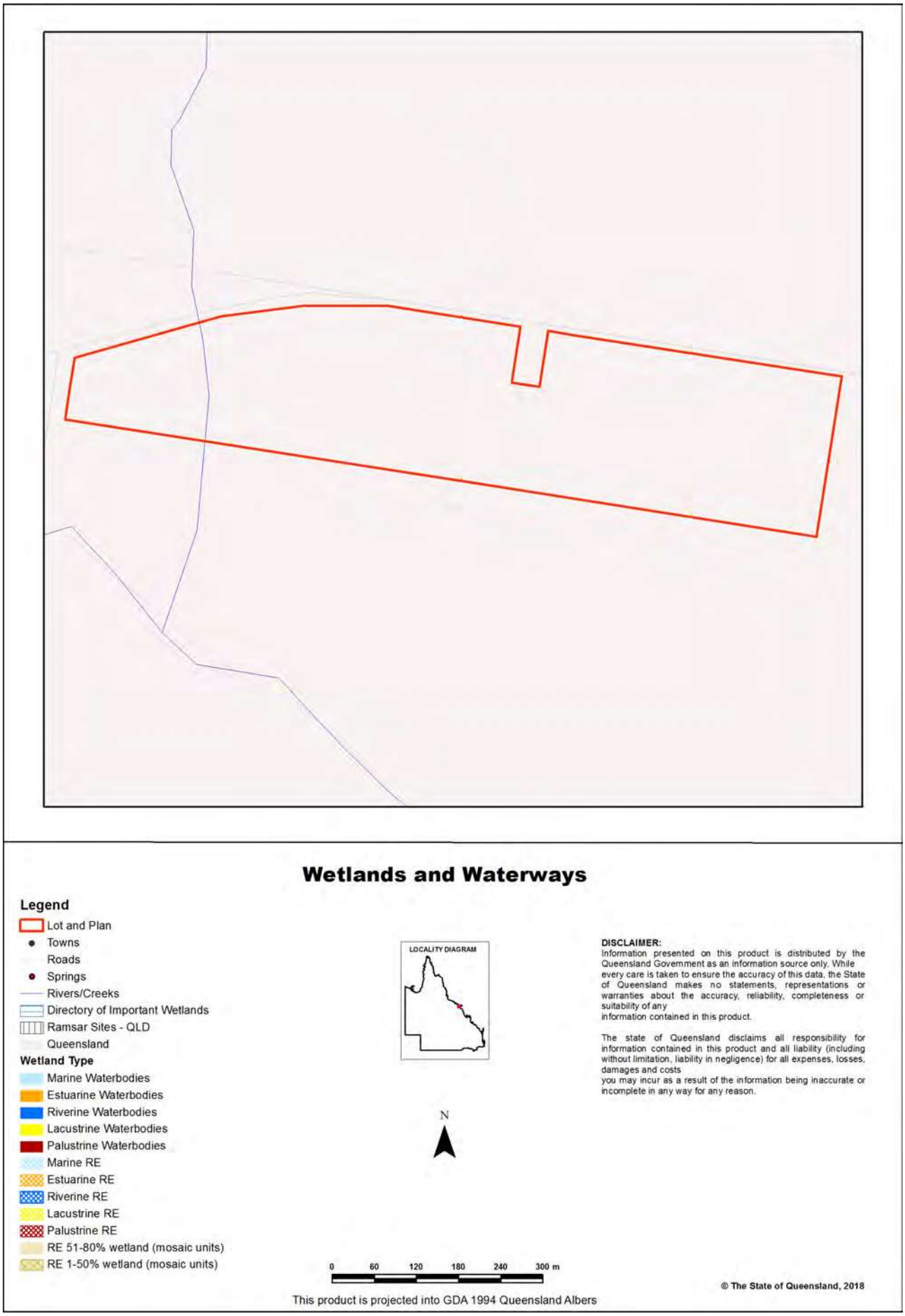
Map 2 - Biodiversity Planning Assessment (BPA)



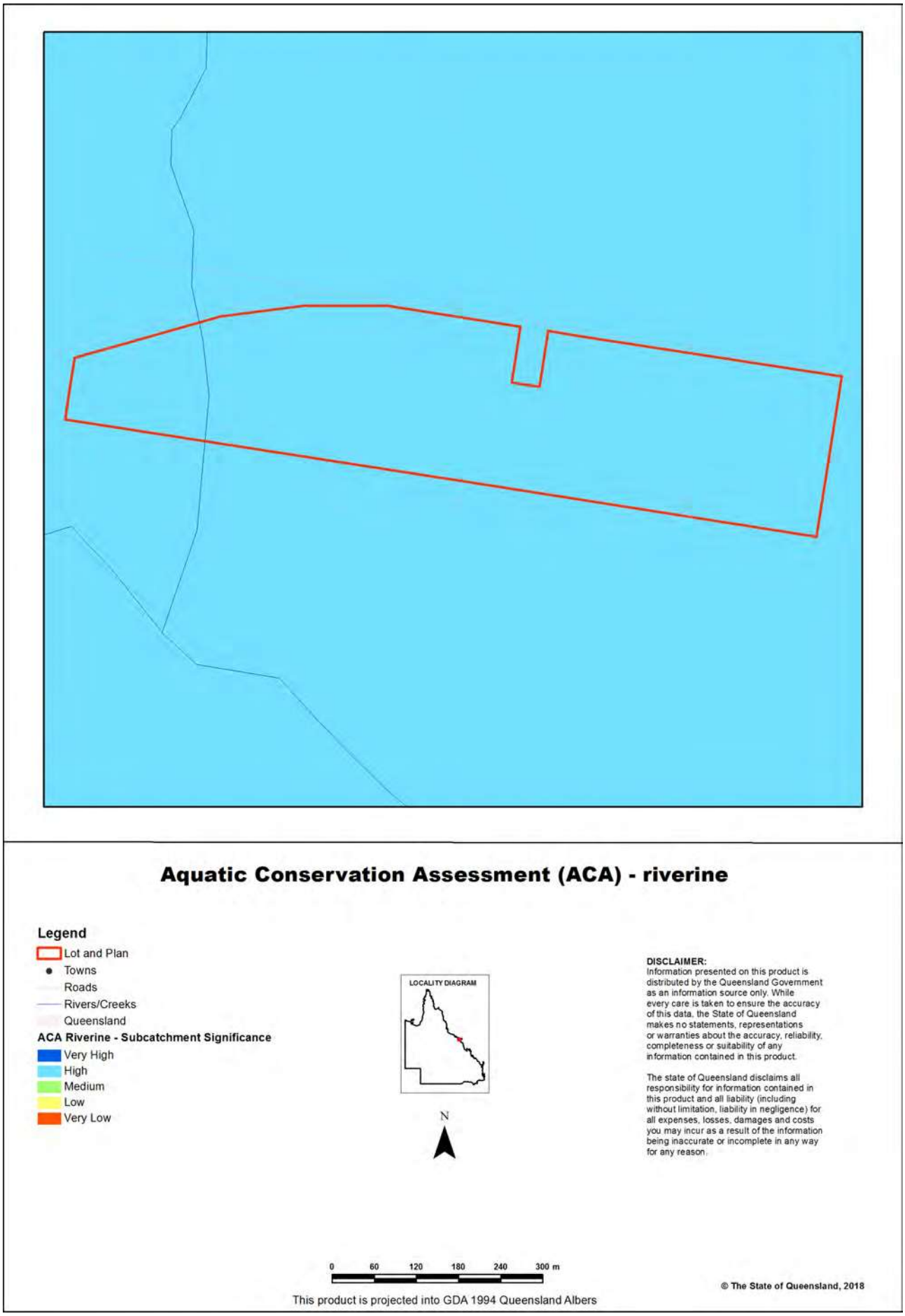
Map 3 - Corridors



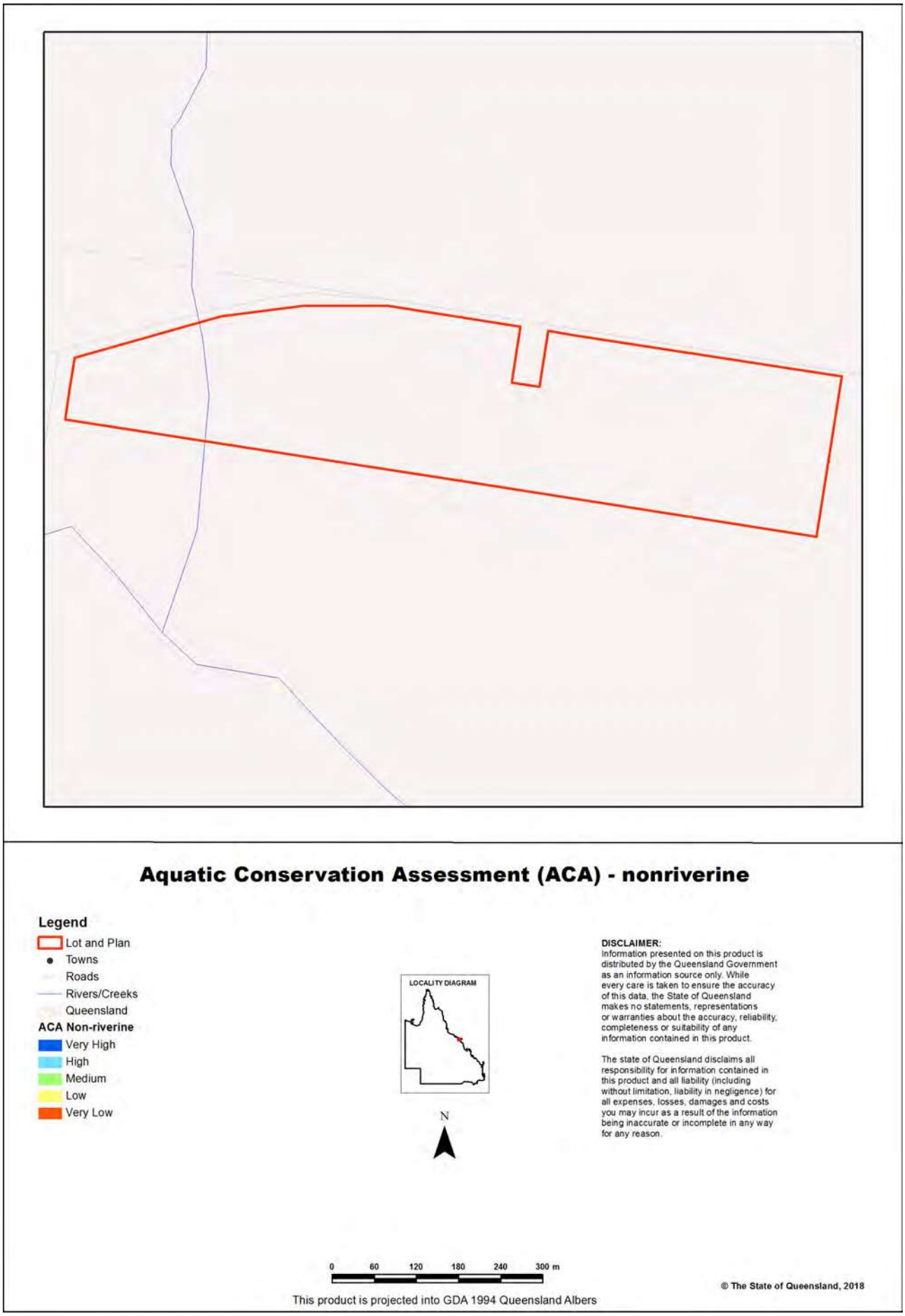
Map 4 - Wetlands and waterways



Map 5 - Aquatic Conservation Assessment (ACA) - riverine



Map 6 - Aquatic Conservation Assessment (ACA) - non-riverine



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Morton, S. R., Short, J. and Barker, R. D. with an Appendix by G.F. Griffin and G. Pearce (1995). *Refugia for Biological Diversity in Arid and Semi-arid Australia. Biodiversity Series* , Paper No. 4, Biodiversity Unit, Environment Australia.

Sattler, P.S. and Williams, R.D. (eds) (1999). *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency, Brisbane.

Appendices

Appendix 1 - Source Data

Theme	Datasets
Aquatic Conservation Assessments Non-riverine*	Combination of the following datasets: Cape York Peninsula Non-riverine v1.1 Great Barrier Reef Catchment Non-riverine v1.3 Lake Eyre and Bulloo Basins v1.1 QMDB Non-riverine ACA v1.4 Southeast Queensland ACA v1.1 WBB Non-riverine ACA v1.1
Aquatic Conservation Assessments Riverine*	Combination of the following datasets: Cape York Peninsula Riverine v1.1 Great Barrier Reef Catchment Riverine v1.1 Lake Eyre and Bulloo Basins v1.1 QMDB Riverine ACA v1.4 Southeast Queensland ACA v1.1 WBB Riverine ACA v1.1
Biodiversity Planning Assessments*	Combination of the following datasets: Brigalow Belt BPA v2.1 Cape York Peninsula BPA v1.1 Central Queensland Coast BPA v1.3 Channel Country BPA v1.1 Desert Uplands BPA v1.3 Einasleigh Uplands BPA v1.1 Gulf Plains BPA v1.1 Mitchell Grass Downs BPA v1.1 Mulga Lands BPA v1.4 New England Tableland v2.3 Southeast Queensland v4.1
Statewide BPA Corridors*	Statewide corridors v1.4
Threatened Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.
BPA Priority Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.
ACA Priority Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.

***These datasets are available at:**

http://dds.information.qld.gov.au/DDS

Appendix 2 - Acronyms and Abbreviations

AOI	- Area of Interest
ACA	- Aquatic Conservation Assessment
AQUABAMM	- Aquatic Biodiversity Assessment and Mapping Methodology
BAMM	- Biodiversity Assessment and Mapping Methodology
BoT	- Back on Track
BPA	- Biodiversity Planning Assessment
CAMBA	- China-Australia Migratory Bird Agreement
DES	- Department of Environment and Science
EPBC	- *Environment Protection and Biodiversity Conservation Act 1999*
EVNT	- Endangered, Vulnerable, Near Threatened
GDA94	- Geocentric Datum of Australia 1994
GIS	- Geographic Information System
JAMBA	- Japan-Australia Migratory Bird Agreement
NCA	- *Nature Conservation Act 1992*
RE	- Regional Ecosystem
REDD	- Regional Ecosystem Description Database
ROKAMBA	- Republic of Korea-Australia Migratory Bird Agreement

Queensland Government

Department of Environment and Heritage Protection

Environmental Reports

Matters of State Environmental Significance

Area of Interest: Longitude: 148.55308 Latitude: -20.388652

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Please direct queries about these reports to: Planning.Support@ehp.qld.gov.au

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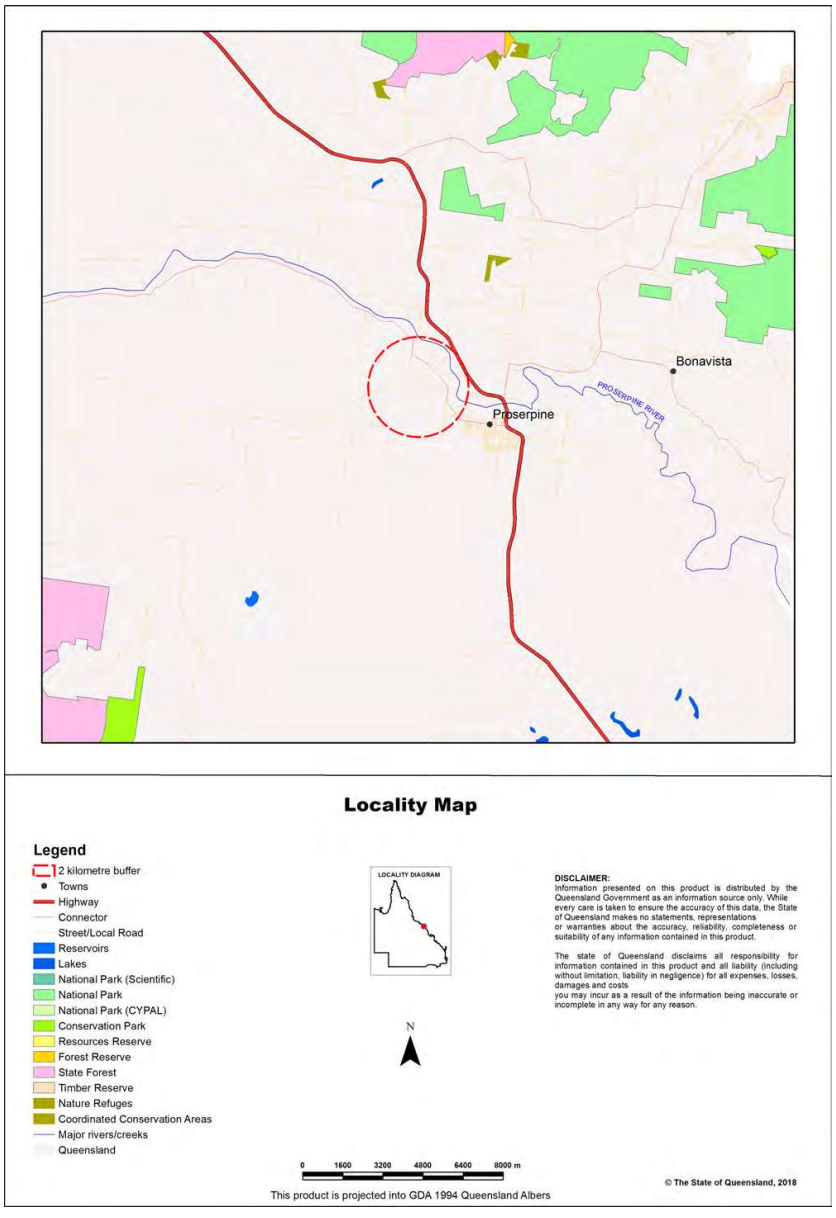
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Assessment Area Details

The following table provides an overview of the area of interest (AOI) with respect to selected topographic and environmental values.

Table 1: Summary table, details for AOI Longitude: 148.55308 Latitude: -20.388652

Size (ha)	1,256.55
Local Government(s)	Whitsunday Regional
Bioregion(s)	Central Queensland Coast
Subregion(s)	Proserpine - Sarina Lowlands
Catchment(s)	Proserpine



Matters of State Environmental Significance (MSES)

MSES Categories

Queensland's State Planning Policy (SPP) includes a biodiversity State interest that states:

'The sustainable, long-term conservation of biodiversity is supported. Significant impacts on matters of national or state environmental significance are avoided, or where this cannot be reasonably achieved; impacts are minimised and residual impacts offset.'

The MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

The SPP defines matters of state environmental significance as:

- Protected areas (including all classes of protected area except coordinated conservation areas) under the *Nature Conservation Act 1992* ;

- Marine parks and land within a 'marine national park', 'conservation park', 'scientific research', 'preservation' or 'buffer' zone under the *Marine Parks Act 2004* ;

- Areas within declared fish habitat areas that are management A areas or management B areas under the Fisheries Regulation 2008;

- Threatened wildlife under the *Nature Conservation Act 1992* and special least concern animals under the Nature Conservation (Wildlife) Regulation 2006;

- Regulated vegetation under the *Vegetation Management Act 1999* that is:

    • Category B areas on the regulated vegetation management map, that are 'endangered' or 'of concern' regional ecosystems;

    • Category C areas on the regulated vegetation management map that are 'endangered' or 'of concern' regional ecosystems;

    • Category R areas on the regulated vegetation management map;

    • Regional ecosystems that intersect with watercourses identified on the vegetation management watercourse and drainage feature map;

    • Regional ecosystems that intersect with wetlands identified on the vegetation management wetlands map;

- Strategic Environmental Areas under the *Regional Planning Interests Act 2014* ;

- Wetlands in a wetland protection area of wetlands of high ecological significance shown on the Map of Referable Wetlands under the Environmental Protection Regulation 2008;

- Wetlands and watercourses in high ecological value waters defined in the Environmental Protection (Water) Policy 2009, schedule 2;

- Legally secured offset areas.

MSES Values Present

The MSES values that are present in the area of interest are summarised in the table below:

Table 2: Summary of MSES present within the AOI

1a Protected Areas- estates	0.0 ha	0.0 %
1b Protected Areas- nature refuges	0.0 ha	0.0 %
2 State Marine Parks- highly protected zones	0.0 ha	0.0 %
3 Fish habitat areas (A and B areas)	0.0 ha	0.0 %
4 Strategic Environmental Areas (SEA)	0.0 ha	0.0 %
5 High Ecological Significance wetlands on the map of Referable Wetlands	0.0 ha	0.0 %
6a High Ecological Value (HEV) wetlands	0.0 ha	0.0 %
6b High Ecological Value (HEV) waterways **	0.0 km	Not applicable
7 Threatened species and Iconic species	0.0 ha	0.0 %
8a Regulated Vegetation - Endangered/Of concern in Category B (remnant)	19.43 ha	1.5%
8b Regulated Vegetation - Endangered/Of concern in Category C (regrowth)	0.0 ha	0.0 %
8c Regulated Vegetation - Category R (GBR riverine regrowth)	90.22 ha	7.2%
8d Regulated Vegetation - Essential habitat	0.0 ha	0.0 %
8e Regulated Vegetation - intersecting a watercourse **	13.3 km	Not applicable
8f Regulated Vegetation - within 100m of a Vegetation Management Wetland	0.0 ha	0.0 %
9a Legally secured offset areas- offset register areas	0.0 ha	0.0 %
9b Legally secured offset areas- vegetation offsets through a Property Map of Assessable Vegetation	0.0 ha	0.0 %

Additional Information with Respect to MSES Values Present

MSES - State Conservation Areas

1a. Protected Areas - estates

(no results)

1b. Protected Areas - nature refuges

(no results)

2. State Marine Parks - highly protected zones

(no results)

3. Fish habitat areas (A and B areas)

(no results)

Refer to **Map 1 - MSES - State Conservation Areas** for an overview of the relevant MSES.

MSES - Wetlands and Waterways

4. Strategic Environmental Areas (SEA)

(no results)

5. High Ecological Significance wetlands on the Map of Referable Wetlands

(no results)

6a. High Ecological Value (HEV) waters - wetlands

(no results)

6b. High Ecological Value (HEV) waters - waterways

(no results)

Refer to **Map 2 - MSES - Wetlands and Waterways** for an overview of the relevant MSES.

MSES - Species

7. Threatened wildlife and special least concern animal

(no results)

Threatened and special least concern species records

(no results)

Note: The Threatened and Special Least Concern Animal (7) layer originates from the previous MSES version (4.1, dated at 2014). The layer does not represent all currently listed species and is subject to review.

**Nature Conservation Act 1992 (NCA) Status- Endangered (E), Vulnerable (V) or Special Least Concern Animal (SL). Environment Protection and Biodiversity Conservation Act 1999 (EPBC) status: Critically Endangered (CE) Endangered (E), Vulnerable (V)*

To request a species list for an area, or search for a species profile, access Wildlife Online at:
https://www.qld.gov.au/environment/plants-animals/species-list/

Refer to **Map 3 - MSES - Species** for an overview of the relevant MSES.

MSES - Regulated Vegetation

8a. Regulated Vegetation - Endangered/Of concern in Category B (remnant)

Regional ecosystem	Vegetation management polygon	Vegetation management status
8.3.6a	O-dom	rem_oc
8.3.5/8.3.3a	O-dom	rem_oc
8.3.2/8.5.2a/8.3.5/8.3.3a	E-dom	rem_end
8.3.2	E-dom	rem_end

8b. Regulated Vegetation - Endangered/Of concern in Category C (regrowth)

Not applicable

For further information relating to regional ecosystems in general, go to:
https://www.qld.gov.au/environment/plants-animals/plants/ecosystems/
For a more detailed description of a particular regional ecosystem, access the regional ecosystem search page at:
https://environment.ehp.qld.gov.au/regional-ecosystems/

8c. Regulated Vegetation - Category R (GBR riverine regrowth)

Regulated vegetation map category	Map number	RVM rule
R	8657	None

8d. Regulated Vegetation - Essential habitat

Not applicable

8e. Regulated Vegetation - intersecting a watercourse**

A vegetation management watercourse is mapped as present

8f. Regulated Vegetation - within 100m of a Vegetation Management wetland

Not applicable

Refer to **Map 4 - MSES - Regulated Vegetation** for an overview of the relevant MSES.

MSES - Offsets

9a. Legally secured offset areas - offset register areas

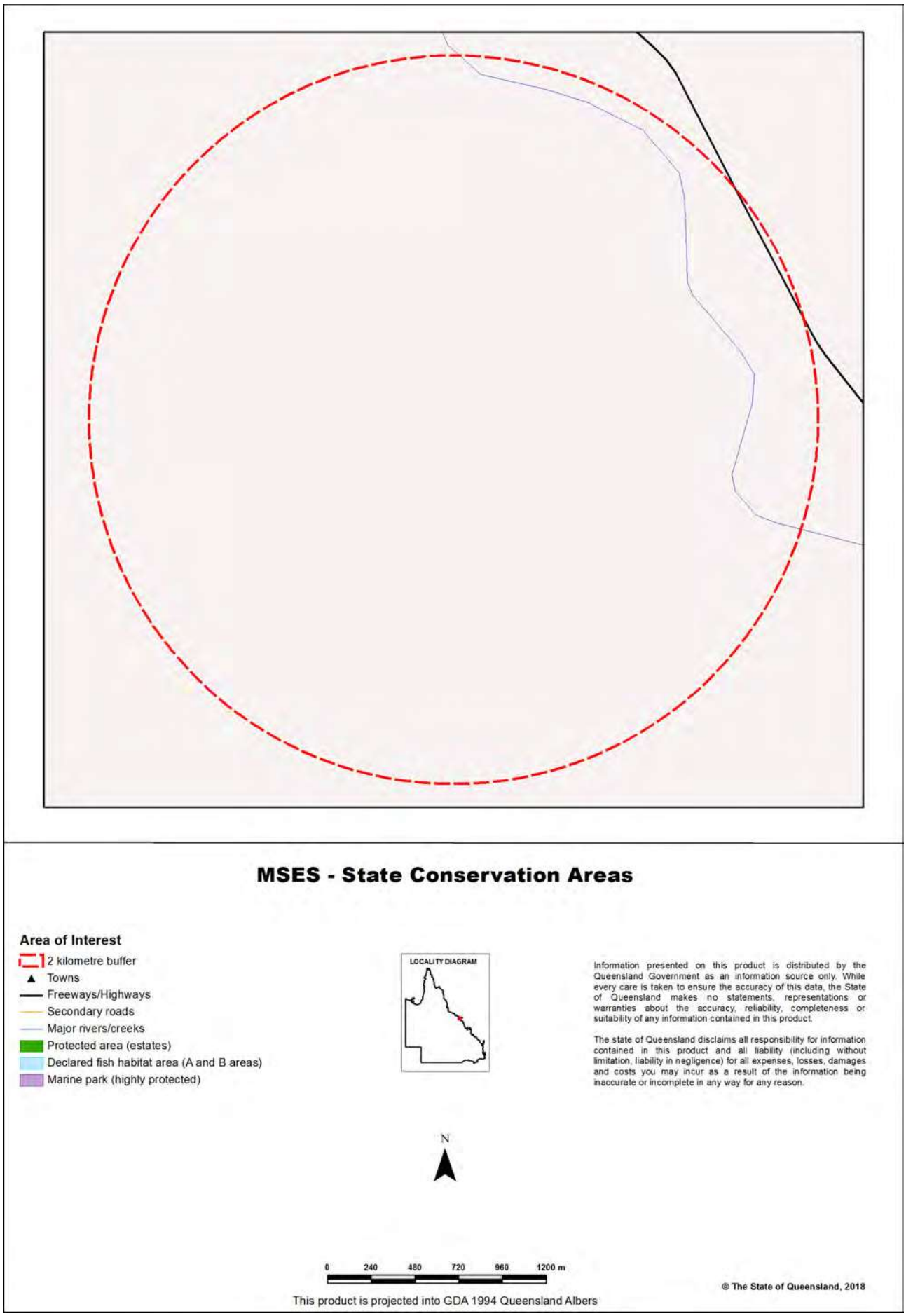
(no results)

9b. Legally secured offset areas - vegetation offsets through a Property Map of Assessable Vegetation

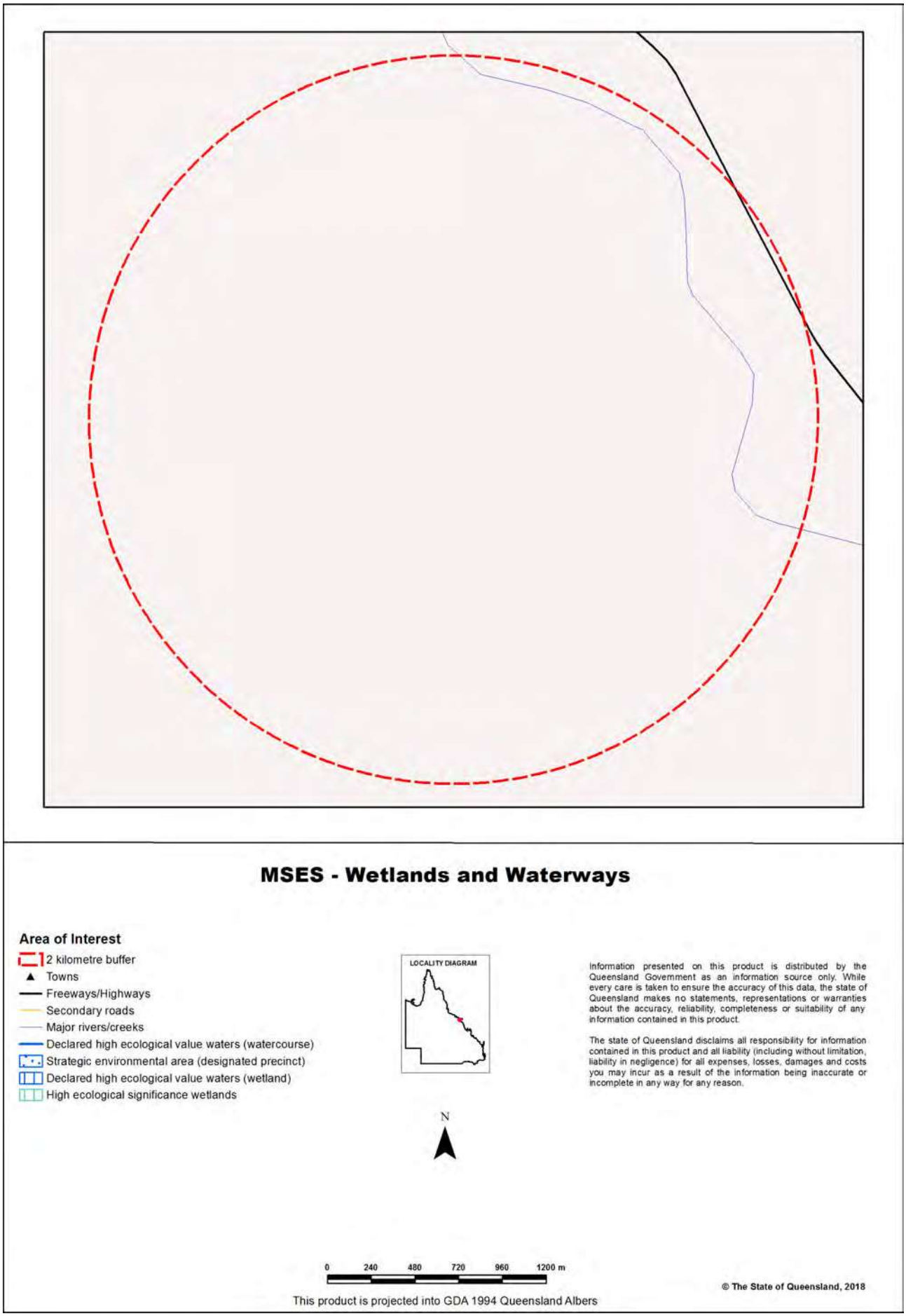
(no results)

Refer to **Map 5 - MSES - Offset Areas** for an overview of the relevant MSES.

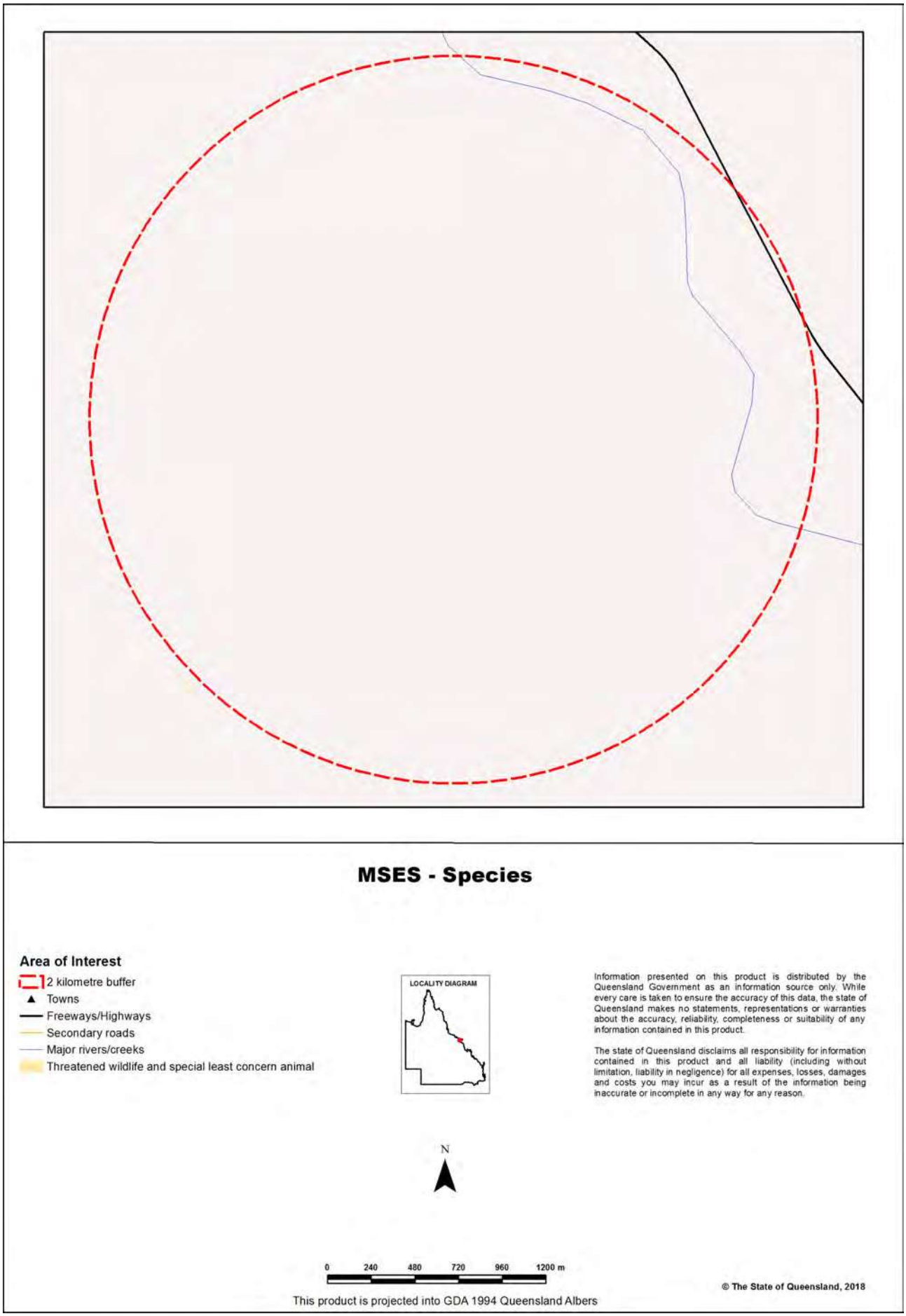
Map 1 - MSES - State Conservation Areas



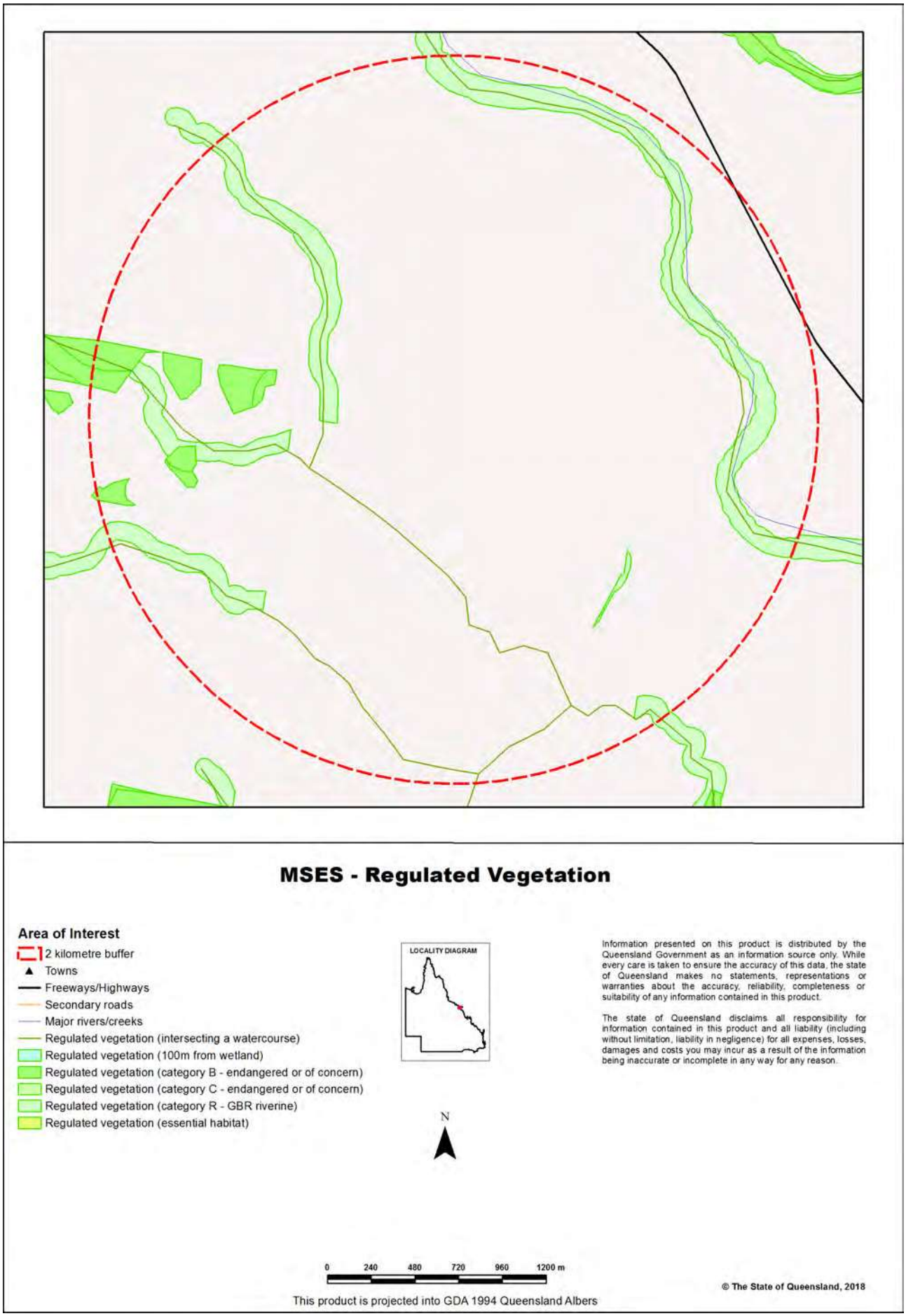
Map 2 - MSES - Wetlands and Waterways



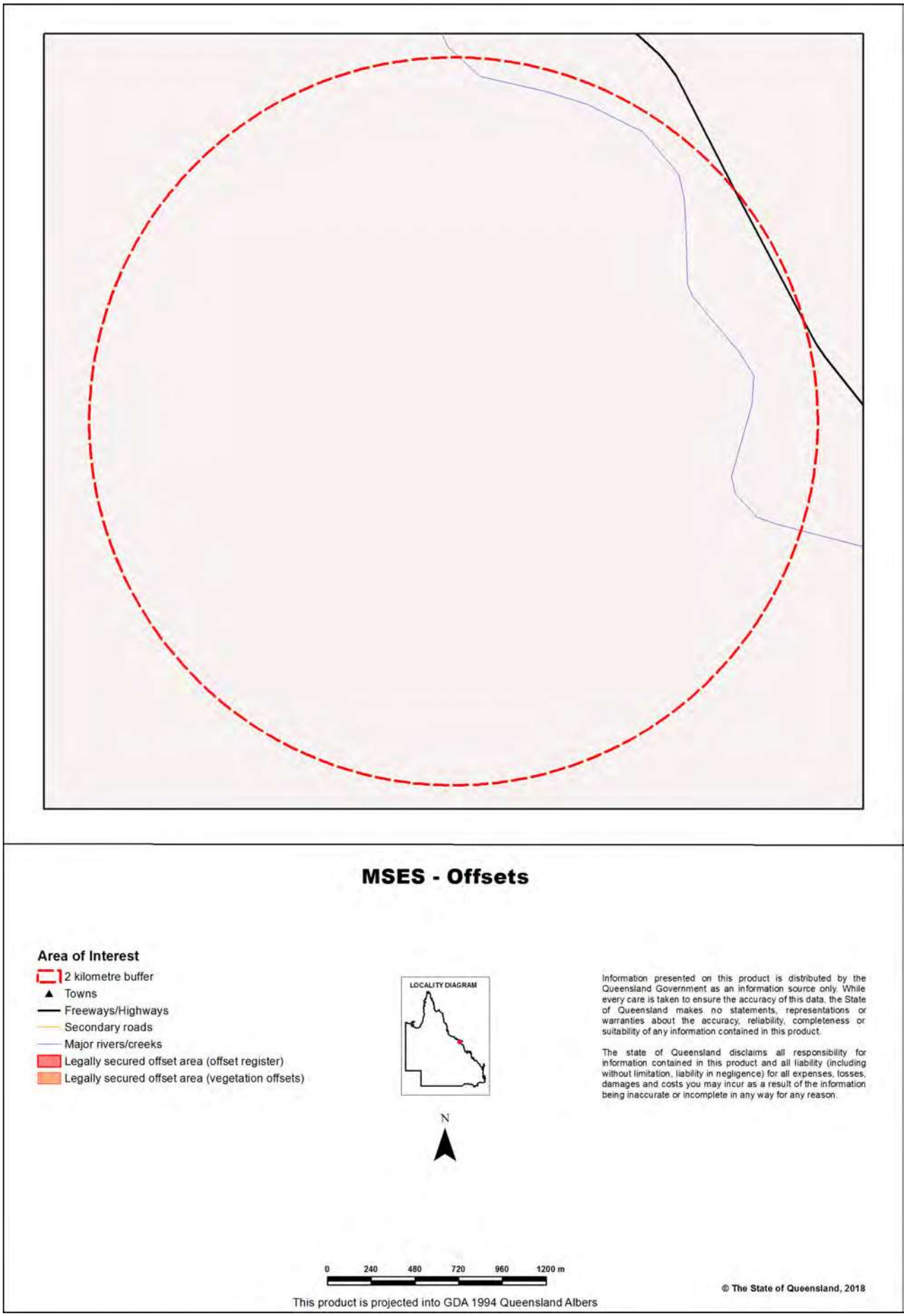
Map 3 - MSES - Species



Map 4 - MSES - Regulated Vegetation



Map 5 - MSES - Offset Areas



Appendices

Appendix 1 - Matters of State Environmental Significance (MSES) methodology

MSES mapping is a regional-scale representation of the definition for MSES under the State Planning Policy (SPP). The compiled MSES mapping product is a guide to assist planning and development assessment decision-making. Its primary purpose is to support implementation of the SPP biodiversity policy. While it supports the SPP, the mapping does not replace the regulatory mapping or environmental values specifically called up under other laws or regulations. Similarly, the SPP biodiversity policy does not override or replace specific requirements of other Acts or regulations.

The Queensland Government's "Method for mapping - matters of state environmental significance for use in land use planning and development assessment" can be downloaded from:

http://www.ehp.qld.gov.au/land/natural-resource/method-mapping-mses.html .

Appendix 2 - Source Data

The datasets listed below are available on request from:

http://qldspatial.information.qld.gov.au/catalogue/custom/index.page

- Matters of State environmental significance

Note: MSES mapping is not based on new or unique data. The primary mapping product draws data from a number of underlying environment databases and geo-referenced information sources. MSES mapping is a versioned product that is updated generally on a twice-yearly basis to incorporate the changes to underlying data sources. Several components of MSES mapping made for the current version may differ from the current underlying data sources. To ensure accuracy, or proper representation of MSES values, it is strongly recommended that users refer to the underlying data sources and review the current definition of MSES in the State Planning Policy, before applying the MSES mapping.

Individual MSES layers can be attributed to the following source data available at QSpatial:

MSES layers	**current QSpatial data (http://qspatial.ingormation.qld.gov.au)**
Protected Areas-Estates and Nature Refuges	- Protected areas of Queensland - Nature Refuges - Queensland
Marine Park-Highly Protected Zones	Moreton Bay marine park zoning 2008
Fish Habitat Areas	Queensland fish habitat areas
Strategic Environmental Areas-designated	Regional Planning Interests Act - Strategic Environmental Areas
HES wetlands	Map of Referable Wetland - wetland layers: - Wetland management area wetlands - Wetland protection area wetlands
wetlands in HEV waters	HEV waters: - EPP Water (multiple locations) intent for waters Source Wetlands: - Queensland Wetland Mapping (Current version 4, 2015) Source Watercourses: - Vegetation management watercourse and drainage feature map (1:100000 and 1:250000) - latest version 1.4
Wildlife habitat (threatened and special least concern)	-WildNet database species records - habitat suitability models (various)
VMA regulated regional ecosystems	Vegetation management regional ecosystem and remnant map - latest version 8.0
VMA Essential Habitat	Vegetation management - essential habitat map - latest version 4.41
VMA Wetlands	Vegetation management wetlands map - latest version 2.41
Legally secured offsets	Vegetation Management Act property maps of assessable vegetation. For offset register data-contact EHP
Regulated Vegetation Map	Vegetation management - regulated vegetation management map - latest version 1.41

Appendix 3 - Acronyms and Abbreviations

AOI	- Area of Interest
EHP	- Department of Environment and Heritage Protection
EP Act	- *Environmental Protection Act 1994*
EPP	- Environmental Protection Policy
GDA94	- Geocentric Datum of Australia 1994
GEM	- General Environmental Matters
GIS	- Geographic Information System
MSES	- Matters of State Environmental Significance
NCA	- *Nature Conservation Act 1992*
RE	- Regional Ecosystem
SPP	- State Planning Policy
VMA	- *Vegetation Management Act 1999*

Queensland Government

Department of Environment and Heritage Protection

Environmental Reports

Regional Ecosystems

Biodiversity Status

Area of Interest: Longitude: 148.55308 Latitude: -20.388652

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "Central co-ordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the input coordinates.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no matters of interest have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Important Note to User

Information presented in this report is based upon the Queensland Herbarium's Regional Ecosystem framework. The Biodiversity Status has been used to depict the extent of "Endangered", "Of Concern" and "No Concern at Present" regional ecosystems in all cases, rather than the status used for the purposes of the *Vegetation Management Act 1999* (VMA). Mapping and figures presented in this document reflect the Queensland Herbarium's Remnant and Pre-clearing Regional Ecosystem Datasets, and not the certified mapping used for the purpose of the VMA.

For matters relevant to vegetation management under the VMA, please refer to the Department of Natural Resources and Mines website

https://www.dnrm.qld.gov.au/

Please direct queries about these reports to: Queensland.Herbarium@dsitia.qld.gov.au

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Summary Information

The following table provides an overview of the AOI with respect to selected topographic and environmental themes. Refer to **Map 1** for locality information.

Table 1: Area of interest details

Area of Interest	148.55308,-20.388652 with 2 kilometre radius
Size (ha)	1256.6
Local Government(s)	WHITSUNDAY REGIONAL
Bioregion(s)	Central Queensland Coast
Subregion(s)	Proserpine - Sarina Lowlands
Catchment(s)	Proserpine

The table below summarizes the extent of remnant vegetation classed as "Endangered", "Of concern" and "No concern at present" classified by Biodiversity Status within the area of interest (AOI).

Table 2: Summary table, biodiversity status of regional ecosystems within the AOI

Biodiversity Status	Area (Ha)	% of AOI
Endangered	17.4	1.4
Of concern	2.0	0.2
No concern at present	0.0	0.0
Total remnant vegetation	19.4	1.5

Refer to **Map 2** for further information.

Regional Ecosystems

1. Introduction

Regional ecosystems are vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil. Descriptions of Queensland's Regional ecosystems are available online from the Regional Ecosystem Description Database (REDD). Descriptions are compiled from a broad range of information sources including vegetation, land system and geology survey and mapping and detailed vegetation site data. The regional ecosystem is regularly reviewed as new information becomes available. A number of vegetation communities may form a single regional ecosystem and are usually distinguished by differences in dominant species, frequently in the shrub or ground layers and are denoted by a letter following the regional ecosystem code (e.g. a, b, c).

The Queensland Herbarium has developed a methodology for mapping regional ecosystems across Queensland. As new information is obtained, the descriptions and status of regional ecosystems is updated. Regional ecosystems and broad vegetation groups descriptions in the format of Sattler and Williams (1999) are maintained in the Regional Ecosystem Description Database (REDD). Vegetation communities and regional ecosystems are amalgamated into the higher level classification of broad vegetation groups (BVGs).

This report provides information on the type, status, and extent of vegetation communities, regional ecosystems and broad vegetation groups present within a user specified area of interest. Please note, for the purpose of this report, the Biodiversity Status is used. This report has not been developed for application of matters relevant to the *Vegetation Management Act 1999* (VMA). Additionally, information generated in this report has been derived from the Queensland Herbarium's Regional Ecosystem Mapping, and not mapping certified for the purposes of the VMA. If your interest/matter relates to regional ecosystems and the VMA, users should refer to the Department of Natural Resources and Mines website.

https://www.dnrm.qld.gov.au/

With respect to the Queensland Biodiversity Status,

"Endangered" regional ecosystems are described as those where:

- remnant vegetation is less than 10 per cent of its pre-clearing extent across the bioregion; or 10-30% of its pre-clearing extent remains and the remnant vegetation is less than 10,000 hectares, or
- less than 10 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss*, or
- 10-30 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 hectares; or
- it is a rare** regional ecosystem subject to a threatening process.***

"Of concern" regional ecosystems are described as those where:

- the degradation criteria listed above for 'Endangered' regional ecosystems are not met and,
- remnant vegetation is 10-30 per cent of its pre-clearing extent across the bioregion; or more than 20 per cent of its pre-clearing extent remains and the remnant extent is less than 10,000 hectares, or
- 10-30 percent of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss.****

and "No concern at present" regional ecosystems are described as those where:

- remnant vegetation is over 30 per cent of its pre-clearing extent across the bioregion, and the remnant area is greater than 10,000 hectares, and
- the degradation criteria listed above for 'Endangered' or 'Of concern' regional ecosystems are not met.

**Severe degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 50 years even with the removal of threatening processes; or soil surface is severely degraded, for example, by loss of A horizon, surface expression of salinity; surface compaction, loss of organic matter or sheet erosion.*

***Rare regional ecosystem: pre-clearing extent (1000 ha); or patch size (100 ha and of limited total extent across its range).*

****Threatening processes are those that are reducing or will reduce the biodiversity and ecological integrity of a regional ecosystem. For example, clearing, weed invasion, fragmentation, inappropriate fire regime or grazing pressure, or infrastructure development.*

*****Moderate degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 20 years even with the removal of threatening processes; or soil surface is moderately degraded.*

2. Remnant Regional Ecosystems

The following table identifies the remnant regional ecosystems and vegetation communities mapped within the AOI, the associated short description, Biodiversity Status using the Queensland Herbarium's framework and the extent area present within the selected AOI. Please note, where heterogeneous vegetated patches (mixed patches of remnant vegetation mapped as containing multiple regional ecosystems) occur within the AOI, they have been split and listed as individual regional ecosystems (or vegetation communities where present) for the purposes of the table below. In such instances, associated area figures have been generated based upon the estimated proportion of each regional ecosystem (or vegetation community) predicted to be present within the larger mixed patch.

Table 3: Remnant regional ecosystems, description and status within the AOI

Regional Ecosystem	Short Description	BD Status	Area (Ha)	% of AOI
8.3.2	Melaleuca viridiflora woodland on seasonally inundated alluvial plains with impeded drainage	Endangered	10.9	0.9
8.3.3a	Melaleuca leucadendra and/or M. fluviatilis and/or Casuarina cunninghamiana +/- Syncarpia glomulifera open forest, on creek banks	Of concern	0.7	0.1
8.3.5	Eucalyptus platyphylla and/or Lophostemon suaveolens and/or Corymbia clarksoniana woodland on alluvial plains	Endangered	3.7	0.3
8.3.6a	Eucalyptus tereticornis and/or Corymbia intermedia (or C. clarksoniana) and/or C. tessellaris +/- Lophostemon suaveolens open forest on alluvial levees and lower terraces	Of concern	1.3	0.1
8.5.2a	Melaleuca viridiflora +/- Allocasuarina luehmannii, or M. viridiflora and M. nervosa woodland on Tertiary sand plains	Endangered	2.8	0.2
non-rem	None	None	1237.1	98.5

Refer to **Map 2** for further information. **Map 3** also provides a visual estimate of the distribution of regional ecosystems present before European settlement.

Table 4 provides further information in regards to the remnant regional ecosystems present within the site with respect to the extent of remnant vegetation remaining within the bioregion, the 1:1,000,000 broad vegetation group (BVG) classification, whether the regional ecosystem is identified as a wetland, and extent of representation in Queensland's Protected Area Estate. For a description of the vegetation communities within the AOI and classified according to the 1:1,000,000 BVG, refer to **Table 6**.

Table 4: Remnant regional ecosystems within the AOI, additional information

Regional Ecosystem	Remnant Extent	BVG (1 Million)	Wetland	Representation in protected estate
8.3.2	Pre-clearing 45000 ha; Remnant 2015 8000 ha	21a	Floodplain (other than floodplain wetlands).	Low
8.3.3a	Pre-clearing 25000 ha; Remnant 2015 15000 ha	22c	Riverine wetland or fringing riverine wetland.	No representation

Regional Ecosystem	Remnant Extent	BVG (1 Million)	Wetland	Representation in protected estate
8.3.5	Pre-clearing 154000 ha; Remnant 2015 21000 ha	9e	None	No representation
8.3.6a	Pre-clearing 67000 ha; Remnant 2015 15000 ha	9e	Floodplain (other than floodplain wetlands).	Low
8.5.2a	Pre-clearing 13000 ha; Remnant 2015 4000 ha	21a	None	Low
non-rem	None	None	None	None

Representation in Protected Area Estate: High greater than 10% of pre-clearing extent is represented; Medium 4 - 10% is represented; Low less than 4% is represented, No representation.

Map 6 displays the distribution of mapped wetland systems within the area of interest.

The following table lists known special values associated with a regional ecosystem type.

Table 5: Remnant regional ecosystems within the AOI, special values

Regional Ecosystem	Special Values
8.3.2	This vegetation type often has a diverse ground stratum, and some of these species remain poorly collected and known. It is known habitat for the threatened species Habenaria xanthantha and Eulophia bicallosa which are both listed as "Near Threatened" in the Queensland Nature Conservation Act 1992. Habitat for a number of poorly known and collected species, or species at the edge of their range, including Pheidochloa gracilis, Cartonema brachyantherum, Platostoma longicorne, Cyperus sanguinolentus, Hibbertia sp. (Barakula V.Hando 122), Eleocharis setifolia, Fimbristylis aestivalis, Fimbristylis depauperata, Fimbristylis tristachya, Haloragis heterophylla, Murdannia gigantea, Phyllanthus simplex, Scleria caricina, Salomonia ciliata, Mitrasacme paludosa, Byblis liniflora, Fimbristylis furva and Drosera burmanni. Likely habitat for Rhamphicarpa australiensis which is listed as "Near Threatened" in the Queensland Nature Conservation Act 1992.

Regional Ecosystem	Special Values
8.3.3a	Habitat for Rourea brachyandra, Rhamphicarpa australiensis, Eulophia bicallosa and Lobelia membranacea which are listed under the Queensland Nature Conservation Act as "Near Threatened". Also habitat for Eucalyptus raveretiana which are listed under the Queensland Nature Conservation Act as "Vulnerable". The combination of the fairly high diversity of canopy or subcanopy species, species not found in the surrounding landscape, and humid micro-environment makes this vegetation community an important food resource and refuge for a variety of fauna which are then often able to utilise the surrounding ecosystems. Habitat for the Rufous Owl and Grey Goshawk. 8.3.3b: Habitat for Grevillea venusta which is listed under the Queensland Nature Conservation Act and the Environment Protection and Biodiversity Conservation Act 1999as "Vulnerable". Habitat for species that are poorly known or poorly collected in the Central Queensland Coast bioregion including Dodonaea triquetra, Daviesia umbellulata, Melaleuca hemisticta, Zieria minutiflora subsp. trichocarpa, Hibbertia velutina, Hovea longipes and species at the northern limit of their range such as Hibbertia vestita, Pomaderris ferruginea, Sannantha bidwillii, Philotheca difformis subsp. smithiana, Macrozamia miquelii, Lepidosperma elatius and Hovea clavata. Also habitat for Bowenia serrulata which is restricted to the Shoalwater area. The combination of the fairly high diversity of canopy or subcanopy species, species not found in the surrounding landscape, and humid micro-environment makes this vegetation community an important food resource and refuge for a variety of fauna which are then often able to utilise the surrounding ecosystems.
8.3.5	A vegetation community with a very diverse ground layer, which has been poorly surveyed for flora and fauna. Likely to be habitat for the Red-cheeked Dunnart (Sminthopsis virginiae) which has been recorded south of Mount Blackwood, and otherwise rarely recorded in the bioregion. Habitat for many plant species which are poorly known and/or collected in the Central Queensland Coast bioregion (and/or at the limits of their known range), including Jacksonia scoparia, Murdannia gigantea, Aristida acuta, Cyperus zollingeri, Hibbertia vestita, Goodenia pilosa, Panicum seminudum var. cairnsianum, Polygala wightiana, Schizachyrium pseudeulalia and Vigna sp. (Station Creek R.J.Lawn CQ3284). Likely habitat for the poorly known species Rhamphicarpa australiensis which is listed as "Near Threatened" in the Queensland Nature Conservation Act 1992.
8.3.6a	Any remnants which are in good condition with minimal weed invasion (if they exist) are considered to be extremely high value as most remnants are heavily invaded by weeds. Known habitat for Red Goshawk (listed as "Endangered" under the Queensland Nature Conservation Act 1992) and arboreal mammals. 8.3.6c: Habitat for species at the northern limit of their range including Petalostigma triloculare, and Podolepis longipedata, as well as species poorly known or collected in the Central Queensland Coast bioregion such as Acacia leiocalyx subsp. leiocalyx, Acronychia imperforata, Planchonella pohlmaniana var. (Gilbert River C.T.White 1409), Hypoxis pratensis var. pratensis and Lomandra leucocephala subsp. leucocephala. The few areas which remain in good condition within the Shoalwater Bay Training Area are extremely valuable given the long history of clearing, and detrimental effects of grazing on this regional ecosystem overall.

Regional Ecosystem	Special Values
8.5.2a	Potential habitat for the species Habenaria xanthantha, Eulophia bicallosa and Rhamphicarpa australiensis which are all listed as "Near Threatened" in the Queensland Nature Conservation Act 1992. The ground layer is very species rich, and includes many species which are poorly collected or known in the Central Queensland Coast, such as Mnesithea formosa, Panicum seminudum var. cairnsianum, Pseudopogonatherum contortum, Buchnera gracilis, Phyllanthus simplex, Phyllanthus sulcatus, Polygala wightiana, Schizachyrium dolosum, Polygala exsquarrosa, Byblis liniflora, Centrolepis exserta, Centrolepis banksii, Cyperus cristulatus, Fimbristylis acuminata, Fimbristylis pterigosperma, Habenaria propinquior, Heliotropium vagum, Hybanthus monopetalus, Mitrasacme laricifolia, Mitrasacme multicaulis, Mitrasacme brachystemonea, Polygala longifolia, Rhynchospora pterochaeta, Sarga angustum, Schizachyrium dolosum, Thaumastochloa major, Thysanotus banksii, Xyris indica, Cartonema brachyantherum, and Rotala occultiflora. 8.5.2c: Potential habitat for the Habenaria xanthantha, Eulophia bicallosa and Rhamphicarpa australiensis which are all listed as "Near Threatened" in the Queensland Nature Conservation Act 1992. The ground layer is very species rich, and includes many species which are poorly collected or known in the Central Queensland Coast bioregion, such as Aristida acuta, Alysicarpus schomburgkii, Cyperus castaneus, Cyperus nervulosus, Eriocaulon nanum, Mnesithea formosa, Panicum seminudum var. cairnsianum, Buchnera gracilis, Phyllanthus simplex, Byblis liniflora, Mitrasacme laricifolia, Mitrasacme multicaulis, Mitrasacme brachystemonea, Polygala longifolia, Rhynchospora pterochaeta, Sarga angustum, Schizachyrium dolosum, Thaumastochloa major, Thysanotus banksii, Xyris indica and Rotala occultiflora.
non-rem	None

3. Remnant Regional Ecosystems by Broad Vegetation Group

BVGs are a higher-level grouping of vegetation communities. Queensland encompasses a wide variety of landscapes across temperate, wet and dry tropics and semi-arid climatic zones. BVGs provide an overview of vegetation communities across the state or a bioregion and allow comparison with other states. There are three levels of BVGs which reflect the approximate scale at which they are designed to be used: the 1:5,000,000 (national), 1:2,000,000 (state) and 1:1,000,000 (regional).

A comprehensive description of BVGs is available at:

https://publications.qld.gov.au/dataset/vegetation-qld/resource/921fa786-e6d5-4a8a-9b0c-e532d2ce3f32

The following table provides a description of the 1:1,000,000 BVGs present and their associated extent within the AOI.

Table 6: Broad vegetation groups (1 million) within the AOI

BVG (1 Million)	Description	Area (Ha)	% of AOI
None	None	1237.1	98.5
21a	Low open woodlands and tall shrublands of Melaleuca citrolens or M. stenostachya or other Melaleuca spp. (land zones 5, 3, 7, 10, 11, 12) (GUP, CYP, EIU, DEU, BRB, [SEQ])	13.7	1.1
22c	Open forests dominated by Melaleuca spp. (M. argentea (silver tea-tree), M. leucadendra (broad-leaved tea-tree), M. dealbata (swamp tea-tree) or M. fluviatilis), fringing major streams with Melaleuca saligna or M. bracteata (black tea-tree) in minor streams. (land zone 3) (CYP, GUP, EIU, BRB, CQC, DEU, NWH, WET, [SEQ])	0.7	0.1

BVG (1 Million)	Description	Area (Ha)	% of AOI
9e	Open forests, woodlands and open woodlands dominated by Corymbia clarksoniana (grey bloodwood) (or C. novoguinensis or C. intermedia (pink bloodwood) or C. polycarpa (long-fruited bloodwood)) frequently with Erythrophleum chlorostachys (red ironwood) or Eucalyptus platyphylla (poplar gum) predominantly on coastal sandplains and alluvia. (land zones 3, 5, 2) (CYP, BRB, CQC, WET, EIU)	5.0	0.4

Refer to **Map 4** for further information. **Map 5** also provides a representation of the distribution of vegetation communities as per the 1:5,000,000 BVG believed to be present prior to European settlement.

4. Technical and BioCondition Benchmark Descriptions

Technical descriptions provide a detailed description of the full range in structure and floristic composition of regional ecosystems (e.g. 11.3.1) and their component vegetation communities (e.g. 11.3.1a, 11.3.1b). See:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

The descriptions are compiled using site survey data from the Queensland Herbarium's CORVEG database. Distribution maps, representative images (if available) and the pre-clearing and remnant area (hectares) of each vegetation community derived from the regional ecosystem mapping (spatial) data are included. The technical descriptions should be used in conjunction with the fields from the regional ecosystem description database (REDD) for a full description of the regional ecosystem.

Quantitative site data from relatively undisturbed sites are extracted from CORVEG and summarized to provide information specific to each vegetation community.

Technical descriptions include the attributes: tree canopy height and cover and native plant species composition of the predominant layer, which are used to assess the remnant status of vegetation under the *Vegetation Management Act 1999*.

However, as technical descriptions reflect the full range in structure and floristic composition across the climatic, natural disturbance and geographic range of the regional ecosystem, local reference sites should be used where possible (Neldner et al. 2012 (PDF)* section 3.3.1 of:

http://www.qld.gov.au/environment/assets/documents/plants-animals/herbarium/herbarium-mapping-methodology.pdf

The technical descriptions are subject to review and are updated as additional data becomes available.

When conducting a BioCondition assessment, these technical descriptions should be used in conjunction with BioCondition benchmarks for the specific regional ecosystem, or component vegetation community.

http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

Benchmarks are subject to review based on additional data and expert opinion. Benchmarks are based on a combination of quantitative and qualitative information and should be used as a guide only. Benchmarks are specific to one regional ecosystem vegetation community, however, the natural variability in structure and floristic composition under a range of climatic and natural disturbance regimes has been considered throughout the geographic extent of the regional ecosystem. Local reference sites should be used for this spatial and temporal (seasonal and annual) variability.

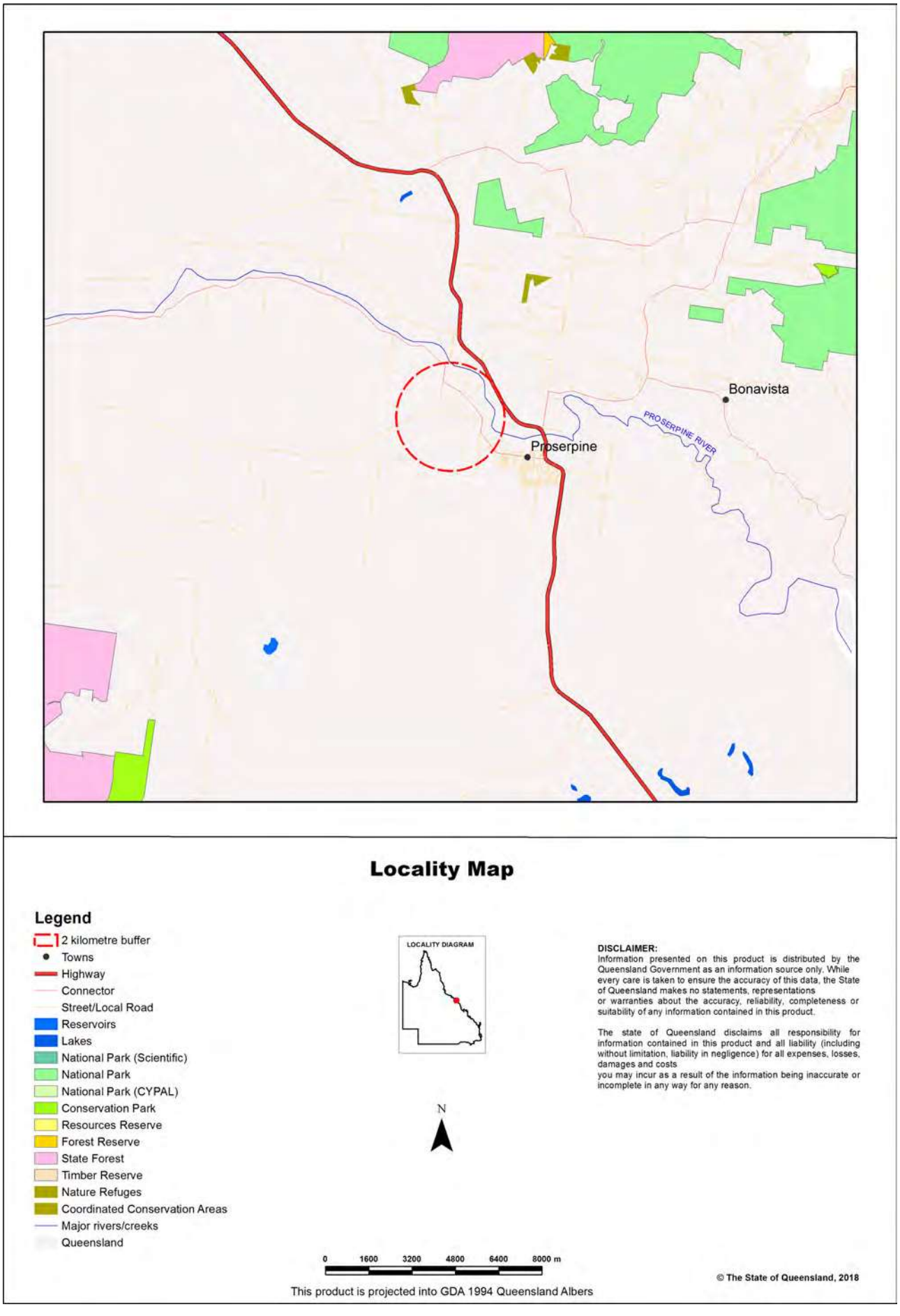
Table 7: List of remnant regional ecosystems within the AOI for which technical and biocondition benchmark descriptions are available

Regional ecosystems mapped as within the AOI	Technical Descriptions	Biocondition Benchmarks
8.3.2	Available	Available
8.3.3a	Available	Not currently available
8.3.5	Available	Not currently available
8.3.6a	Available	Not currently available

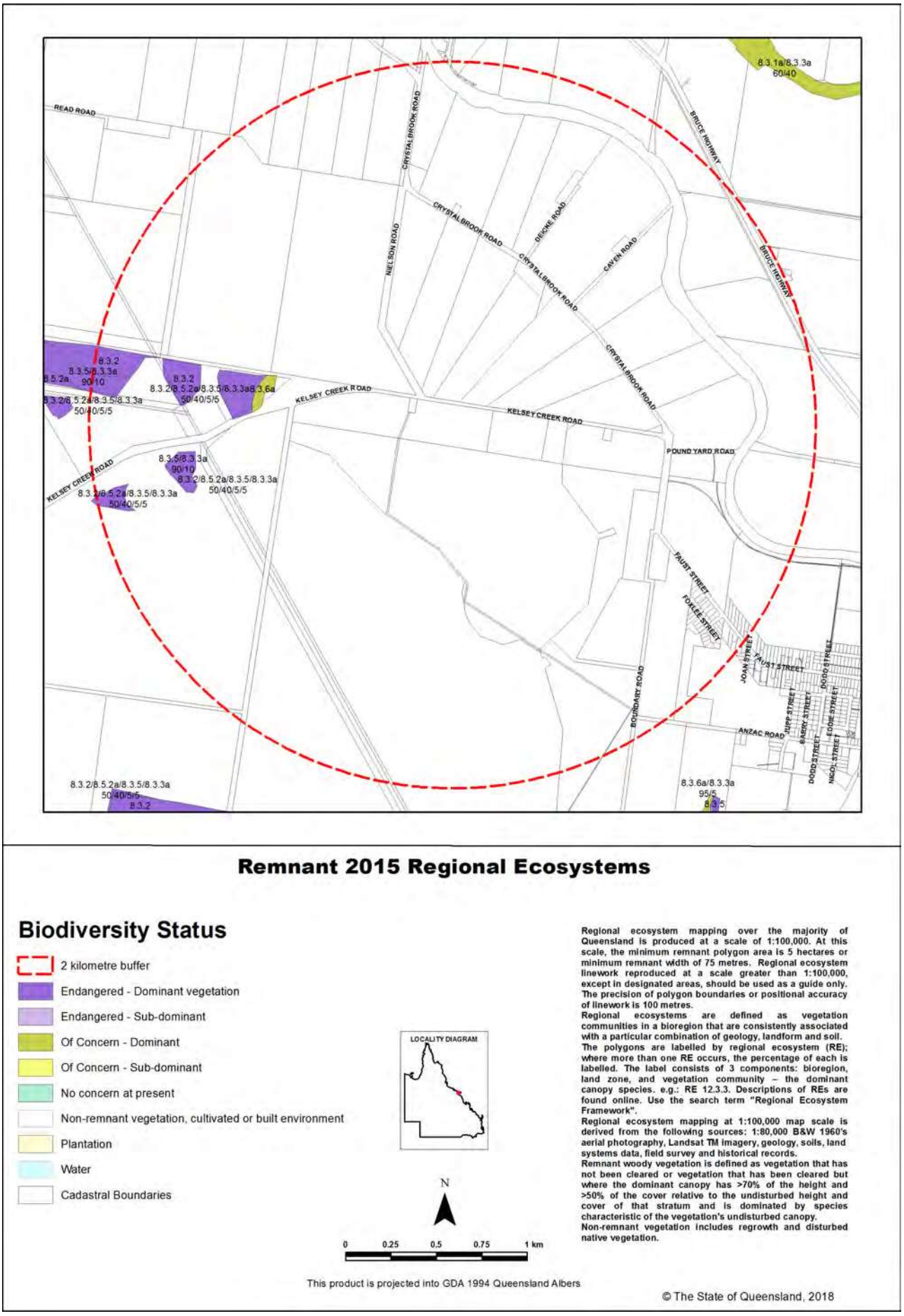
Regional ecosystems mapped as within the AOI	Technical Descriptions	Biocondition Benchmarks
8.5.2a	Available	Not currently available
non-rem	Not currently available	Not currently available

Maps

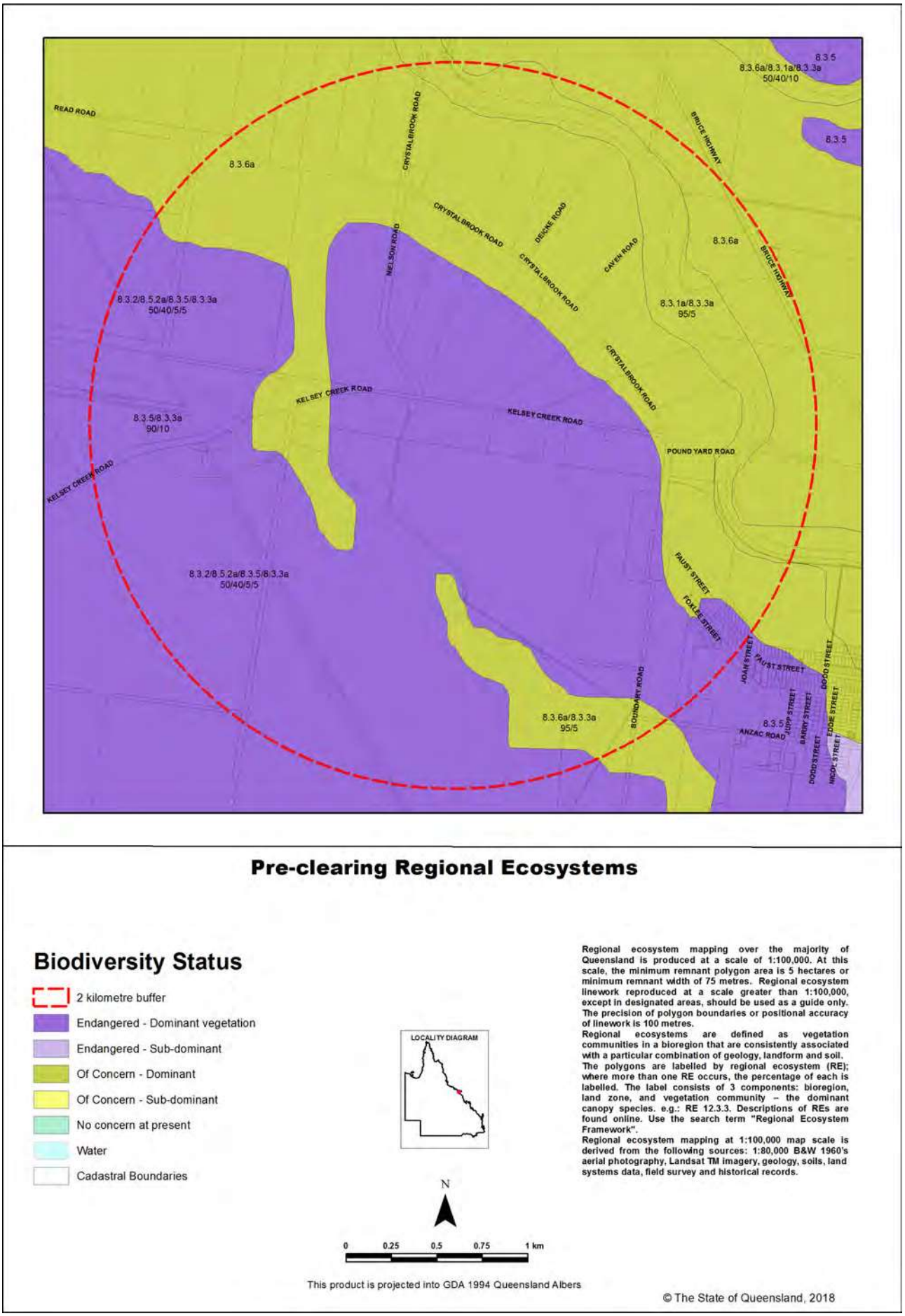
Map 1 - Location



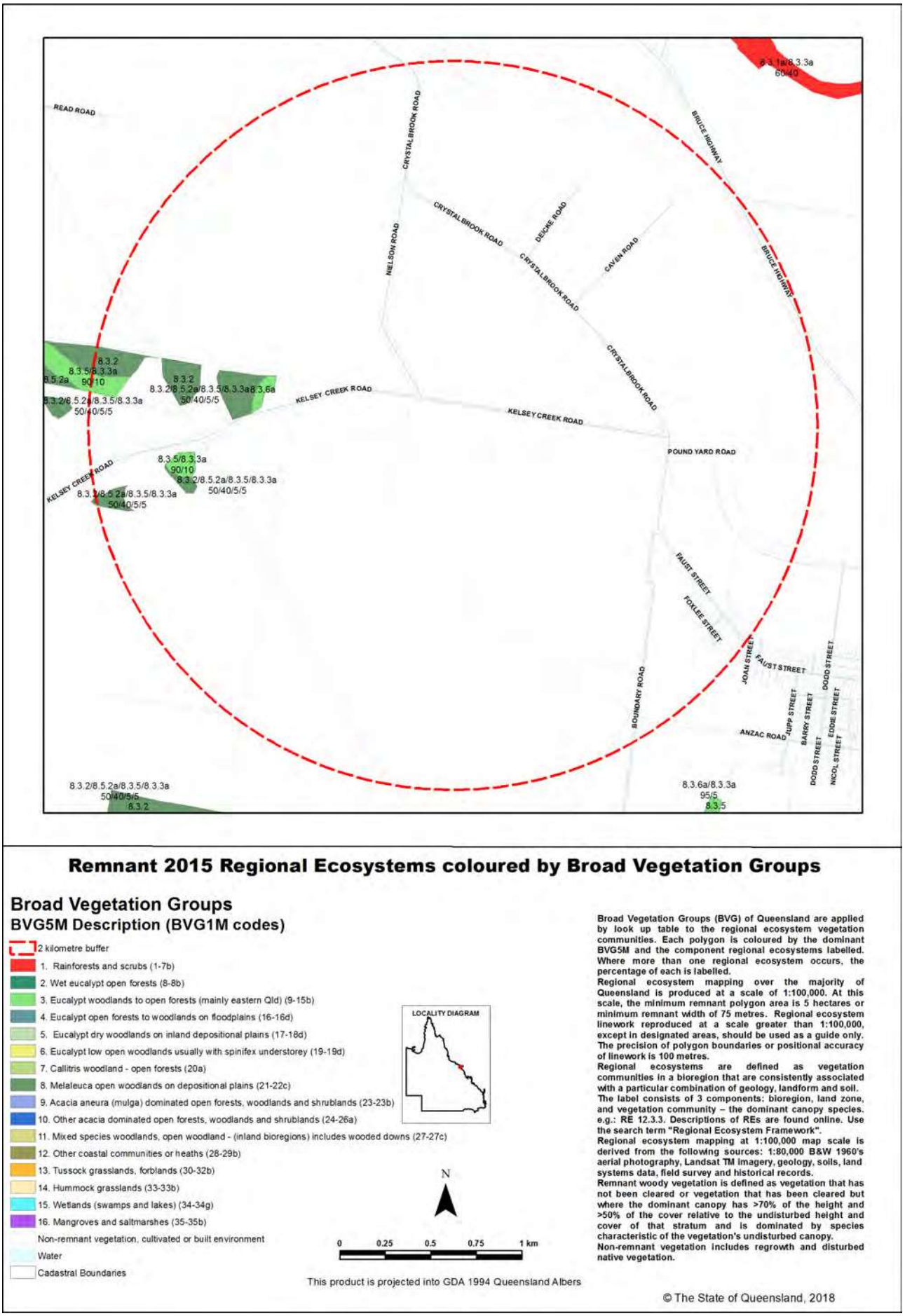
Map 2 - Remnant regional ecosystems



Map 3 - Pre-clearing remnant regional ecosystems



Map 4 - Remnant regional ecosystems by BVG (5M)



Remnant 2015 Regional Ecosystems coloured by Broad Vegetation Groups

Broad Vegetation Groups
BVG5M Description (BVG1M codes)

- 2 kilometre buffer
- 1. Rainforests and scrubs (1-7b)
- 2. Wet eucalypt open forests (8-8b)
- 3. Eucalypt woodlands to open forests (mainly eastern Qld) (9-15b)
- 4. Eucalypt open forests to woodlands on floodplains (16-16d)
- 5. Eucalypt dry woodlands on inland depositional plains (17-18d)
- 6. Eucalypt low open woodlands usually with spinifex understorey (19-19d)
- 7. Callitris woodland - open forests (20a)
- 8. Melaleuca open woodlands on depositional plains (21-22c)
- 9. Acacia aneura (mulga) dominated open forests, woodlands and shrublands (23-23b)
- 10. Other acacia dominated open forests, woodlands and shrublands (24-26a)
- 11. Mixed species woodlands, open woodland - (inland bioregions) includes wooded downs (27-27c)
- 12. Other coastal communities or heaths (28-29b)
- 13. Tussock grasslands, forblands (30-32b)
- 14. Hummock grasslands (33-33b)
- 15. Wetlands (swamps and lakes) (34-34g)
- 16. Mangroves and saltmarshes (35-35b)
- Non-remnant vegetation, cultivated or built environment
- Water
- Cadastral Boundaries

LOCALITY DIAGRAM

N

0 0.25 0.5 0.75 1 km

This product is projected into GDA 1994 Queensland Albers

Broad Vegetation Groups (BVG) of Queensland are applied by look up table to the regional ecosystem vegetation communities. Each polygon is coloured by the dominant BVG5M and the component regional ecosystems labelled. Where more than one regional ecosystem occurs, the percentage of each is labelled.

Regional ecosystem mapping over the majority of Queensland is produced at a scale of 1:100,000. At this scale, the minimum remnant polygon area is 5 hectares or minimum remnant width of 75 metres. Regional ecosystem linework reproduced at a scale greater than 1:100,000, except in designated areas, should be used as a guide only. The precision of polygon boundaries or positional accuracy of linework is 100 metres.

Regional ecosystems are defined as vegetation communities in a bioregion that are consistently associated with a particular combination of geology, landform and soil. The label consists of 3 components: bioregion, land zone, and vegetation community – the dominant canopy species. e.g.: RE 12.3.3. Descriptions of REs are found online. Use the search term "Regional Ecosystem Framework".

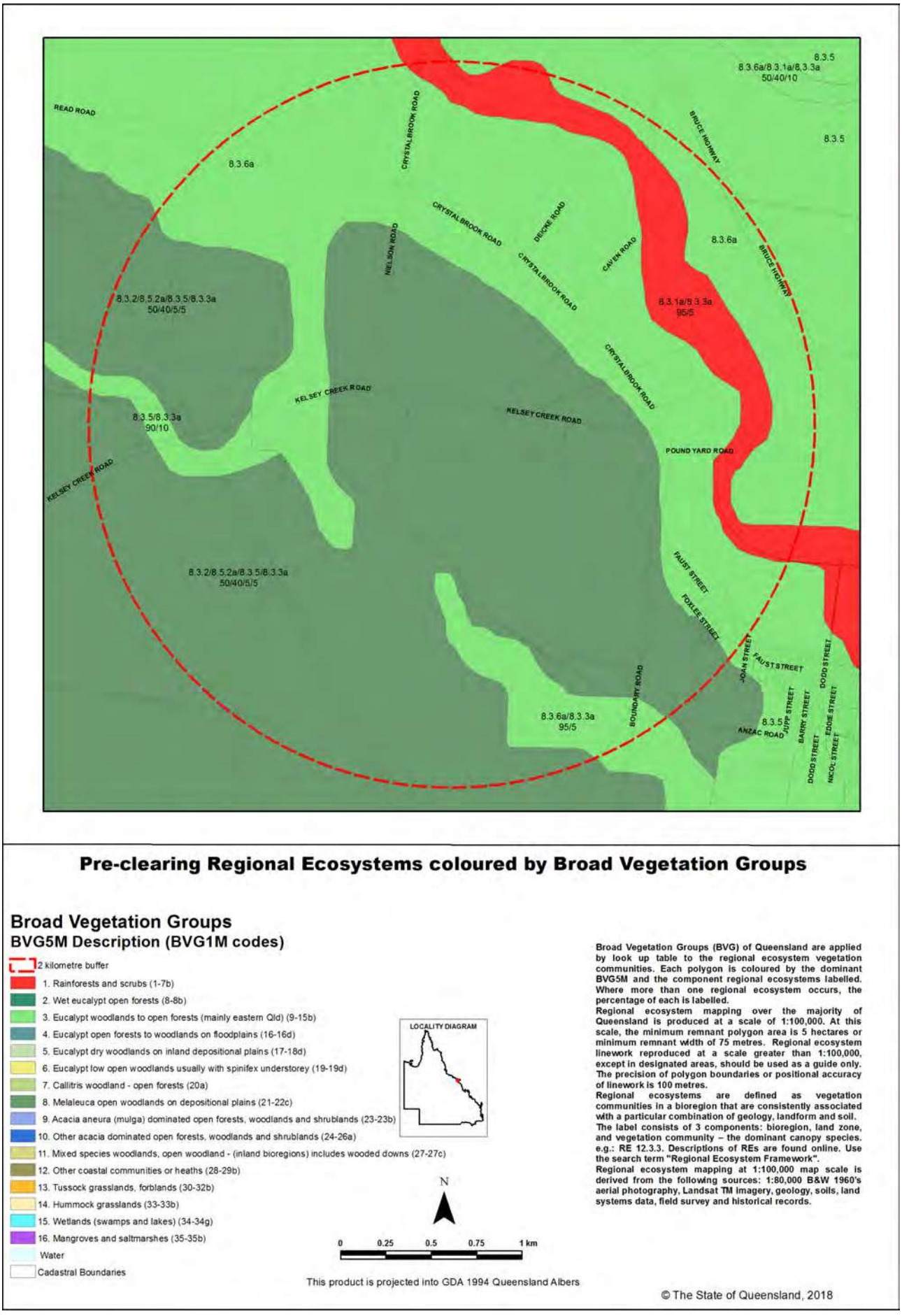
Regional ecosystem mapping at 1:100,000 map scale is derived from the following sources: 1:80,000 B&W 1960's aerial photography, Landsat TM imagery, geology, soils, land systems data, field survey and historical records.

Remnant woody vegetation is defined as vegetation that has not been cleared or vegetation that has been cleared but where the dominant canopy has >70% of the height and >50% of the cover relative to the undisturbed height and cover of that stratum and is dominated by species characteristic of the vegetation's undisturbed canopy.

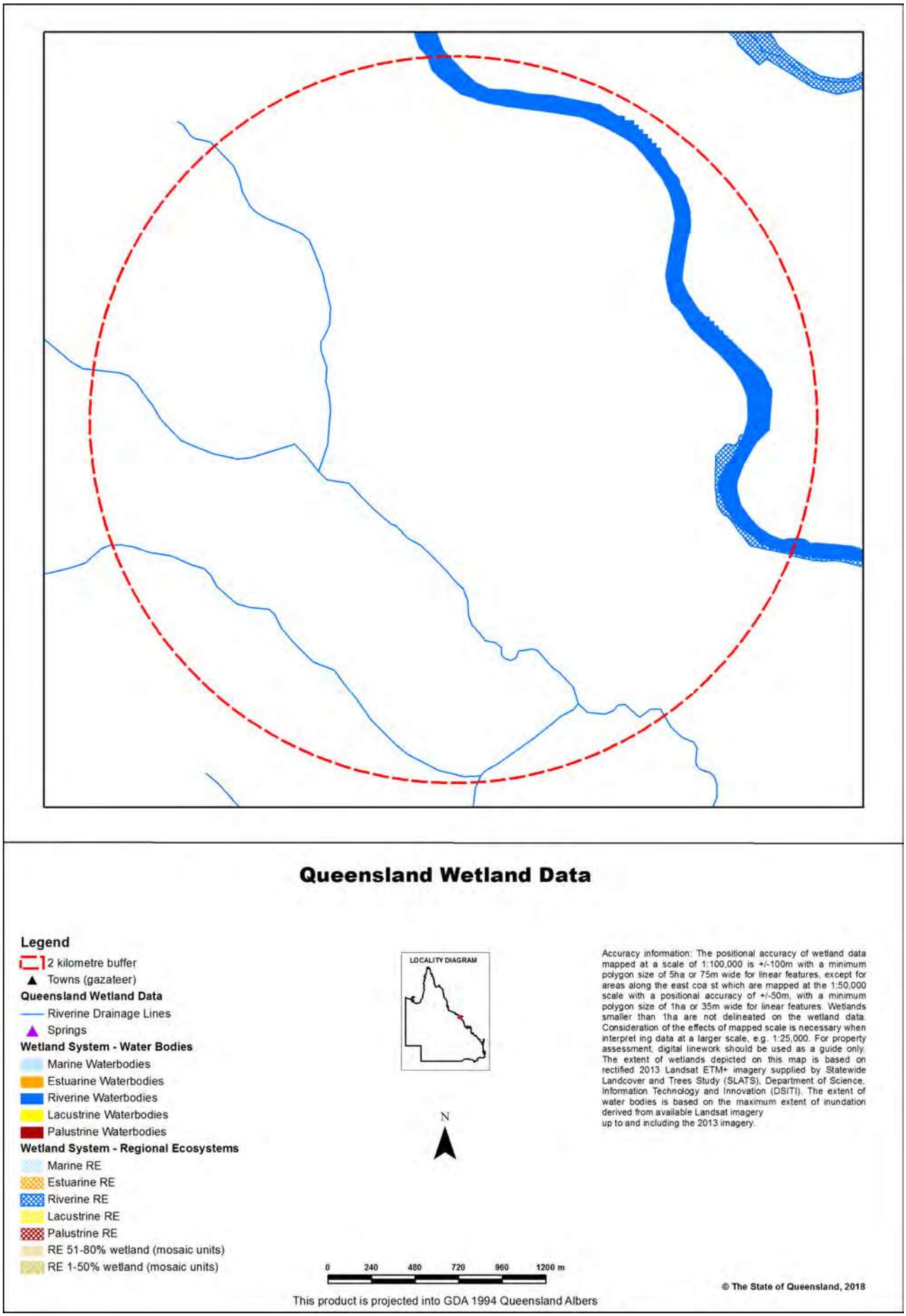
Non-remnant vegetation includes regrowth and disturbed native vegetation.

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Map 5 - Pre-clearing remnant regional ecosystems by BVG (5M)



Map 6 - Wetlands and waterways



Links and Other Information Sources

The Department of Environment and Heritage's Website -

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/

provides further information on the regional ecosystem framework, including access to links to the Regional Ecosystem Database, Broad Vegetation Group Definitions, Regional Ecosystem and Land zone descriptions.

Descriptions of the broad vegetation groups of Queensland can be downloaded from:

https://publications.qld.gov.au/dataset/vegetation-qld/resource/921fa786-e6d5-4a8a-9b0c-e532d2ce3f32

The methodology for mapping regional ecosystems can be downloaded from:

http://www.qld.gov.au/environment/assets/documents/plants-animals/herbarium/herbarium-mapping-methodology.pdf

Technical descriptions for regional ecosystems can be obtained from:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

Benchmarks can be obtained from:

http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

For further information associated with the remnant regional ecosystem dataset used by this report, such as the year at which the extent of remnant is reflective of, refer to the metadata associated with the relevant Remnant Regional Ecosystems of Queensland dataset (version listed in **Appendix 1**) and which is available through the Queensland Government Information System portal,

http://dds.information.qld.gov.au/dds/

The Queensland Globe is a mapping and data application implemented inside the Google Earth TM application. As an interactive online tool, Queensland Globe allows you to view and explore Queensland maps, imagery (including up-to-date satellite images) and other spatial data, including regional ecosystem mapping. To further view and explore regional ecosystems over an area of interest, access the Biota Globe (a component of the Queensland Globe). The Queensland Globe can be accessed via the following link:

http://www.dnrm.qld.gov.au/mapping-data/queensland-globe

References

Neldner, V.J., Wilson, B.A., Thompson, E.J., and Dillewaard, H.A. (2012). *Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland*. Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts.

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Neldner, V.J., Niehus R.E., Wilson, B.A. McDonald, W.J.F. and Ford, A.J. (2014). The Vegetation of Queensland. Descriptions of Broad Vegetation Groups. Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts.

(https://publications.qld.gov.au/dataset/vegetation-qld/resource/921fa786-e6d5-4a8a-9b0c-e532d2ce3f32)

Sattler, P.S. and Williams, R.D. (eds) (1999). *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency, Brisbane.

Appendices

Appendix 1: Source Data

The dataset listed below is available for download from:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/download/

- Regional Ecosystem Description Database

The datasets listed below are available for download from:

http://dds.information.qld.gov.au/dds/

- Remnant Regional Ecosystems of Queensland
- Pre-clearing Vegetation Communities and Regional Ecosystems of Queensland
- Queensland Wetland Data Version - Wetland lines
- Queensland Wetland Data Version - Wetland points
- Queensland Wetland Data Version - Wetland areas

Appendix 2 - Acronyms and Abbreviations

AOI	- Area of Interest
DNRM	- Department of Natural Resources and Mines
EHP	- Department of Environment and Heritage Protection
GDA94	- Geocentric Datum of Australia 1994
GIS	- Geographic Information System
RE	- Regional Ecosystem
REDD	- Regional Ecosystem Description Database
VMA	- *Vegetation Management Act 1999*

Queensland Government

Department of Environment and Heritage Protection

Environmental Reports

Biodiversity and Conservation Values

Biodiversity Planning Assessments and Aquatic Conservation Assessments

Area of Interest: Longitude: 148.55308 Latitude: -20.388652

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or Area of Interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "Central co-ordinates" option, the resulting assessment area encompasses an area extending from 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Please direct queries about these reports to: biodiversity.planning@ehp.qld.gov.au

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness, or suitability, for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which the user may incur as a consequence of the information being inaccurate or incomplete in any way and for any reason.



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Summary Information

Tables 1 to 8 provide an overview of the AOI with respect to selected topographic and environmental values.

Table 1: Area of interest details

Area of Interest	148.55308,-20.388652 with 2 kilometre radius
Size (ha)	1256.6
Local Government(s)	WHITSUNDAY REGIONAL
Bioregion(s)	Central Queensland Coast
Subregion(s)	Proserpine - Sarina Lowlands
Catchment(s)	Proserpine

The following table identifies available Biodiversity Planning Assessments (BPAs) and Aquatic Conservation Assessments (ACAs) with respect to the AOI.

Table 2: Available Biodiversity Planning and Aquatic Conservation Assessments

Assessment Type	Assessment Area and Version
Biodiversity Planning Assessment(s)	Central Queensland Coast v1.3
Aquatic Conservation Assessment(s) (riverine)	Great Barrier Reef Catchment v1.1
Aquatic Conservation Assessment(s) (non-riverine)	Great Barrier Reef Catchment v1.3

Table 3: Remnant regional ecosystems within the AOI as per the Qld Herbarium's 'biodiversity status'

Biodiversity Status	Area (Ha)	% of AOI
Endangered	17.4	1.4%
Of Concern	2.0	0.2%
No concern at present	0.0	0.0%

The following table identifies the extent and proportion of the user specified area of interest (AOI) which is mapped as being of "State", "Regional" or "Local" significance via application of the Queensland Department of Environment and Heritage Protection's *Biodiversity Assessment and Mapping Methodology* (BAMM).

Table 4: Summary table, biodiversity significance

Biodiversity significance	Area (Ha)	% of AOI
State Habitat for EVNT taxa	0.0	0.0%
State	19.9	1.6%
Regional	33.1	2.6%
Local or Other Values	0.0	0.0%

Table 5: Non-riverine wetlands intersecting the AOI

Non-riverine wetland types intersecting the area of interest	#
(No Records)	

NB. The figures presented in the table above are derived from the relevant non-riverine Aquatic Conservation Assessment(s). Later releases of wetland mapping produced via the Queensland Wetland Mapping Program may provide more recent information in regards to wetland extent.

Table 6: Named waterways intersecting the AOI

Name	Permanency
PROSERPINE RIVER	Perennial

Refer to **Map 1** for general locality information.

The following two tables identify the extent and proportion of the user specified AOI which is mapped as being of "Very High", "High", "Medium", "Low", or "Very Low" aquatic conservation value for riverine and non-riverine wetlands via application of the Queensland Department of Environment and Heritage Protection's *Aquatic Biodiversity Assessment and Mapping Method* (AquaBAMM).

Table 7: Summary table, aquatic conservation significance (riverine)

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	48.7	3.9%
High	1183.0	94.1%
Medium	24.9	2.0%
Low	0.0	0.0%
Very Low	0.0	0.0%

Table 8: Summary table, aquatic conservation significance (non-riverine)

Aquatic conservation significance (non-riverine wetlands)	Area (Ha)	% of AOI
(No Records)		

Biodiversity Planning Assessments

Introduction

The department of Environment and Heritage Protection (EHP) attributes biodiversity significance on a bioregional scale through a Biodiversity Planning Assessment (BPA). A BPA involves the integration of ecological criteria using the *Biodiversity assessment and Mapping Methodology* (BAMM) and is developed in two stages: 1) **diagnostic criteria**, and 2) **expert panel criteria**. The diagnostic criteria are based on existing data which is reliable and uniformly available across a bioregion, while the expert panel criteria allows for the refinement of the mapped information from the diagnostic output by incorporating local knowledge and expert opinion.

The BAMM methodology has application for identifying areas with various levels of significance solely for biodiversity reasons. These include threatened ecosystems or taxa, large tracts of habitat in good condition, ecosystem diversity, landscape context and connection, and buffers to wetlands or other types of habitat important for the maintenance of biodiversity or ecological processes. While natural resource values such as dryland salinity, soil erosion potential or land capability are not dealt with explicitly, they are included to some extent within the biodiversity status of regional ecosystems recognised by the EHP.

Biodiversity Planning Assessments (BPAs) assign three levels of overall biodiversity significance.

- **State significance** - areas assessed as being significant for biodiversity at the bioregional or state scales. They also include areas assessed by other studies/processes as being significant at national or international scales. In addition, areas flagged as being of State significance due to the presence of endangered, vulnerable and/or near threatened taxa, are identified as "State Habitat for EVNT taxa".
- **Regional significance** - areas assessed as being significant for biodiversity at the subregional scale. These areas have lower significance for biodiversity than areas assessed as being of State significance.
- **Local significance and/or other values** - areas assessed as not being significant for biodiversity at state or regional scales. Local values are of significance at the local government scale.

For further information on released BPAs and a copy of the underlying methodology, go to:

http://www.qld.gov.au/environment/plants-animals/biodiversity/planning/

The GIS results can be downloaded from the Queensland Spatial Catalogue at:

http://qspatial.information.qld.gov.au/geoportal/

The following table identifies the extent and proportion of the user specified AOI which is mapped as being of "State", "Regional" or "Local" significance via application of the BAMM.

Table 9: Summary table, biodiversity significance

Biodiversity significance	Area (Ha)	% of AOI
State Habitat for EVNT taxa	0.0	0.0%
State	19.9	1.6%
Regional	33.1	2.6%
Local or Other Values	0.0	0.0%

Refer to **Map 2** for further information.

Diagnostic Criteria

Diagnostic criteria are based on existing data which is reliable and uniformly available across a bioregion. These criteria are diagnostic in that they are used to filter the available data and provide a "first-cut" or initial determination of biodiversity significance. This initial assessment is then combined through a second group of other essential criteria.

A description of the individual diagnostic criteria is provided in the following sections.

Criteria A. Habitat for EVNT taxa: Classifies areas according to their significance based on the presence of endangered, vulnerable and/or rare (EVNT) taxa. EVNT taxa are those scheduled under the *Nature Conservation Act 1992* and/or the *Environment Protection and Biodiversity Conservation Act 1999*. It excludes highly mobile fauna taxa which are instead considered in Criterion H and brings together information on EVNT taxa using buffering of recorded sites or habitat suitability models (HSM) where available.

Criteria B. Ecosystem value: Classifies on the basis of biodiversity status of regional ecosystems, their extent in protected areas (presence of poorly conserved regional ecosystems), the presence of significant wetlands and intertidal zones; and areas of national importance such as World Heritage areas and Ramsar sites. Ecosystem value is applied at a bioregional (**B1**) and regional (**B2**) scale.

Criteria C. Tract size: Measures the relative size of tracts of vegetation in the landscape. The size of any tract is a major indicator of ecological significance, and is also strongly correlated with the long-term viability of biodiversity values. Larger tracts are less susceptible to ecological edge effects and are more likely to sustain viable populations of native flora and fauna than smaller tracts.

Criteria D. Relative size of regional ecosystems: Classifies the relative size of each regional ecosystem unit within its bioregion (**D1**) and its subregion (**D2**). Remnant units are compared with all other occurrences with the same regional ecosystem. Large examples of a regional ecosystem are more significant than smaller examples of the same regional ecosystem because they are more representative of the biodiversity values particular to the regional ecosystem, are more resilient to the effects of disturbance, and constitute a significant proportion of the total area of the regional ecosystem.

Criteria F. Ecosystem diversity: Is an indicator of the number of regional ecosystems occurring within an area. An area with high ecosystem diversity will have many regional ecosystems and ecotones relative to other areas within the bioregion.

Criteria G. Context and connection: Represents the extent to which a remnant unit incorporates, borders or buffers areas such as significant wetlands, endangered ecosystems; and the degree to which it is connected to other vegetation.

A summary of the biodiversity status based upon the diagnostic criteria is provided in the following table.

Table 10: Summary of biodiversity significance based upon diagnostic criteria with respect to the AOI

Biodiversity significance	Description	Area (Ha)	% of AOI
State	Remnant contains at least 1 Endangered RE (B1)	20.0	1.6

Assessment of diagnostic criteria with respect to the AOI

The following table reflects an assessment of the individual diagnostic criteria noted above in regards to the AOI.

Table 11: Assessment of individual diagnostic criteria with respect to the AOI

Diagnostic Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
A: Habitat for EVNT Taxa							19.9	1.6
B1: Ecosystem Value (Bioregion)	19.9	1.6						
B2: Ecosystem Value (Subregion)	9.3	0.7	10.6	0.8				
C: Tract Size							19.9	1.6
D1: Relative RE Size (Bioregion)							19.9	1.6
D2: Relative RE Size (Subregion)							19.9	1.6
F: Ecosystem Diversity	1.5	0.1	14.6	1.2	3.8	0.3		
G: Context and Connection			2.0	0.2	12.2	1.0	5.7	0.5

Other Essential Criteria

Other essential criteria (also known as expert panel criteria) are based on non-uniform information sources and which may rely more upon expert opinion than on quantitative data. These criteria are used to provide a "second-cut" determination of biodiversity significance, which is then combined with the diagnostic criteria for an overall assessment of relative biodiversity significance. A summary of the biodiversity status based upon the other essential criteria is provided in the following table.

Table 12: Summary of biodiversity significance based upon other essential criteria with respect to the AOI

Biodiversity significance	Description	Area (Ha)	% of AOI
Regional	Remnant forms part of a bioregional corridor (J)	33.1	2.6

A description of each of the other essential criteria and associated assessment in regards to the AOI is provided in the following sections.

Criteria H. Essential and general habitat for priority taxa: Priority taxa are those which are at risk or of management concern, taxa of scientific interest as relictual (ancient or primitive), endemic taxa or locally significant populations (such as a flying fox camp or heronry), highly specialised taxa whose habitat requirements are complex and distributions are not well correlated with any particular regional ecosystem, taxa important for maintaining genetic diversity (such as complex spatial patterns of genetic variation, geographic range limits, highly disjunct populations), taxa critical for management or monitoring of biodiversity (functionally important or ecological indicators), or economic and culturally important taxa.

This criterion can be used to identify essential and general habitat for EVNT and other priority taxa additional to that derived under Diagnostic Criterion A. Information sources include expert and local knowledge, technical reports and papers, and modelled maps of essential and general habitat.

Criteria I. Special biodiversity values: areas with special biodiversity values are important because they contain multiple taxa in a unique ecological and often highly biodiverse environment. Areas with special biodiversity values can include the following:

- Ia - centres of endemism - areas where concentrations of taxa are endemic to a bioregion or subregion are found.
- Ib - wildlife refugia (Morton *et al*. 1995), for example, islands, mound springs, caves, wetlands, gorges, mountain ranges and topographic isolates, ecological refuges, refuges from exotic animals, and refuges from clearing. The latter may include large areas that are not suitable for clearing because of land suitability/capability.
- Ic - areas with concentrations of disjunct populations.
- Id - areas with concentrations of taxa at the limits of their geographic ranges.
- Ie - areas with high species richness.
- If - areas with concentrations of relictual populations (ancient and primitive taxa).
- Ig - areas containing REs with distinct variation in species composition associated with geomorphology and other environmental variables.
- Ih - an artificial waterbody or managed/manipulated wetland considered by the panel/s to be of ecological significance.
- Ii - areas with a high density of hollow-bearing trees that provide habitat for animals.
- Ij - breeding or roosting sites used by a significant number of individuals.
- Ik - climate change refuge.

The following table identifies the value and extent area of the Other Essential Criteria H and I within the AOI.

Table 13: Relative importance of expert panel criteria (H and I) used to access overall biodiversity significance with respect to the AOI

Expert Panel	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
H: Core Habitat Priority Taxa								
Ia: Centres of Endemism								
Ib: Wildlife Refugia								
Ic: Disjunct Populations								
Id: Limits of Geographic Ranges								
Ie: High Species Richness								

Expert Panel	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
If: Relictual Populations								
Ig: Variation in Species Composition								
Ih: Artificial Wetland								
Ii: Hollow Bearing Trees								
Ij: Breeding or Roosting Site								
Ik: Climate Refugia								

NB. Whilst biodiversity values associated with Criteria I may be present within the site (refer to tables 12 and 15), for the New England Tableland and Central Queensland Coast BPAs, area and % area figures associated with Criteria Ia through to Ij cannot be listed in the table above (due to slight variations in data formats between BPAs).

Criteria J. Corridors: areas identified under this criterion qualify either because they are existing vegetated corridors important for contiguity, or cleared areas that could serve this purpose if revegetated. Some examples of corridors include riparian habitats, transport corridors and "stepping stones".

Bioregional and subregional conservation corridors have been identified in the more developed bioregions of Queensland through the BPAs, using an intensive process involving expert panels. Map 3 displays the location of corridors as identified under the Statewide Corridor network. The Statewide Corridor network incorporates BPA derived corridors and for bioregions where no BPA has been assessed yet, corridors derived under other planning processes. *Note: as a result of updating and developing a statewide network, the alignment of corridors may differ slightly in some instances when compared to those used in individual BPAs.*

The functions of these corridors are:

- **Terrestrial** Bioregional corridors, in conjunction with large tracts of remnant vegetation, maintain ecological and evolutionary processes at a landscape scale, by:

  • Maintaining long term evolutionary/genetic processes that allow the natural change in distributions of species and connectivity between populations of species over long periods of time;

  • Maintaining landscape/ecosystems processes associated with geological, altitudinal and climatic gradients, to allow for ecological responses to climate change;

  • Maintaining large scale seasonal/migratory species processes and movement of fauna;

  • Maximising connectivity between large tracts/patches of remnant vegetation;

  • Identifying key areas for rehabilitation and offsets; and

- **Riparian** Bioregional Corridors also maintain and encourage connectivity of riparian and associated ecosystems.

The location of the corridors is determined by the following principles:

- Terrestrial

  • Complement riparian landscape corridors (i.e. minimise overlap and maximise connectivity);

  • Follow major watershed/catchment and/or coastal boundaries;

  • Incorporate major altitudinal/geological/climatic gradients;

  • Include and maximise connectivity between large tracts/patches of remnant vegetation;

  • Include and maximise connectivity between remnant vegetation in good condition; and

- Riparian

  • Located on the major river or creek systems within the bioregion in question.

The total extent of remnant vegetation triggered as being of "State", "Regional" or "Local" significance due to the presence of an overlying BPA derived terrestrial or riparian corridor within the AOI, is provided in the following table. For further information on how remnant vegetation is triggered due to the presence of an overlying BPA derived corridor, refer to the relevant landscape BPA expert panel report(s).

Table 14: Extent of triggered remnant vegetation due to the presence of BPA derived corridors with respect to the AOI

Biodiversity Significance	Area (Ha)	% of AOI
State	0.0	0.0%
Regional	33.1	2.6%
Local or Other Values	0.0	0.0%

NB: area figures associated with the extent of corridor triggered remnant vegetation are only available for those bioregions where a BPA has been undertaken.

Refer to **Map 3** for further information.

Threatening process/condition (Criteria K) - areas identified by experts under this criterion may be used to amend (upgrade or downgrade) biodiversity significance arising from the "first-cut" analysis. The condition of remnant vegetation is affected by threatening processes such as weeds, ferals, grazing and burning regime, selective timber harvesting/removal, salinity, soil erosion, and climate change.

Assessment of Criteria K with respect to the AOI is not currently included in the "Biodiversity and Conservation Values" report, as it has not been applied to the majority of Queensland due to data/information limitations and availability.

Special Area Decisions

Expert panel derived "Special Area Decisions" are used to assign values to Other Essential Criteria. The specific decisions which relate to the AOI in question are listed in the table below.

Table 15: Expert panel decisions for assigning levels of biodiversity significance with respect to the AOI

Decision Number	Description	Panel Recommended Significance	Criteria Values
cqc_l_22	Myrtle Creek	Regional	J: High

Expert panel decision descriptions:

cqc_l_22

Myrtle Creek is an important riparian corridor and should be Regionally Significant.

Aquatic Conservation Assessments

Introduction

The Aquatic Biodiversity Assessment and Mapping Method or AquaBAMM (Clayton *et al.* 2006), was developed to assess conservation values of wetlands in queensland, and may also have application in broader geographical contexts. It is a comprehensive method that uses available data, including data resulting from expert opinion, to identify relative wetland conservation/ecological values within a specified study area (usually a catchment). The product of applying this method is an Aquatic Conservation Assessment (ACA) for the study area.

An ACA using AquaBAMM is non-social, non-economic and identifies the conservation/ecological values of wetlands at a user-defined scale. It provides a robust and objective conservation assessment using criteria, indicators and measures that are founded upon a large body of national and international literature. The criteria, each of which may have variable numbers of indicators and measures, are naturalness (aquatic), naturalness (catchment), diversity and richness, threatened species and ecosystems, priority species and ecosystems, special features, connectivity and representativeness. An ACA using AquaBAMM is a powerful decision support tool that is easily updated and simply interrogated through a geographic information system (GIS).

Where they have been conducted, ACAs can provide a source of baseline wetland conservation/ecological information to support natural resource management and planning processes. They are useful as an independent product or as an important foundation upon which a variety of additional environmental and socio-economic elements can be added and considered (i.e. an early input to broader 'triple-bottom-line' decision-making processes). An ACA can have application in:

- determining priorities for protection, regulation or rehabilitation of wetlands and other aquatic ecosystems
- on-ground investment in wetlands and other aquatic ecosystems
- contributing to impact assessment of large-scale development (e.g. dams)
- water resource and strategic regional planning prcesses

For a detailed explanation of the methodology please refer to the summary and expert panel reports relevant to the ACA utilised in this assessment. These reports can be accessed at Wetland*Info*:

http://wetlandinfo.ehp.qld.gov.au/wetlands/assessment/assessment-methods/aca

The GIS results can be downloaded from the Queensland Spatial Catalogue at:

http://qspatial.information.qld.gov.au/geoportal/

Explanation of Criteria

Under the AquaBAMM, eight criteria are assessed to derive an overall conservation value. Similar to the Biodiversity Assessment and Mapping Methodology, the criteria may be primarily diagnostic (quantitative) or primarily expert opinion (qualitative) in nature. The following sections provide a brief description of each of the 8 criteria.

Criteria 1. Naturalness - Aquatic: This attribute reflects the extent to which a wetland's (riverine, non-riverine, estuarine) aquatic state of naturalness is affected through relevant influencing indicators which include: presence of exotic flora and fauna; presence of aquatic communities; degree of habitat modification and degree of hydrological modification.

Criteria 2. Naturalness - Catchment: The naturalness of the terrestrial systems of a catchment can have an influence on many wetland characteristics including: natural ecological processes e.g. nutrient cycling, riparian vegetation, water chemistry, and flow. The indicators utilised to assess this criterion include: presence of exotic flora and/or fauna; riparian, catchment and flow modification.

Criteria 3. Naturalness - Diversity and Richness: This criterion is common to many ecological assessment methods and can include both physical and biological features. It includes such indicators as species richness, riparian ecosystem richness and geomorphological diversity.

Criteria 4. Threatened Species and Ecosystems: This criterion evaluates ecological rarity characteristics of a wetland. This includes both species rarity and rarity of communities / assemblages. The communities and assemblages are best represented by regional ecosystems. Species rarity is determined by NCA and EPBC status with Endangered, Vulnerable or Near-threatened species being included in the evaluation. Ecosystem rarity is determined by regional ecosystem biodiversity status i.e. Endangered, Of Concern, or Not of Concern.

Criteria 5. Priority Species and Ecosystems: Priority flora and fauna species lists are expert panel derived. These are aquatic, semi-aquatic and riparian species which exhibit at least 1 particular trait in order to be eligible for consideration. For flora species the traits included:

- It forms significant macrophyte beds (in shallow or deep water).
- It is an important food source.
- It is important/critical habitat.
- It is implicated in spawning or reproduction for other fauna and/or flora species.
- It is at its distributional limit or is a disjunct population.
- It provides stream bank or bed stabilisation or has soil binding properties.
- It is a small population and subject to threatening processes.

Fauna species are included if they meet at least one of the following traits:

- It is endemic to the study area (>75 per cent of its distribution is in the study area/catchment).
- It has experienced, or is suspected of experiencing, a serious population decline.
- It has experienced a significant reduction in its distribution and has a naturally restricted distribution in the study area/catchment.
- It is currently a small population and threatened by loss of habitat.
- It is a significant disjunct population.
- It is a migratory species (other than birds).
- A significant proportion of the breeding population (>one per cent for waterbirds, >75 per cent other species) occurs in the waterbody (see Ramsar criterion 6 for waterbirds).
- Limit of species range.

See the individual expert panel reports for the priority species traits specific to an ACA.

Criteria 6. Special Features: Special features are areas identified by flora, fauna and ecology expert panels which exhibit characteristics beyond those identified in other criteria and which the expert panels consider to be of the highest ecological importance. Special feature traits can relate to, but are not solely restricted to geomorphic features, unique ecological processes, presence of unique or distinct habitat, presence of unique or special hydrological regimes e.g. spring-fed streams. Special features are rated on a 1 - 4 scale (4 being the highest).

Criteria 7. Connectivity: This criterion is based on the concept that appropriately connected aquatic ecosystems are healthy and resilient, with maximum potential biodiversity and delivery of ecosystem services.

Criteria 8. Representativeness: This criterion applies primarily to non-riverine assessments, evaluates the rarity and uniqueness of a wetland type in relation to specific geographic areas. Rarity is determined by the degree of wetland protection within "protected Areas" estate or within an area subject to the *Fisheries Act 1994*, *Coastal Protection and Management Act 1995*, or *Marine Parks Act 2004*. Wetland uniqueness evaluates the relative abundance and size of a wetland or wetland management group within geographic areas such as catchment and subcatchment.

Riverine Wetlands

Riverine wetlands are all wetlands and deepwater habitats within a channel. The channels are naturally or artificially created, periodically or continuously contain moving water, or connecting two bodies of standing water. AquaBAMM, when applied to riverine wetlands uses a discrete spatial unit termed subsections. A subsection can be considered as an area which encompasses discrete homogeneous stream sections in terms of their natural attributes (i.e. physical, chemical, biological and utilitarian values) and natural resources. Thus in an ACA, an aquatic conservation significance score is calculated for each subsection and applies to all streams within a subsection, rather than individual streams as such.

Please note, the area figures provided in Tables 16 and 17, are derived using the extent of riverine subsections within the AOI. Refer to **Map 5** for further information. A summary of the conservation significance of riverine wetlands within the AOI is provided in the following table.

Table 16: Overall level/s of riverine aquatic conservation significance

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	48.7	3.9%
High	1183.0	94.1%
Medium	24.9	2.0%
Low	0.0	0.0%
Very Low	0.0	0.0%

The individual aquatic conservation criteria ratings for riverine wetlands within the AOI are listed below.

Table 17: Level/s of riverine aquatic conservation significance based on selected criteria

Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
1. Naturalness aquatic					48.7	3.9	1207.9	96.1
2. Naturalness catchment	48.7	3.9	1183.0	94.1	24.9	2.0		
3. Diversity and richness	48.7	3.9			1207.9	96.1		
4. Threatened species and ecosystems	1256.6	100.0						
5. Priority species and ecosystems	73.6	5.9	1183.0	94.1				
6. Special features	48.7	3.9						
7. Connectivity	1256.6	100.0						

The table below lists and describes the relevant expert panel decisions used to assign conservation significance values to riverine wetlands within the AOI.

Table 18: Expert panel decisions for assigning overall levels of riverine aquatic conservation significance

Decision number	Special feature	Catchment	Criteria/Indicator/Measure	Conservation rating (1-4)
pr_r_ec_02	Proserpine River at Goorganga Plane	Proserpine	6.3.1 6.3.3	4
pr_r_fl_02	Regional ecosystems 11.3.25a & 8.3.3	Proserpine	5.2.1	4
pr_r_fl_03	Regional ecosystem 8.3.1	Proserpine	5.2.1	4

4 is the highest rating/value

Expert panel decision descriptions:

pr_r_ec_02

The Central Queensland Coast BPA Panel nominated all of Goorganga Plain (from Proserpine River to O'Connell River as a state significant- nationally important wetland, to be listed on the Directory of Important Wetlands in Australia. The area of beach scrub and regional ecosystem 8.3.13b are only found in this area. The area also contains the most southern population of **Livistona drudei** (vulnerable) at Conway Beach/Wilsons Beach. In addition, the Proserpine river has the highest density of crocodiles (**Crocodylus porosus**) in the region and also provides habitat for false water-rats (**Xeromys**

myoides), sea turtles and species listed in the JAMBA convention. Links from Goorganga to Proserpine River provide important wildlife corridors and should be included with the Goorganga Plain for its importance as wildlife refugia. In addition, the area boasts very high species richness and provides significant breeding and roosting sites throughout. Threats to the area include Condor Oil Shale development.

pr_r_fl_02

These threatened regional ecosystems are the only ecosystems where you can find black ironbox (**Eucalyptus raveretiana**). These ecosystems provide important habitat for many fauna species.

pr_r_fl_03

This regional ecosystem provides habitat for a number of rare and threatened species.

Non-riverine Wetlands

Non-riverine wetlands include both lacustrine and palustrine wetlands, however, do not currently incorporate estuarine, marine or subterranean wetland types. A summary of the conservation significance of non-riverine wetlands within the AOI is provided in the following table. Refer to **Map 6** for further information.

Table 19: Overall level/s of non-riverine aquatic conservation significance

Aquatic conservation significance (non-riverine wetlands)	Area (Ha)	% of AOI
(No Records)		

The following table provides an assessment of non-riverine wetlands within the AOI and associated aquatic conservation criteria values.

Table 20: Level/s of non-riverine aquatic conservation significance based on selected criteria

Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
(No Records)								

The table below lists and describes the relevant expert panel decisions used to assign conservation significance values to non-riverine wetlands within the AOI.

Table 21: Expert panel decisions for assigning overall levels of non-riverine aquatic conservation significance.

(No Records)

4 is the highest rating/value

Expert panel decision descriptions:

(No Records)

Threatened and Priority Species

Introduction

This chapter contains a list of threatened and priority flora and/or fauna species that have been recorded on, or within 4km of the Assessment Area.

The information presented in this chapter with respect to species presence is derived from compiled databases developed primarily for the purpose of BPAs and ACAs. Data is collated from a number of sources and is updated periodically.

It is important to note that the list of species provided in this report, may differ when compared to other reports generated from other sources such as the State government's WildNet, Herbrecs or the federal government's EPBC database for a number of reasons.

Records for threatened and priority species are filtered and checked based on a number of rules including:

- Taxonomic nomenclature - current scientific names and status,
- Location - cross-check co-ordinates with location description,
- Taxon by location - requires good knowledge of the taxon and history of the record,
- Duplicate records - identify and remove,
- Expert panels - check records and provide new records,
- Flora cultivated records excluded,
- Use precise records less than or equal to 2000m,
- Use recent records greater than or equal to 1975 animals, greater than or equal to 1950 plants.

Threatened Species

Threatened species are those species classified as "Endangered" or "Vulnerable" under the *Environment Protection and Biodiversity Conservation Act 1999* or "Endangered", "Vulnerable" or "Near threatened" under the *Nature Conservation Act 1992*.

The following threatened species have been recorded on, or within approximately 4km of the AOI.

Table 22: Threatened species recorded on, or within 4km of the AOI

Species	Common name	NCA status	EPBC status	Back on Track rank	Migratory species*	Wetland species**	Identified flora/fauna
Dasyurus hallucatus	Northern Quoll		E	Medium			FA
Rostratula australis	Australian Painted Snipe	V	E	Medium		Y	FA
Petrogale persephone	Proserpine Rock-wallaby	E	E	Critical			FA

NB. Please note that the threatened species listed in this section are based upon the most recently compiled DEHP internal state-wide threatened species dataset. This dataset may contain additional records that were not originally available for inclusion in the relevant individual BPAs and ACAs.

**JAMBA - Japan-Australia Migratory Bird Agreement; CAMBA - China-Australia Migratory Bird Agreement; ROKAMBA - Republic of Korea-Australia Migratory Bird Agreement; CMS - Convention on the Conservation of Migratory Species.*

***Y - wetland indicator species.*

BPA Priority Species

A list of BPA priority species that have been recorded on, or within approximately 4km of the AOI is contained in the following table.

Table 23: Priority species recorded on, or within 4km of the AOI

(no results)

NB. Please note that the list of priority species is based on those species identified in the BPAs, however records for these species may be more recent than the originals used. furthermore, the BPA priority species databases are updated from time to time. At each update, the taxonomic details for all species are amended as necessary to reflect current taxonomic name and/or status changes.

ACA Priority Species

A list of ACA priority species used in riverine and non-riverine ACAs that have been recorded on, or within approximately 4km of the AOI are contained in the following tables.

Table 24: Priority species recorded on, or within 4 km of the AOI - riverine

Species	Common name	Back on Track rank	Identified flora/fauna
Rostratula australis	Australian Painted Snipe	Medium	FA
Ardea modesta	Eastern Great Egret	Low	FA
Myriophyllum verrucosum	water milfoil		FL

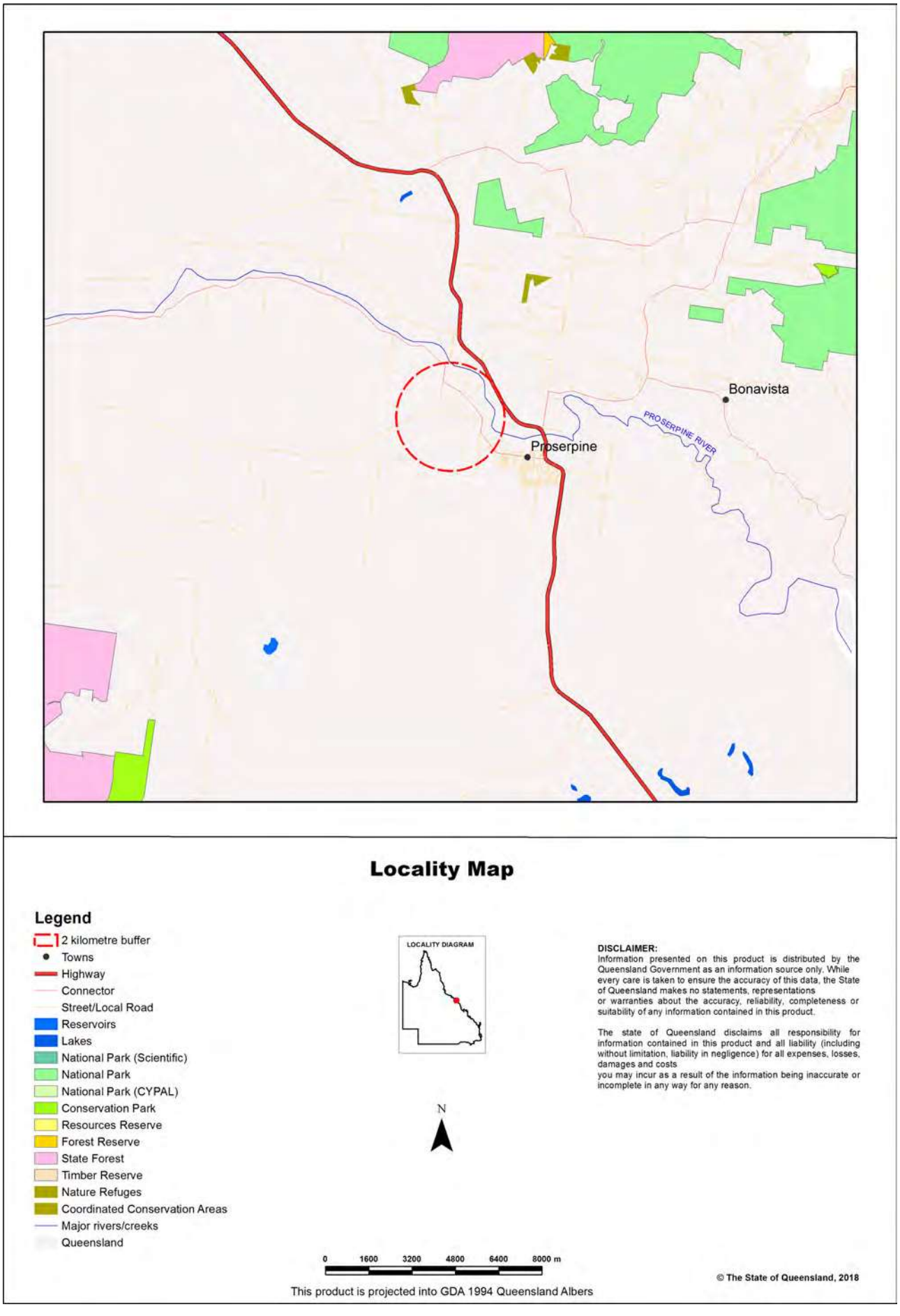
Table 25: Priority species recorded on, or within 4 km of the AOI - non-riverine

Species	Common name	Back on Track rank	Identified flora/fauna
Rostratula australis	Australian Painted Snipe	Medium	FA
Ardea ibis	Cattle Egret	Low	FA
Ardea modesta	Eastern Great Egret	Low	FA
Myriophyllum verrucosum	water milfoil		FL

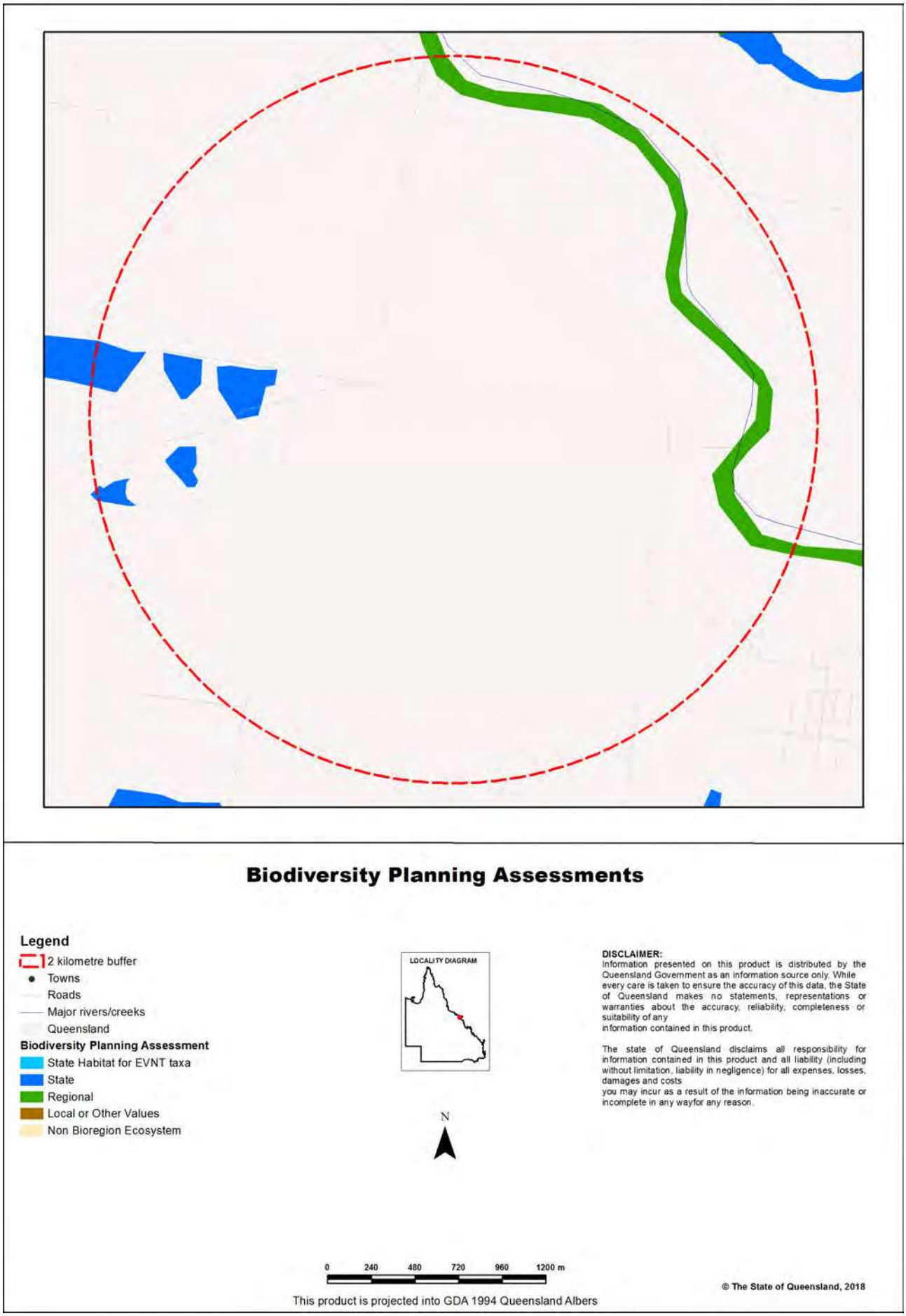
NB. Please note that the priority species records used in the above two tables are comprised of those adopted for the released individual ACAs. The ACA riverine and non-riverine priority species databases are updated from time to time to reflect new release of ACAs. At each update, the taxonomic details for all ACAs records are amended as necessary to reflect current taxonomic name and/or status changes.

Maps

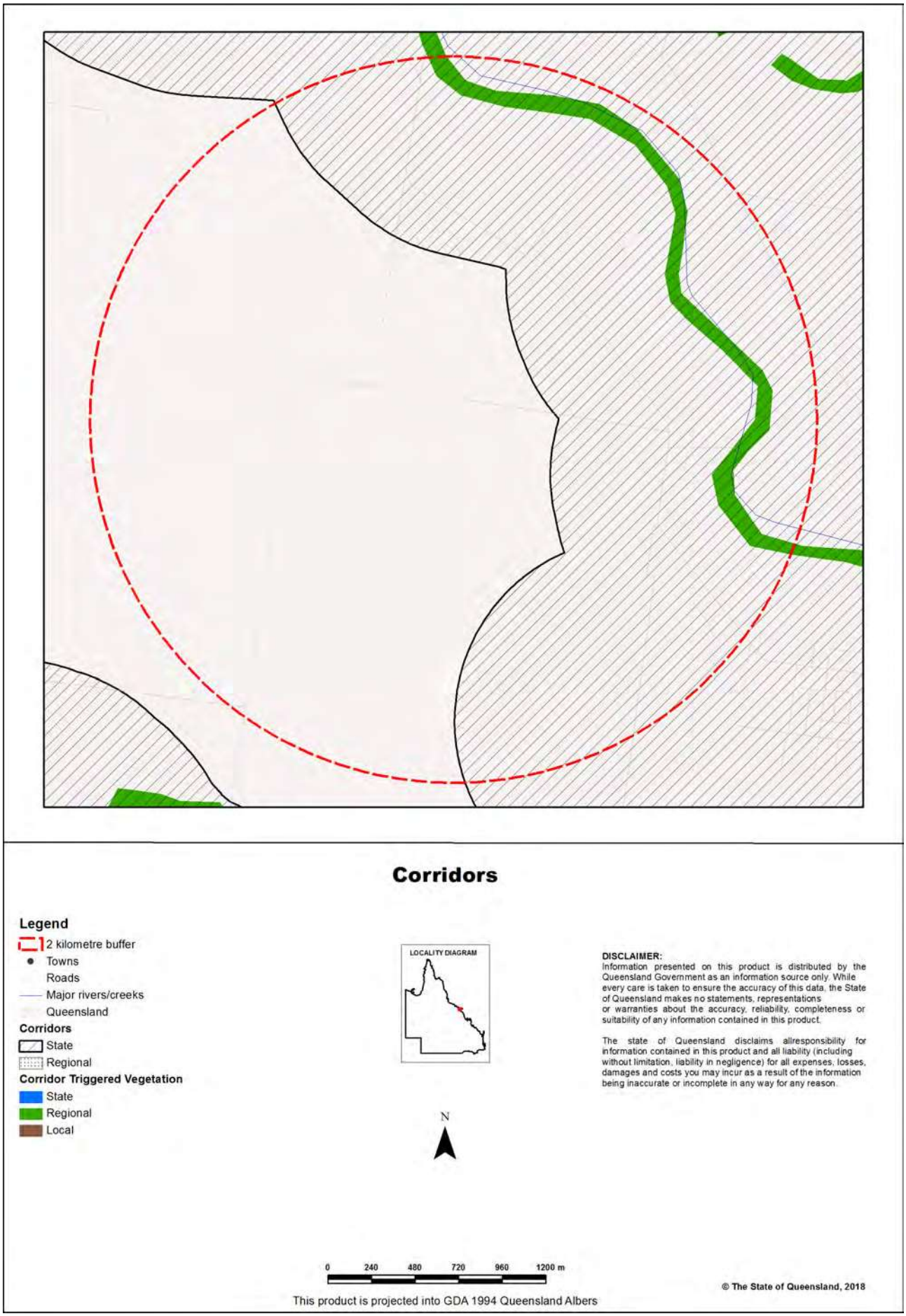
Map 1 - Locality Map



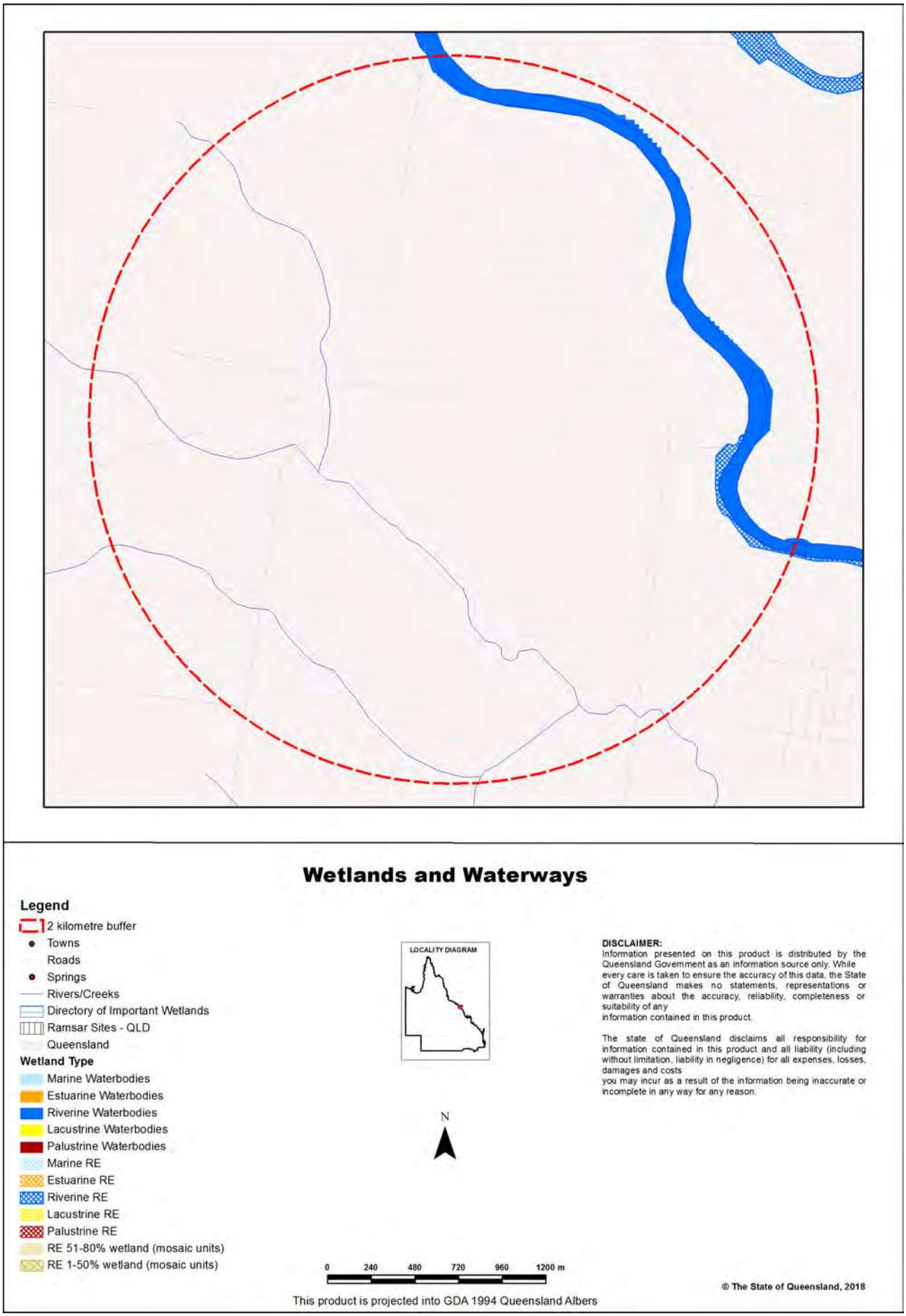
Map 2 - Biodiversity Planning Assessment (BPA)



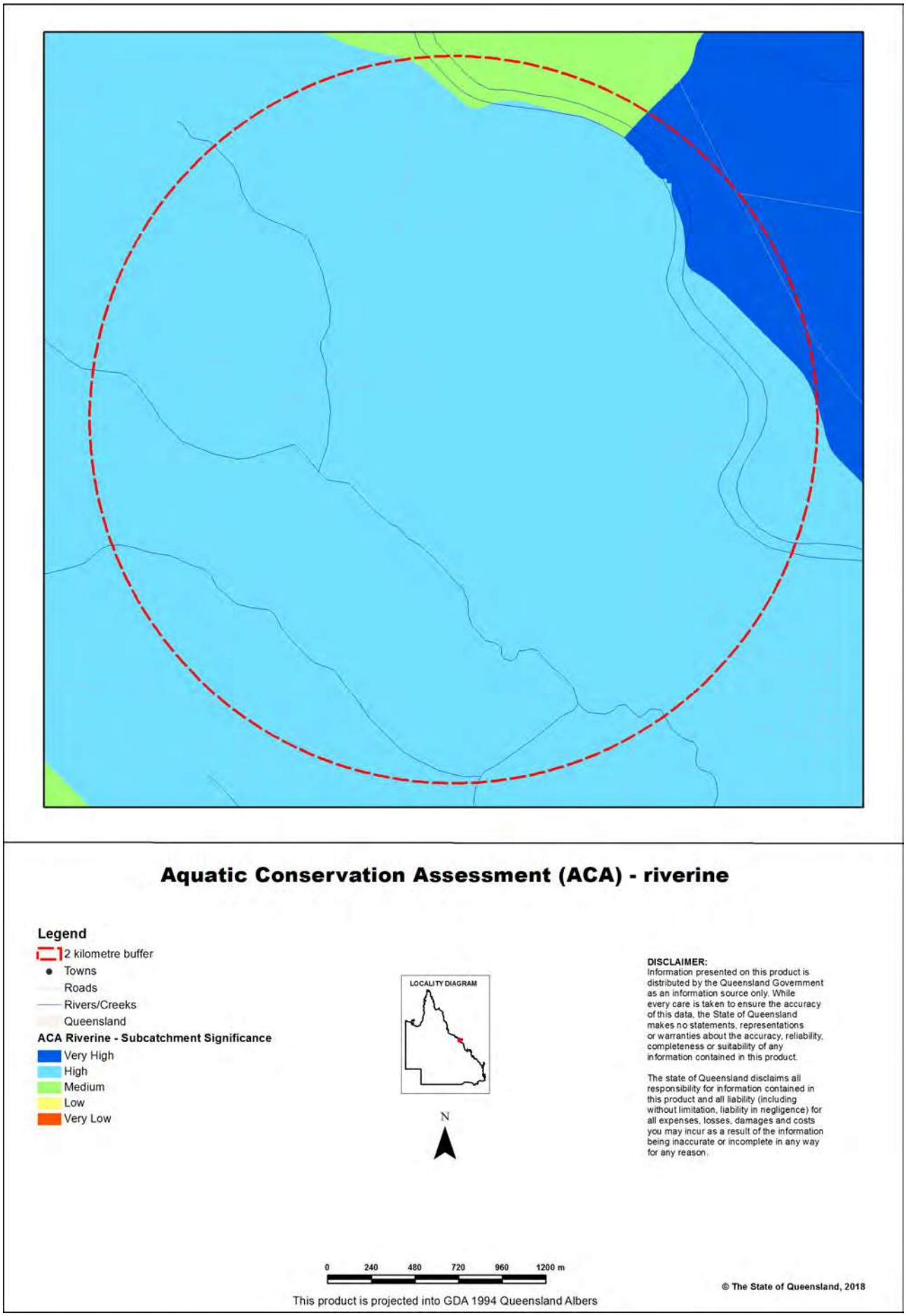
Map 3 - Corridors



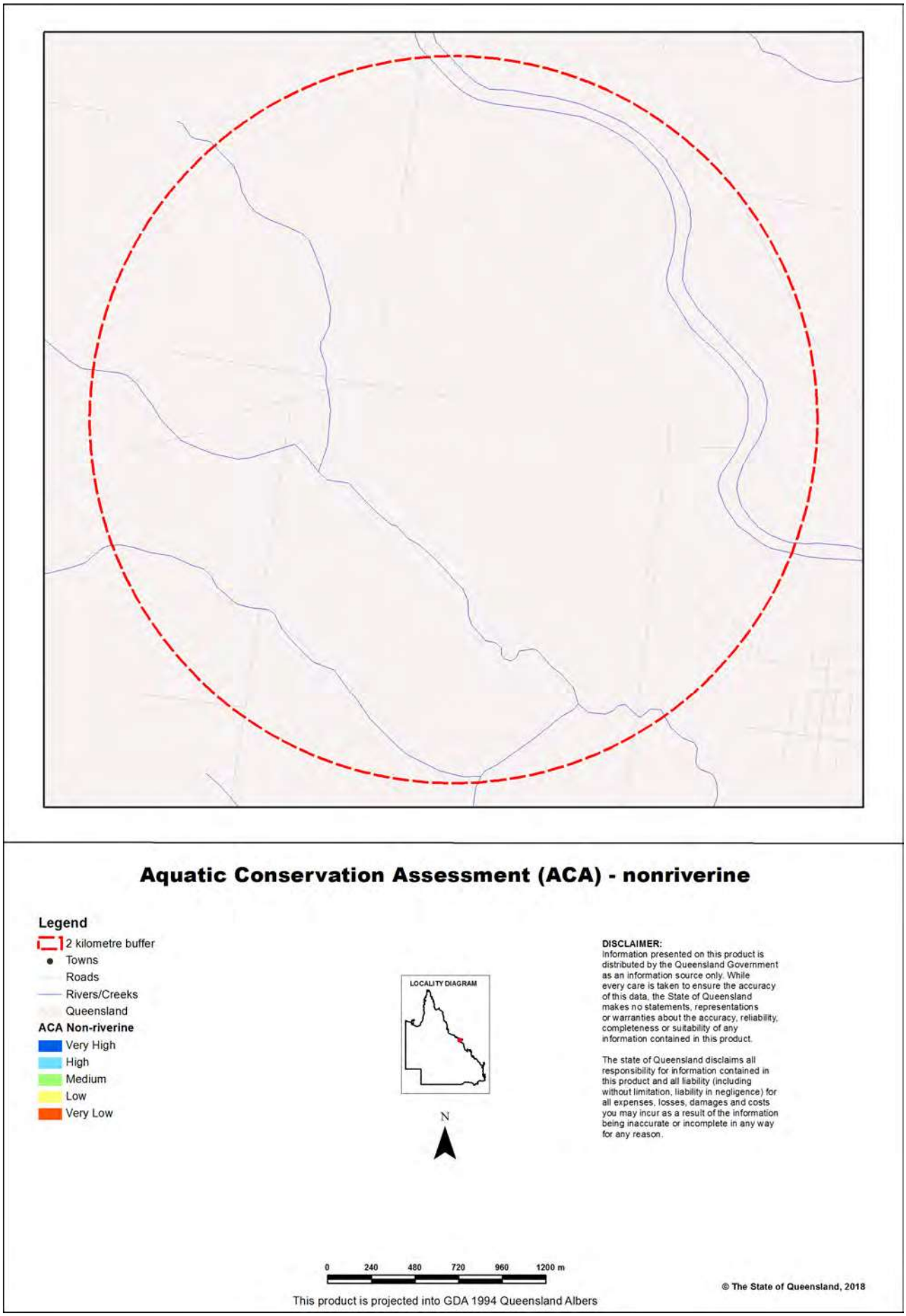
Map 4 - Wetlands and waterways



Map 5 - Aquatic Conservation Assessment (ACA) - riverine



Map 6 - Aquatic Conservation Assessment (ACA) - non-riverine



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Appendices

Appendix 1: Source Data

Theme	Datasets
Aquatic Conservation Assessments Non-riverine*	Combination of the following datasets: Cape York Peninsula Non-riverine v1.1 Great Barrier Reef Catchment Non-riverine v1.3 Lake Eyre and Bulloo Basins v1.1 QMDB Non-riverine ACA v1.4 Southeast Queensland ACA v1.1 WBB Non-riverine ACA v1.1
Aquatic Conservation Assessments Riverine*	Combination of the following datasets: Cape York Peninsula Riverine v1.1 Great Barrier Reef Catchment Riverine v1.1 Lake Eyre and Bulloo Basins v1.1 QMDB Riverine ACA v1.4 Southeast Queensland ACA v1.1 WBB Riverine ACA v1.1
Biodiversity Planning Assessments*	Combination of the following datasets: Brigalow Belt BPA v1.3 Cape York Peninsula BPA v1.1 Central Queensland Coast BPA v1.3 Channel Country BPA v1.1 Desert Uplands BPA v1.3 Einasleigh Uplands BPA v1.1 Gulf Plains BPA v1.1 Mitchell Grass Downs BPA v1.1 Mulga Lands BPA v1.4 New England Tableland v2.3 Southeast Queensland v4.1
Statewide BPA Corridors*	Statewide corridors v1.3
Threatened Species	An internal DEHP database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.
BPA Priority Species	An internal DEHP database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.
ACA Priority Species	An internal DEHP database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.

***These datasets are available at:**

http://dds.information.qld.gov.au/DDS

Appendix 2 - Acronyms and Abbreviations

AOI	- Area of Interest
ACA	- Aquatic Conservation Assessment
AQUABAMM	- Aquatic Biodiversity Assessment and Mapping Methodology
BAMM	- Biodiversity Assessment and Mapping Methodology
BoT	- Back on Track
BPA	- Biodiversity Planning Assessment
CAMBA	- China-Australia Migratory Bird Agreement
EHP	- Department of Environment and Heritage Protection
EPBC	- *Environment Protection and Biodiversity Conservation Act 1999*
EVNT	- Endangered, Vulnerable, Near Threatened
GDA94	- Geocentric Datum of Australia 1994
GIS	- Geographic Information System
JAMBA	- Japan-Australia Migratory Bird Agreement
NCA	- *Nature Conservation Act 1992*
RE	- Regional Ecosystem
REDD	- Regional Ecosystem Description Database
ROKAMBA	- Republic of Korea-Australia Migratory Bird Agreement

APPENDIX G

Monitoring Program

22 July 2016

LEACHATE DETECTION MONITORING PROGRAM

Bowen Landfill

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REPORT

Report Number. 147633126-002-R-Rev0

Distribution:

Whitsunday Regional Council
Golder Associates Pty Ltd

Golder Associates

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1.0 INTRODUCTION

Whitsunday Regional Council (Council) commissioned Golder Associates Pty Ltd (Golder) to produce a Leachate Detection Monitoring Program (LDMP) for the Bowen Landfill that is located at 908 Peter Delemonthe Road (Bowen Developmental Road), refer Figure 1, attached.

1.1 Context

The need for the LDMP was triggered by the installation of new groundwater wells and recent changes in guidance documentation issued by the Department of Environment and Heritage Protection (EHP). This LDMP has primarily been developed to assist Council to achieve compliance with the relevant conditions of the Environmental Authority (EA) for Bowen Landfill NR175 (dated 30 July 1997). The program has also been designed with consideration given to recent changes to ERA60 'Model operating conditions' which allow for the selection of site specific contaminant limit release values for both surface water and groundwater that 'tailor the environmental authority to their particular operation'.

1.2 Objectives

The objectives of this LDMP are to establish:

- A list of key analytes / locations for laboratory analysis for ongoing groundwater monitoring, based on review of historical data and EA conditions;
- An outline of monitoring and measurement techniques to be utilised; and
- Appropriate release / trigger values for surface water and groundwater.

2.0 SITE DETAILS

The site details are summarised in Table 1.

Table 1: Summary of Site details

	Details
Street Address	908 Peter Delemonthe Road, Collinsville, Bowen, Queensland 4804
Lot and Plan	Lot 22 on Survey Plan 106414
Land Area	46.53 hectares
Regional Topography and Drainage	The site is located within a relatively flat alluvial plain within the upper catchment of Sandy Creek and adjacent to the catchment area of the Don River. Local surface elevations range between 25 m and 30 m AHD (Australian Height Datum). Sandy Creek flows generally northwards into the Don River delta, discharging at the coastline to the west of Bowen (straight line distance of approximately 13.5 km). The landfill site area is likely to drain westwards into a tributary of Sandy Creek that is located adjacent to the western site boundary. The catchment for the Don River appears to be located on the opposite side of the Bowen Development Road, approximately 4.5 km east of the site.
Local Lithology	Underlying rock predominantly comprises weathered granite and other igneous rock intrusions such as porphyry and diorite. Surficial soil deposits of clays, sand and gravel (identified as Don River Alluvium) generally overlie the granite at depths varying between less than 0.5 m to a maximum of 15 m proven on site. Silty sand has been intercepted between 7 m -9 m depth in the north-western corner of the site only.

	Details
Regional Geology	Published mapping indicates regional geology to comprise Quaternary alluvium and lacustrine deposits, underlain by stratified units of volcanic and metamorphic rock. Alluvial deposits of clays, sand and gravel overlie the granite rock to depths varying between 4 m to at least 18 m. Soil Units surrounding the landfill site typically comprise alluvial terrace sandy loam overlying dark brown sandy clay.
Hydrogeology	Sandy Creek runs through the south-eastern corner of the site area and exits the site on the western site boundary. The creek runs adjacent to the western boundary of the landfill for approximately 840 m. The two closest surface water bodies are the Don River, located 1.7 km east of the site and Euri Creek located approximately 4.8 km north-west of the site. Groundwater flow direction is likely to be seasonally influenced. Based on topography, surface water is likely to flow towards Sandy Creek while regional groundwater is likely to flow towards the Don River. Depending on seasonal groundwater levels, groundwater discharge would mostly occur into the lower reaches of the Don River and Euri Creek and into the Great Barrier Reef near shore lagoon. During high rainfall periods groundwater discharge into the middle to upper reaches of the Don River, Euri Creek and Sandy Creek would be expected to occur.
Climate	Climate statistics reported from the nearest rainfall measurement site data reported by the Queensland Government Bureau of Meteorology. Average monthly rainfall data (1961-1990) recorded at Bowen pump station 033264 located 9.2 km north-east of the site: May – October: max 107 mm, min 0 mm, mean 14 mm November – April: max 598 mm, min 0 mm, mean 114 mm Average monthly temperature data (2015-2016) recorded at station 33327 located 8.9 km north-east of the site: May – October: max 29.5°C, min 25.2°C, mean 27.2 °C November – April: max 33°C, min 30.1°C, mean 31.9 °C

2.1 Monitoring Network

2.1.1 Sampling Points Groundwater

Fifteen groundwater monitoring bores have been installed at selected locations to detect possible landfill leachate impact to the underground aquifer (refer to Figure 1 for locations). The rationale for bore placement is presented below:

- Monitoring wells MB2 – MB5: to assess deeper groundwater conditions in the source area.
- Monitoring well MB6: to assess background conditions if a localised groundwater mound is considered to be present below the waste cell areas.
- Monitoring wells MB10, MB12 and MB14: constructed within the weathered granite to assess potential downgradient impacts from both landfill cell areas if the water storage ponds are locally raising groundwater levels.

- Monitoring wells MB7S, MB8S, MB9S, MB11S, MB13S, MB15S and MB16S: constructed within the alluvium and upper surface of the weathered granite to assess potential downgradient impacts from both landfill cell areas.

A description of the monitoring bores is provided in Table 2 below:

Table 2: Bowen Landfill Monitoring Bores

Bore	Depth (m bgl)[1]	DTW[2]	Screened Sub-Aquifer	GPS coordinates[3]
MB2	17.50	5.59	Weathered granite	E 55062029.0 N 7779846.0
MB3	10.50	4.50	Weathered granite	20°04'21.47" S 148°08'52.85" E
MB4	17.60	10.40	Weathered granite	E55062097.0 N 7780211.0
MB5	16.15	8.40	Weathered granite	E550620427.0 N 7780036.0
MB6	18.22	8.64	Weathered granite	20°04'55.06" S 148°08'49.22" E
MB7S	10	6.00	Don River Alluvium	E 55062031.0 N 7779846.0
MB8S	9.80	4.00	Don River Alluvium	E 560468721.0 N 7075494.0
MB9S	9.49	4.00	Don River Alluvium	E 550619965.0 N 7779925.0
MB10	15.57	4.00	Weathered Granite (upper surface)	E 550619965.0 N 7779933.0
MB11S	9.62	3.89	Don River Alluvium	E 550620125.0 N 7780223.0
MB12	15.55	3.77	Weathered Granite (upper surface)	E550620125.0 N 7780231.0
MB13S	9.40	5.25	Don River Alluvium	E55062095.0 N 7780211.0
MB14	15.96	6.87	Weathered Granite (upper surface)	E 550620428.0 N 7780164.0
MB15S	9.53	6.00	Don River Alluvium	E 550620423.0 N 7780160.0
MB16S	9.45	5.15	Don River Alluvium	E550620428.0 N 7780036.0

Note 1: metres below ground level)

Note 2: Recorded May 2016 (Golder, 2016)

Note 3: MGA94 56 for all except MB3 and MB6 which are recorded as Latitude, Longitude

2.1.2 Sampling Points Leachate Ponds

Two of the three former borrow pit ponds located adjacent to the southern side of the main waste disposal area have been nominally allocated for leachate storage and evaporation arising from the western face of the main landfill mound.

Surface water samples are collected from the leachate ponds at locations LP1 and LP2, as identified on Figure 1.

2.2 Conceptual Site Model

2.2.1 Source

The source of the potentially contamination is the leachate generated by the decomposition of waste and infiltrating precipitation in the landfill waste.

Waste disposal at the Bowen Landfill site is currently confined to the main mound located at the northern end of the site. The two existing waste cells are located within a number of former sand and clay borrow pits and have been constructed without engineered liners or leachate collection systems. The borrow pits may have been up to 8 m in depth below the surrounding ground level. Both cell areas have waste disposal capacity remaining and capping is limited to the use of interim cover soils.

The current waste mound and separate construction and demolition waste disposal cells currently do not have a formal leachate collection system. Two of the three former borrow pit ponds located adjacent to the southern side of the main waste disposal have been nominally allocated for leachate storage and evaporation. These ponds collect breakout leachate from the western face of the main landfill mound. There are, however, no engineered systems in place on-site for leachate collection, treatment or disposal.

2.2.2 Pathways

The groundwater and surface water at the landfill can be treated as both pathways and receptors for landfill emissions arising from Bowen Landfill. Surface water, groundwater flows and leachate elevations within the waste mound appear to be heavily influenced by seasonal rainfall conditions.

The underlying ground conditions at the site are dominated by Don River alluvium comprising sands and gravels, underlain by weathered granite.

2.2.3 Receptors

There are two surface water bodies (considered to be the primary receptors for discharges from site) located to the east and west of the Bowen landfill and the direction of groundwater flow is expected to depend on seasonal conditions. Based on recent groundwater monitoring conducted at the site, groundwater has been inferred to be flowing in a westerly direction towards Euri Creek, however this may change depending on seasonal conditions. Both Euri Creek and Don River are freshwater river systems.

3.0 REVIEW OF EXISTING MONITORING DATA

3.1 Leachate Indicators

The existing monitoring program has been designed to characterise the groundwater under the landfill's footprint. Leachate composition and quantity is very much dependent on:

- The type and quantity of materials placed in the landfill;
- The stage of degradation of the placed wastes;
- Underlying lithology and geology of the area;
- Climatic conditions;
- Management of the biological processes within the site; and
- The absorptive capacity of the wastes.

3.2 Available Monitoring Data

A full statistical review of the historical monitoring data was beyond the scope of this project, however the following observations are noted:

- Previous monitoring at the site reports that pesticides, PAHs, phenols, PCBs and VOCs have not been observed above the method detection limit during sampling conducted from 1996 to 2016; and
- Typical landfill contaminants of concern which are consistently detected in groundwater at the site include nickel, ammonia, nitrogen, total recoverable hydrocarbons (TRH), elevated biological oxygen demand (BOD) and elevated chemical oxygen demand (COD).

Following further monitoring rounds, the data should be reviewed, a statistical analysis performed and the trigger values updated accordingly. This is discussed further in Section 5.4.

4.0 COMPLIANCE FRAMEWORK

4.1 Identified Environmental Values

Sandy Creek, Euri Creek and Menilden Creek are ephemeral waterways and have significant environmental values for agricultural use and as a wildlife corridor and riparian zone. Both systems ultimately discharge to Queens Bay which supports marine aquatic ecosystems.

Groundwater seepage can play an important role in maintaining terrestrial aquatic ecosystems, particularly during dry season periods when ephemeral waterways receive minimal surface water run-off.

Identified environmental values associated with surface water and groundwater conditions that could be impacted by the operation of Bowen Landfill are summarised below.

Table 3: Identified Environmental Values

Receptors	Existing Conditions	Environmental Values
Fresh Water Creek Aquatic Ecosystems - Sandy Creek - Euri Creek - Don River	- Ephemeral streams (flows only following periods of rainfall) - Riparian zones disturbed by agricultural and urban development - Leachate impacts to groundwater identified onsite.	- Disturbed aquatic ecosystem (when flowing) - Recreation - Stock water - Moderate environmental value - Low to moderate risk
Urban Extraction and Irrigation (Bootooloo, Buckley and Merinda)	- Many registered bores for groundwater extraction - Limited mains water reticulation - Likely to be some unregistered bores - Marginal conditions in alluvial and granite aquifer	- Possible use for irrigation on crops and residential gardens - Moderate environmental value - Low risk from landfill leachate
Marine Aquatic Ecosystems	- Groundwater discharge into local ephemeral streams discharging to Queens Bay - Surface water run-off from landfill captured in leachate collection ponds. - No coastal wetlands in groundwater discharge zone	- Slightly disturbed marine aquatic ecosystem - Recreation and human consumer - High environmental value - Low risk from landfill leachate

Although other values exist, only those environmental values relevant to landfill releases have been considered.

4.2 Published Water Quality Monitoring Guidelines

4.2.1 Current Environmental Authority Conditions

The relevant sections of the EA (NR175) to which this LDMP refers are:

H11 The holder of this environmental authority must by the first Annual Return date develop and implement a Detection Monitoring Program for each of the licences places, which will effectively detect any release of contaminants from the licenced place to groundwater and/or surface waters.

H12 The Detection Monitoring Program referred to in Condition (H11) must be developed by a person possessing appropriate qualifications and experience in the fields of hydrogeology and groundwater monitoring program design to be able to competently make recommendations about these matters.

H13 The Detection Monitoring Program must include:

a) sufficient monitoring points and/or wells to obtain representative samples of groundwater and surface waters both up gradient and downgradient of the potential influence of the licenced place; and

b) monitoring and measurement techniques that will yield representative samples: and

c) analysis of a sufficient number of indicator parameters whereby significant change of these parameters from up gradient to downgradient will indicate the presence of a release of contaminants from the licensed place; and

d) sampling with sufficient spatial and temporal replication to make statistically valid conclusions about the presence or absence of a release from the licensed place with at least an eighty percent chance of detecting any release of contaminants from the licenced place if one exists.

A copy of the complete EA is provided in Appendix 1.

This document has been prepared by individuals with appropriate qualifications and experience to design this monitoring program.

4.2.2 Aquatic Ecosystem Monitoring Guidelines

Identification of potential aquatic ecosystem monitoring guidelines suitable for comparison of water quality data was based on guidance provided in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC 2000) for the assessment of surface water receptors.

The ANZECC 2000 guidelines note that although they '*provide extensive default guideline values, they strongly emphasise the need to develop more locally relevant guidelines*'. Queensland Water Quality Guidelines (QWQG 2009) have subsequently been prepared to:

- '*Provide guideline values (numbers) that are tailored to Queensland regions and water types*'
- '*Providing a process/framework for deriving and applying local guidelines for waters in Queensland (i.e. more specific guidelines than those in the QWQG)*'.

QWQG (2009) places the site within the Central Coast Region. Waterways located within the Central Coast Region, have catchment specific guidelines for a limited range of physio-chemical parameters. Most potential landfill contaminants default back to the ANZECC 2000 Guidelines. Specific derived values for the Don River Basin are currently in the development phase and are yet to be released.

Given the extensive clearing of the catchment area around the landfill site for agricultural land use and the freshwater receiving waters of the Don River and Euri Creek, site specific published water quality guidelines were selected using the following hierarchy:

- QWQG (2009): Central Coast Region – lowland streams
- ANZECC (2000): Moderately Disturbed Freshwater Ecosystems (95%). The trigger values for fresh water for 95% species level protection for a moderately disturbed ecosystem, have been used as a basis for comparison with water quality data from Bowen Landfill as the closest receiving surface water body are freshwater ephemeral streams including the Sandy Creek adjacent to the site, Euri Creek and the Don River. Selection of the moderately disturbed ecosystem guideline in preference to the highly disturbed ecosystem guideline reflects a more conservative approach aimed at improving water quality over time.

Although these guidelines have also been adopted as trigger values for surface water and groundwater assessment it must be recognised that issues such natural attenuation, advection, adsorption and contaminant flux must be taken into account to assess potential risks to down gradient aquatic ecosystems.

Other reference guidelines such as the National Environmental Protection Measure (NEPM, 1999) (amended 2013) and Queensland Water Quality Guidelines (for toxicants) take their reference values from both ANZECC and the Australian Drinking Water Guidelines (ADWG, 2011, updated 2016) and therefore these guidelines have been referenced in this instance.

4.2.3 Public Health Guidelines

ADWG (2011, updated 2016) was developed by the National Health and Medical Research Council (NHMRC) in collaboration with the Natural Resource Management Ministerial Council (NRMMC) to provide guidance on what constitutes good quality drinking water from both a health perspective and aesthetic value.

Although groundwater and run-off from ephemeral waterways at Bowen Landfill should not be used for potable water use purposes, non-potable household use at neighbouring rural properties, cannot be discounted. The ADWG (2011, updated 2016) have therefore been adopted as a reference point for aesthetic values only. Health based criteria have not been considered in the selection of trigger values for groundwater quality assessment.

5.0 PROPOSED WATER QUALITY MONITORING PROGRAM

5.1 Approach

The blanket adoption of published guideline values as environmental release limits is not supported on the basis that there is no available monitoring data that documents undisturbed background water quality conditions in the Bowen area.

In the selection and adoption of appropriate water quality monitoring criteria, we propose a tiered approach comprising:

- Use of an annual statistical assessment process in accordance with EHP guidelines as the primary regulatory compliance requirement for the landfill.
- Direct sampling of upstream and downstream receiving waters of Sandy Creek for comparison with groundwater onsite (locations to be nominated based on accessibility).
- Assessment of groundwater results against the nominated guidelines in Table 4. When assessing groundwater against these trigger values it must be recognised that natural attenuation of contamination, advection, adsorption and contaminant flux have not been incorporated into these values when assessing potential risks to down gradient aquatic ecosystem receptors.

Table 4: Proposed Water Quality Limits – Detection Monitoring for Groundwater

Sampling point	Quality Characteristic (unit)	Limit	Limit Type	Minimum monitoring frequency
MB2 – MB6, MB7S, MB8S, MB9S, MB10, MB11S, MB12, MB13S, MB14, MB15S and MB16S, (refer Figure 1)	pH	6.5-8.0[1]	Range	Quarterly
	Electrical Conductivity (µS/cm)	660[1]	Maximum	
	BOD (mg/L)	1.2[3]	Maximum	
	Sodium (mg/L)	180[4]	Maximum	
	Sulfate (mg/L)	250[4]	Maximum	
	Chloride (mg/L)	250[4]	Maximum	
	Cyanide (mg/L)	0.007[2]	Maximum	
	Ammonia (mg/L)	0.9[2]	Maximum	
	Total nitrogen (mg/L)	0.5[1]	Maximum	
	Total phosphorous (mg/L)	0.05[1]	Maximum	
	Nitrate	0.7[1]	Maximum	
	Major ions (carbonate, bicarbonate, calcium, magnesium, potassium), Total Kjeldahl Nitrogen (TKN)	Monitor for changes and trends		
	Copper (mg/L)	0.0014[2]	Maximum	
	Lead (mg/L)	0.0034[2]	Maximum	
	Zinc (mg/L)	0.008[2]	Maximum	
	Manganese (mg/L)	1.9[2]	Maximum	
	Iron (dissolved) (mg/L)	0.3[3]	Maximum	
MB2 – MB6, MB7S, MB8S, MB9S, MB10, MB11S, MB12, MB13S, MB14, MB15S and MB16S, (refer Figure 1)	Total Petroleum Hydrocarbons	No visible sheen or odour.	Monitor for changes and trends	Annually
	Total Organochlorine Pesticides - Chlordane (µg/L) - DDT (µg/L) - Endosulfan (µg/L) - Endrin (µg/L) - Heptachlor (µg/L) - Lindane (µg/L) - Toxaphene (µg/L)	 - 0.08[2] - 0.01[2] - 0.2[2] - 0.02[2] - 0.09[2] - 0.2[2] - 0.2[2]	Maximum	

1 – QWQG (2009) Central Coast Region Lowland Waters

2 – ANZECC (2000) 95% trigger level for freshwater.

3 – QWQG (2009) Background level for Biochemical oxygen demand for Queensland waters (80th percentile) for moderately disturbed ecosystems in a freshwater environment.

4– ADWG (2006) for aesthetic values.

5.2 Actions

Where results above trigger values are recorded, the following actions should be undertaken:

- Review site conditions to identify possible changed conditions or sources.
- Identify and address issues that may not comply with the conditions of the EA
- Rectify non conformances with the EA.

5.3 Monitoring Regime

5.3.1 Sampling

All samples are to be collected and treated as per the requirements of the following documents:

- DEHP "Monitoring and Sampling Manual 2009" Version 2 July 2013
- AS/NZS 5667.1:1998 Water quality – Sampling (Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples)
- AS/NZS 5667.11:1998 Water quality – Sampling (Guidance on sampling of groundwaters).

5.3.2 Analysis Methods

Samples that shall be filtered upon collection include:

- Dissolved metals;
- Dissolved nutrients; and
- Dissolved non purgeable organic carbon.

Filtration is to be done using a 0.45um polyethylsulfonate membrane filter.

Analysis methods are as per APHA 21ST Ed 2005 or USEPA.

Table 5: Analytical methods of analysis

Leachate Quality Indicator	Analytical Method
pH	APHA 4500 H^+ B
Electrical conductivity	APHA 2510 C
Dissolved oxygen	APHA 2510 C
Temperature	APHA 2550 B
Total Dissolved Solids (TDS)	APHA 2540 C
Sodium	APHA 3125
Potassium	APHA 3125
Calcium	APHA 3125
Magnesium	APHA 3125
Chloride	APHA 4500 B
Sulphate	APHA 4500 SO4
Alkalinity (Hydroxide Alkalinity (as CaCO3))	APHA 2320 B
Total Kjeldahl Nitrogen	APHA 4500-Norg D
Total Nitrogen	APHA 4500 N C
Total Cyanide	APHA 4500-CN O
Total Phosphorous	APHA 4500-P H

Leachate Quality Indicator	Analytical Method
Biochemical Oxygen Demand	APHA 5210 B
Chemical Oxygen Demand	APHA 5220 B
Arsenic	APHA 3125
Cadmium	APHA 3125
Chromium	APHA 3125
Copper	APHA 3125
Iron	APHA 3125
Lead	APHA 3125
Manganese	APHA 3125
Mercury	APHA 3125
Nickel	APHA 3125
Zinc	APHA 3125
Total Recoverable Hydrocarbons	USEPA SW 846 - 8260B (volatile) & 8015A (semi volatile)
Benzene, Toluene, Ethyl Benzene, Xylenes	USEPA SW 846 - 8260B
Total Organochlorines	USEPA SW 846 - 8270D
Total Organophosphates	USEPA SW 846 - 8270D
PCBs	USEPA SW 846 - 8270D
Polycyclic Aromatic Hydrocarbons	USEPA SW 846 - 8270D
Phenols	USEPA SW 846 - 8270D
Vinyl Chloride	USEPA SW 846 - 8260B
Chloroethane	USEPA SW 846 - 8260B
Carbon Tetrachloride	USEPA SW 846 - 8260B

5.3.3 Analysis Frequency

The frequency of the groundwater monitoring program needs to be based upon a number of factors such as:

- Landfill design and operation. Bowen Landfill does not have an engineered liner and leachate management system.
- Potential environmental risks. Golder (2012) previously identified that the Bowen Landfill should be classified as a Moderate to High Environmental Risk based on the following risk factors:
  - Non-engineered construction of the landfill.
  - Moderately permeable strata down to the aquifer.
  - Shallow depth to groundwater.
  - Moderate groundwater quality.
  - Proximity of the site to sensitive receptors such as water supply bores and adjacent waterways.
- Seasonal variations in groundwater conditions. Groundwater levels have risen considerably over the past 5 years and is likely to be present within waste filled former borrow pit areas and may result in flows occurring within shallow alluvial soils that could discharge into the adjacent section of Sandy Creek.
- Existing groundwater monitoring results. Recent results indicate that concentrations for some key indicators present at monitoring wells located adjacent to the waste cell are up to twice the concentrations identified at the nominal background monitoring location (MB6).

Given the site conditions, all sample points are to be sampled on a quarterly basis for a limited sampling suite with one annual monitoring suite to be completed on all parameters. Where the bores or leachate ponds are not able to be sampled during the wet season due to excessively high groundwater levels, arrangements are to be made to sample as soon as conditions permit and notation must be made as to the reason for not sampling at the designated time.

5.3.4 Sampling Parameters

Selection of water quality indicators (physio-chemical) has taken into account the chemical composition of leachate which varies greatly depending on the age of the waste interred in the landfill.

The chemical constituents of ground and surface water selected for analysis will give an indication of leachate escape, regardless of whether it was generated from recently interred wastes (acetogenic phase of degradation) or older waste (methanogenic phase of degradation).

The groundwater and leachate pond sampling parameters are outlined in Table 6.

Table 6: Quarterly Groundwater & Leachate Pond (Surface Water) monitoring parameters

Physical Parameters	
pH	Temperature
Electrical conductivity	Depth
Oxidation Reduction Potential	Dissolved Oxygen
NTU	Salinity
Sample Quality Parameters	
Total Dissolved Solids (TDS)	Alkalinity
Chemical Oxygen Demand	Biochemical Oxygen Demand
Total Kjeldahl Nitrogen	Total Nitrogen
Total Cyanide	Total Phosphorous
Heavy Metals (dissolved + total)	
Arsenic	Lead
Cadmium	Manganese
Chromium	Mercury
Copper	Nickel
Iron	Zinc
Major Ions	
Bicarbonate	Magnesium
Calcium	Potassium
Carbonate	Sodium
Chloride	Sulphate
Organics & Inorganics	
Total Recoverable Hydrocarbons (fractioned)	

Previous monitoring at the site reports that pesticides, PAHs, phenols, PCBs and VOCs have not been observed above the method detection limit during sampling conducted from 1996 to 2016. Therefore analysis of these analytes, presented in Table 7 is proposed to be undertaken on a biannual basis, in addition to the schedule presented in Table 6.

Table 7: Additional Annual Groundwater & Leachate Pond monitoring parameters

Organic and Inorganics	
Benzene, Toluene, Ethyl Benzene, Xylenes	Polycyclic Aromatic Hydrocarbons (PAH)
Polychlorinated Biphenyls (PCBs)	Phenols
Total Organo-chlorine Pesticides	Total Organophosphate Pesticides
Vinyl Chloride	Carbon Tetrachloride
Chloroethane	

5.3.5 Water Table Depth Monitoring

Aquifer depth measurements are to be taken prior to disturbance of the water in each bore upon commencement of each sampling round. Standing groundwater levels are to be measured (tape measurement to 0.01m accuracy) by qualified staff and referenced to a common height datum.

The number of monitoring wells required for water quality sampling could potentially be reduced over time as more detailed understanding of current flow conditions develops.

5.4 Data Analysis, Interpretation and Reporting

Preliminary assessment of the groundwater and surface water data shall be performed by graphing the results in an X-Y plot over time. This will allow WRC staff to visually detect any major data spikes which may be indicative of groundwater contamination.

Included in these plots is the trigger levels identified in Section X.

Annual detailed statistical analysis shall consist of:

- preliminary data assessment using X-Y plots;
- cation / anion balance to identify possible errors and outliers;
- Box-whisker plot to represent the spread of the data; and
- Shapiro-Wilk test to check the dataset for normality.

Statistical analysis for this LDMP is limited to intra-well statistical comparisons. These comparisons are aimed at evaluating if there is a statistically significant change in a parameter that may indicate contamination occurring between annual monitoring intervals. Background and / or inter-well statistical comparisons are not conducted on the data.

5.5 LDMP Quality Assurance

The monitoring regime implemented aims to achieve quality assurance of the data and confidence that objectives are achieved by:

- The selection of representative sampling sites;
- Adequate sampling frequencies;
- Sampling with sufficient spatial and temporal replication to allow for statistically valid conclusions;
- Proper sampling methods;
- Laboratory analysis in accordance with AS/NZS 5667.1:1998 including the use of duplicate sampling, spike recovery, and instrument control charts;

- Appropriate post-analysis evaluation of data quality; and
- Non-parametric or parametric statistical analysis (as appropriate) of analytical monitoring data as part of the annual return requirements for the site.

The leachate detection monitoring approach described herein meets the intent of providing early detection of leachate emissions from the Bowen Landfill within the hydrogeologic regime of the Don River catchment, and is tailored to accommodate the compliance requirements set out in the EA for the site (NR175).

6.0 IMPORTANT INFORMATION

Your attention is drawn to the document titled - “Important Information Relating to this Report”, which is included as Appendix B to this document. The statements presented in that document are intended to inform a reader of the report about its proper use. There are important limitations as to who can use the report and how it can be used. It is important that a reader of the report understands and has realistic expectations about those matters. The Important Information document does not alter the obligations Golder Associates has under the contract between it and its client.

7.0 REFERENCES

Australian Drinking Water Guidelines (ADWG) 2006 (updated 2016), published by National Health and Medical Research Council (NHMRC).

Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) 2000 *Australian and New Zealand guidelines for fresh and marine water quality. Volume 1, The guidelines,* National Water Quality Management Strategy Paper No. 4

Australian / New Zealand Standard *Water quality — Sampling Part 1: Guidance on the design of sampling programs, sampling techniques and the preservation and handling of samples* AS/NZS 5667.1:1998.

Australian / New Zealand Standard *Water quality — Sampling Part 11: Guidance on sampling of ground waters* AS/NZS 5667.11:1998

Department of Environment and Heritage Protection (DEHP) 2009 *Monitoring and Sampling Manual 2009*, Version 2, July 2013 format edits.

DEHP 2009 *Queensland Water Quality Guidelines (QWQG), Version 3*.

Environmental Protection Act (1994) (Qld) Environmental Authority Licence Number NR175, dated 15 August 1997

Golder Associates, 2012 *Groundwater Monitoring Program Review Report, Bowen Landfill,* 127673016-R-Rev0

Golder Associates, 2015 *May 2015 Leachate, Environmental Monitoring: Bowen and Kelsey Creek Landfills,* 152781-001-L-Rev0

Golder Associates, 2015 *December 2015 Leachate, Environmental Monitoring: Bowen and Kelsey Creek Landfills,* 152781-002-L-Rev0

Golder Associates, 2016 *May 2016 Leachate, Environmental Monitoring: Bowen Landfill,* 147633126-001-L-Rev0

National Environmental Protection Council (NEPC) 1999 *Schedule B(1) Guideline on the Investigation Levels for Soil and Groundwater,* NEPC.

Report Signature Page

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Senior Environmental Scientist

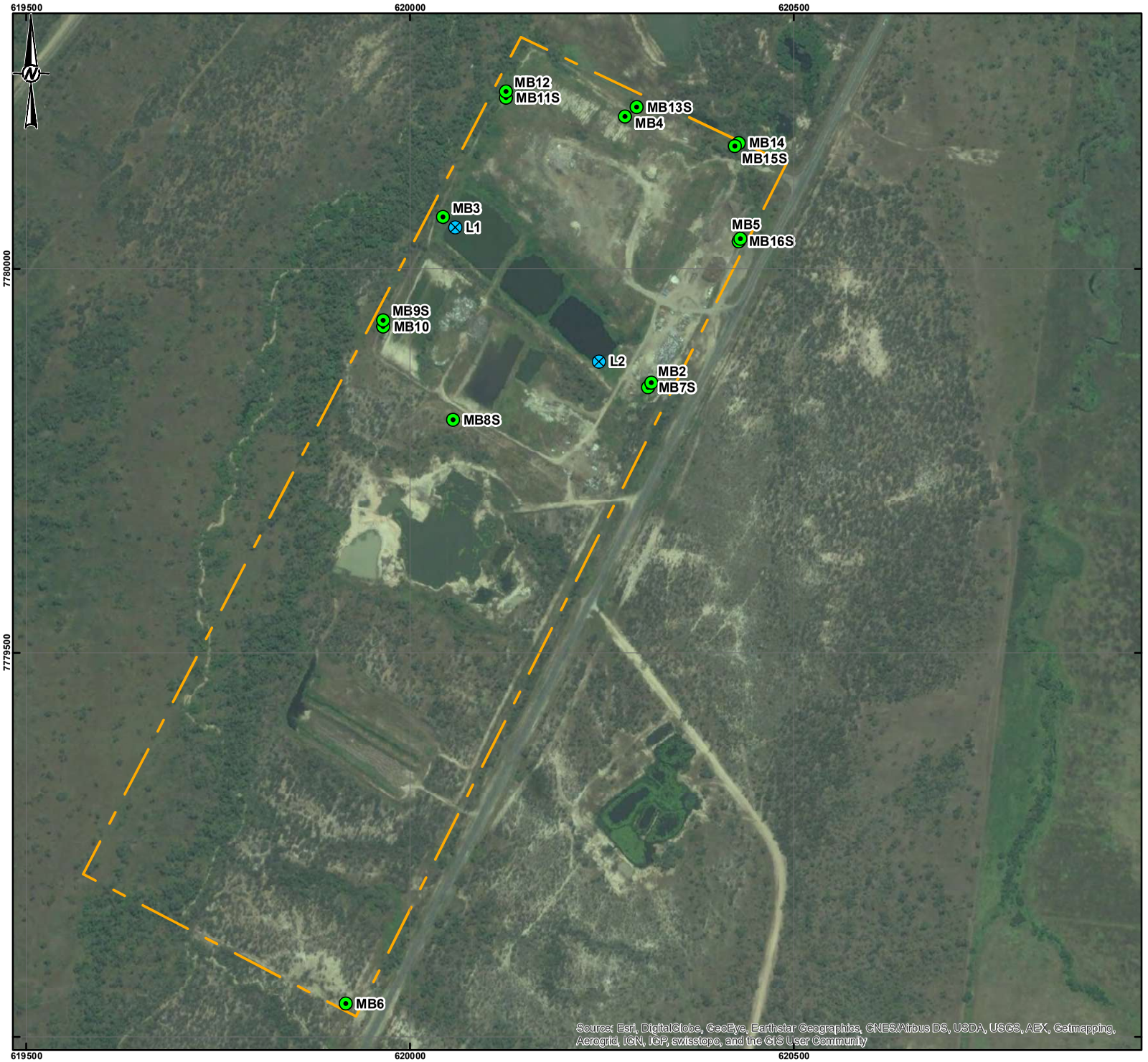
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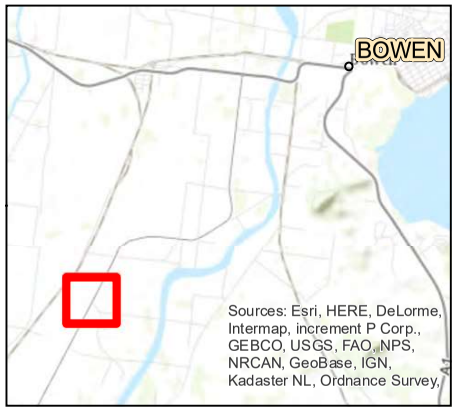
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Figure 1 Monitoring Bore Location Plan



SITE LOCALITY



LEGEND

- Site Boundary
- Monitoring Well
- Leachate Location

0 100 200 300 400

1:5,000 METERS

CLIENT
WHITSUNDAY REGIONAL COUNCIL

PROJECT
147633126

TITLE
BOWEN LANDFILL
LEACHATE DETECTION MONITORING PLAN

CONSULTANT
Golder Associates

YYYY-MM-DD	13 JULY 2016
DESIGNED	ECG
PREPARED	ECG
REVIEWED	CJ
APPROVED	CJ

PROJECT NO.	CONTROL	REV.	FIGURE
147633126	001	1	001

PATH: U:\A_Geo\3 - Local Job Files\00223 - Bowen Landfill\147633126_WellLocations.mxd
IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ISO A3
25mm
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APPENDIX A

Environmental Authority

Environmental Protection Act 1994

Licence No [redacted] NA 175

Section 45(1)

Under the provisions of the *Environmental Protection Act 1994* this environmental authority is issued:

To: Bowen Shire Council
Address: 67 Herbert Street
BOWEN QLD 4805

in respect of carrying out the environmentally relevant activities:
- 74. General Waste Disposal Facility - operating a facility for disposing of general waste designed to received waste at the rate of:
(a) more than 1 tonne but not more than 2 000 tonnes per year and

being carried out at premises on land described as:
- Collinsville Mt Coolon Road, Mt Coolan

being carried out at premises located at:
SL42273 Part Lot 4 SM61 Parish of Acre County of Sellheim

in respect of carrying out the environmentally relevant activities:
- 74. General Waste Disposal Facility - operating a facility for disposing of general waste designed to received waste at the rate of:
(b) 2 000 tonnes or more, but less than 5 000 tonnes per year.

being carried out at premises on land described as:
Part Lot 1 PER2630 Parish of Springlands County of Drake

being carried out at premises located at:
Walker Street. Collinsville

in respect of carrying out the environmentally relevant activities:
- 74. General Waste Disposal Facility - operating a facility for disposing of general waste designed to received waste at the rate of:
(e) 20 000 tonnes or more, but less than 50 000 tonnes per year
- 76 Regulated waste disposal facility - operating a facility for disposing of regulated waste.

being carried out at premises on land described as:
Reserve 448 Lot 22 HR944 Parish of Marlow

being carried out at premises located at:
- Collinsville Road, Bowen

This environmental authority is issued subject to the conditions set out in the schedules attached to this environmental authority.

This licence takes effect from 15 August 1997.

signed .....

Maurice Mathews
Regional Manager (Environment)
Delegate of Administering Authority
Environmental Protection Act 1994

date 30/7/97

This environmental authority consists of the following schedules-

Schedule A - General Conditions

Schedule B - Air

Schedule C - Water

Schedule D - Stormwater Management

Schedule E - Land Application

Schedule F - Noise

Schedule G - Waste Management

Schedule H - Monitoring and Reporting

Schedule I - Definitions

End of list of Schedules

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SCHEDULE A - GENERAL CONDITIONS

Application of Conditions of Environmental Authority

(A1) Except where otherwise indicated the conditions of this environmental authority apply to all premises subject to this environmental authority.

Licence Awareness

(A2) The holder of this environmental authority must ensure that any person responsible for carrying out any of the licensed activities is familiar with the conditions of this environmental authority as they relate to the person's responsibilities.

Competency

(A3) The holder of the environmental authority shall ensure that the operation and maintenance of the licensed activities is carried out by or under the supervision of a person competent to operate and maintain the plant and equipment used in carrying out the licensed activities.

Alterations

(A4) No change, replacement or operation of any plant or equipment is permitted if the change, replacement or operation of the plant or equipment increases, or is likely to substantially increase, the risk of environmental harm above that expressly provided by this environmental authority.

Maintenance of Plant and Equipment

(A5) The holder of this environmental authority must implement an effective maintenance program to ensure that all plant and equipment used in the carrying out of the licensed activities is maintained in good working order to minimise the environmental harm caused by the carrying out of the activities and to ensure compliance with the conditions of this environmental authority.

Calibration

(A6) All instruments and devices used for the measurement or monitoring of any parameter under any condition of this environmental authority must be calibrated, and appropriately operated and maintained.

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Records

(A7) Any record or document required to be kept as a condition of this environmental authority must be kept at the Bowen Shire Council Offices for a period of at least 5 years and be available for examination by an authorised person. The record retention requirements of this condition will be satisfied if any daily and weekly records are kept for a period of at least 3 years and these records are then kept in the form of annual summaries after that period.

Integrated Environmental Management System (IEMS)

(A8) The holder of this environmental authority must:

(a) further develop and implement the Integrated Environmental Management System which was submitted to the administering authority in support of the application for this environmental authority;

(b) in further developing the Integrated Environmental Management System provide for the following functions:

(i) the monitoring of releases of contaminants into the environment and an environmental assessment of the releases; and
(ii) staff training and awareness of environmental issues; and
(iii) the conduct of environmental and energy audits; and
(iv) waste prevention, treatment and disposal; and

(c) lodge with the administering authority on or before 1 January 1998 and at 6 monthly intervals thereafter until 1 January 1999, a brief report describing the progress in developing and implementing the Integrated Environmental Management System; and

(d) on or before 1 February 1999, have completed and implemented the Integrated Environmental Management System, and

(e) on or before 1 March 1999 lodge a detailed description of the Integrated Environmental Management System and its documentation with the administering authority for its review and comment; and

(f) have due regard to that comment in the finalisation of the Integrated Environmental Management System.

(A9) A copy of the IEMS must be kept at the Bowen Shire Council offices.

(A10) The holder of this environmental authority must not implement or amend an IEMS where such implementation or amendment would result in a contravention of any condition of this environmental authority.

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(A11) The holder of this environmental authority must submit details of any amendment to the IEMS to the administering authority with the Annual Return which immediately follows the enactment of any such amendment.

(A12) The IEMS must address the management of the actual and potential environmental impacts resulting from the carrying out of the environmentally relevant activity/activities by the holder of this environmental authority at each of the premises subject to this environmental authority.

Site-Based Management Plan
- Bowen Waste Disposal Site & Mt Coolon Waste Disposal Site

Note: If a licensed place is to be closed within 12 months of the date of issue of this environmental authority then a site-based management plan will not be required and a Closure Plan must be prepared for the waste disposal facility. If the licensed place is to remain open for more than 12 months a Site-Based Management Plan must be developed to address management of the licensed place until a Post Closure Care and Maintenance Plan has been implemented.

(A13) The holder of this environmental authority must:

(1) develop and implement Site-Based Management Plans for each of the licensed places covered by this environmental authority which provide for at least the following functions:

(a) routine operating procedures to prevent or minimise environmental harm; and
(b) contingency plans and emergency procedures to deal with foreseeable risks and hazards; and
(c) maintenance practices and procedures; and
(d) staff training and awareness of environmental issues; and
(e) definition of key tasks and responsibilities for implementation of the plan; and
(f) the monitoring of releases of contaminants into the environment and assessment of the environmental harm caused by the releases; and
(g) monitoring of compliance with any of the requirements of:
(i) the conditions of this environmental authority; or
(ii) any plans or programs prepared under this licence.
(h) keeping and production of environmental records and reports; and
(i) handling of environmental complaints; and
(j) preparation of a stormwater management plan which has the objective of avoidance and minimisation of contaminated stormwater and includes consideration of at least the following options (where appropriate):
(i) diversion of upstream runoff away from areas containing wastes or contaminants; and
(ii) minimisation of the size of any contaminated areas; and
(iii) any other specific requirements within the stormwater management schedule of this environmental authority.

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(k) preparation of a site development plan as required by condition (A14)
(l) review and amendment or improvement of operating procedures and plans or programs where deficiencies are revealed; and
(m) any other specific requirements of this environmental authority including the preparation of any other plans and/or programs required under this environmental authority; and

(2) have completed the site-based management plan for:

(a) Bowen waste disposal site on or before 1 February 1999;
(b) Mt Coolon waste disposal site on or before 1 February 1999.

(3) keep a copy of the site-based management plan at a location readily accessible to personnel carrying out the activity.

Note: Site based management plans are an integral part of the Integrated Environmental Management System required under this environmental authority.

Site Development Plan - Bowen Waste Disposal Site

(A14) The holder of this environmental authority must develop and implement, *as part of the Site Based Management Plan required under this licence,* a Site Development Plan for the licensed place, to cover each 5 year period for which the licensed place is open to receive wastes or until a Post Closure Care and Maintenance Plan has been implemented.

(A15) The Site Development Plan must include details of at least the following:

(a) dimensions of any area of the licensed place used for waste disposal and storage over the period covered by this Site Development Plan;

(b) an accurate level survey of any area of the licensed place to be utilised for the disposal and storage of wastes over the period covered by this Site Development Plan. The levels must be reduced to a common datum and related to contour plans of the licensed place;

(c) the approximate dimensions of each waste disposal area and dimensions of the active waste disposal face to be constructed in the area designated in (a) over the period covered by this site development plan;

(d) the in situ permeability of earthen materials which are to be used for capping and/or lining of waste disposal areas and into which excavations will be made for the purposes of waste disposal;

(e) approximate location of any leachate dam or pond, pump well to be used or other plant and equipment installed as part of a leachate collection, storage or recirculation system;

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(f) location of any stormwater drains or diversion embankments to be constructed to achieve compliance with this environmental authority; and

(g) location of any areas to be capped, the proposed final surface levels and contours, final drainage system and species of vegetation to be planted as part of a rehabilitation program for licensed place over the period covered by this site development plan.

Review and Comment on Plans and Programs Prepared under this Environmental Authority

(A16) The holder of this environmental authority must:

(a) submit any Site-Based Management Plan, Site Development Plan, Stormwater Management Plan, Post Closure Care and Maintenance Plan or Detection Monitoring Program required under this environmental authority to the administering authority for its review and comment; and

(b) have due regard to that comment in the finalisation of the plans or programs; and

(c) complete and commence implementation of the plans or programs within 3 months of receipt of any comment from the administering authority; and

(d) submit a copy of the finalised plans or programs to the administering authority within 30 days of its finalisation.

(A17) The holder of this environmental authority must submit details of any amendments to any Site-Based Management Plan, Site Development Plan, Stormwater Management Plan, Post Closure Care and Maintenance Plan or Detection Monitoring Program required under this environmental authority to the administering authority with the Annual Return which immediately follows the enactment of any such amendment.

End of Conditions for Schedule A

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SCHEDULE B - AIR

Noxious or Offensive Odour

(B1) In the event of a complaint being made to the administering authority about odour generated on the licensed place that constitutes annoyance and that the administering authority considers to be neither frivolous or vexatious the holder of this environmental authority must take measures to mitigate the odour source to minimise noxious or offensive odour being released beyond the boundaries of the licensed place.

Landfill Gas Management

(B2) The holder of this environmental authority must adopt such practices and procedures as necessary to ensure that:

(a) the concentration of landfill gas (methane standards) generated by the landfill unit does not exceed 25 percent of the lower explosive limit for methane in useable closed spaces located on the facility excluding any gas control or recovery system components; and

(b) the concentration of landfill gas components, other than methane, generated by the landfill does not exceed concentrations which may pose a health risk to persons within useable closed spaces located on the facility excluding gas control or recovery system components.

Dust Control

(B3) The holder of this environmental authority must ensure that the stockpiles of inert cover material are managed so as to minimise wind blown dust emissions.

(B4) The holder of this environmental authority must ensure that all wastes accepted onto the licensed place are handled, disposed of or stockpiled in such a way as to minimise dust generation.

(B5) Leachate, contaminated stormwater, landfill gas condensate, effluent from truck wash facilities or waste oil must not be used for dust suppression outside of the waste disposal area.

(B6) In the event of a complaint being made to the administering authority about dust generated on the licensed place that constitutes annoyance and that the administering authority considers to be neither frivolous or vexatious the holder of this environmental authority must take all reasonable and practicable measures to minimise the quantity of dust released beyond the boundaries of the licensed place.

End of Conditions for Schedule B

SCHEDULE C - WATER

nil conditions

End of Conditions for Schedule C

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SCHEDULE D - STORMWATER MANAGEMENT

Stormwater

(D1) The holder of this environmental authority must effectively and appropriately manage the carrying out of the environmentally relevant activity so as to prevent, as far as is practicable, any contamination of stormwater and any release of contaminated stormwater.

Stormwater Diversion

(D2) A system of suitable diversion drains or embankments must be constructed and maintained to divert surface waters away from any area of the licensed place where contact with wastes or contaminants may occur, paying particular attention to :

(a) the active disposal area; and
(b) any waste storage areas; and
(c) any area previously used for waste disposal; and
(d) any leachate collection ponds (if applicable); and
(e) area used to treat wastes prior to disposal.

(D3) Rainfall and stormwater runoff which may contact wastes or contaminants on the licensed place must not be released to any stormwater drain roadside gutters or waters without the holder of this environmental authority taking such practicable measures as may be necessary to prevent the release.

End of Conditions for Schedule D

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SCHEDULE E - LAND APPLICATION

nil conditions

End of Conditions for Schedule E

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SCHEDULE F - NOISE

Emission of Noise

(F1) In the event of a complaint about noise that the administering authority considers is reasonable, then the emission of noise from the licensed place must not result in levels greater than those specified in Table 1 of the Noise Schedule until the circumstance which gave rise to the complaint is resolved..

Schedule F - Table 1

Noise Level at a Noise Sensitive Place Measured as the Adjusted Maximum Sound Pressure Level $L_{Amax\ adj,T}$	**Period**
background noise level plus 5dB(A)	7 am - 6 pm
background noise level plus 5dB(A)	6 pm - 10 pm
background noise level plus 3dB(A)	10 pm - 7 am
Noise Limits at a Commercial Place Measured as the Adjusted Maximum Sound Pressure Level $L_{Amax\ adj,T}$	**Period**
background noise level plus 10dB(A)	7 am - 6 pm
background noise level plus 10dB(A)	6 pm - 10 pm
background noise level plus 8dB(A)	10 pm - 7 am

End of Conditions for Schedule F

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SCHEDULE G - WASTE MANAGEMENT

General

(G1) The holder of this environmental authority must not:

(a) burn waste at or on any licensed place covered by this environmental authority; nor
(b) allow waste to burn or be burned at or on any licensed place covered by this environmental authority; nor
(c) remove waste from any licensed place covered by this environmental authority and burn such waste elsewhere.

Permitted Wastes

(G2) This environmental authority permits only the following wastes to be disposed of at the licensed place;

(a) domestic waste;
(b) commercial waste;
(c) domestic clean-up waste;
(d) construction or demolition waste;
(e) industrial waste;
(f) garden wastes;
(g) putrescible wastes;
(h) solid inert wastes;
(i) certain regulated wastes in accordance with condition G3.

(G3) Regulated wastes interred at the licensed place must be restricted to the following wastes except where the disposal of regulated wastes is specifically authorised by the administering authority for the purposes of administering the Contaminated Land Act 1991.

(i) regulated wastes listed in schedule G - Table 1; and
(ii) regulated wastes listed in schedule G - Table 2; and

- the disposal rate for such wastes does not exceed 5 percent by mass of the total mass of wastes interred in the waste disposal facility during any calendar year; and

- the wastes are disposed under supervised burial.

Schedule G - Table 1.

asbestos wastes (for special burial)
tyres

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Schedule G - Table 2.

Food processing wastes (liquid waste streams to be prohibited)
Grease interceptor trap effluent and residues
Potentially Infectious clinical and related wastes which have been effectively treated to render them non-infectious.
Solid pharmaceutical products rendered unrecognisable (other than any substances listed under Schedule 8 of the Poisons Regulations 1978 and cytotoxic wastes)

NOTES:

(a) wet cell batteries and waste oil may be accepted and stored at the licensed place for recycling.

(b) drums containing any residual regulated waste are a regulated waste unless effectively cleaned.

(c) definitions of domestic, commercial, domestic clean-up, construction or demolition, garden and regulated wastes are in S12 of the *Environmental Protection (Interim Waste) Regulation 1996)*

Prohibited wastes

(G4) Notwithstanding condition number (G3), the following wastes must not be accepted onto the licensed place:

(a) liquescent waste streams or any waste capable of yielding free liquids (does not include leachate or condensate arising from gas collection within the licensed place and grease trap waste);
(b) untreated infectious and chemical wastes and liquid pharmaceuticals from clinical and related waste stream;
(c) cytotoxic wastes;
(d) untreated sharps;
(e) S8 pharmaceuticals;
(f) all radioactive wastes, unless otherwise approved under the *Radioactive Substances Act 1958;*
(g) pyrophoric wastes (where co-disposed with other potentially combustible material);
(h) explosives and ammunition, pyrotechnics or propellants, apart from trace residues no longer capable of supporting combustion or an explosive reaction;

(G5) No wastes must be interred at the waste disposal facility which exhibit any of the hazard characteristics listed in Schedule G - Table 3.

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Schedule G - Table 3.

Hazard Characteristic	Description Of The Hazard Characteristic
Ignitability	Regulated wastes that are capable of causing a fire when ignited through friction, absorption of moisture, or spontaneous chemical changes under standard temperature and pressure
Corrosivity	Regulated wastes which on dissolution exhibit a pH of 2 or less, or 12.5 or greater
Reactivity	Regulated wastes if they have any of the following properties: • react violently with water; • form potentially explosive mixtures with water; and or other co-disposed wastes; • generate toxic gases, vapours, of fumes dangerous to human health or the environment when mixed with water; and or other co-disposed wastes; • contain substances which generate toxic gases vapours or fumes when exposed to pH conditions between 2 and 12.5; and / or • are capable of detonation or explosive reaction when subjected to a strong initiating source or if heated under confinement; and / or • are readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.
Radioactivity	Regulated wastes containing radioactive substances unless disposal is specifically authorised under the *Radioactive Substances Act 1958*

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(G6) Notwithstanding G5, minor amounts of regulated waste not specifically permitted to be accepted may be deposited at the licensed place provided:

(i) the regulated waste is incidental to and commingled with the general waste stream; and
(ii) the quantity and concentration of the regulated waste (both individually and in aggregate) is insignificant; and
(iii) it is impracticable to segregate the regulated waste from other waste which is permitted to be deposited; and
(iv) the deposition of the regulated waste is not likely to cause any risk of fire, explosion, public health danger, nuisance, or environmental harm; and
(v) all practicable steps are taken to inform persons using the facility that such wastes are not be included in the waste stream to be deposited at the waste disposal facility.

On and Off Site Movement of Regulated Wastes

(G7) Where regulated waste is received at any licensed place covered by this environmental authority the holder of this environmental authority must monitor and keep records of the following:

(a) the date and quantity and type of waste received; and
(b) the name of the approved waste transport operator that delivered the waste; and
(c) the waste disposal method and disposal location.

(G8) Where regulated waste is removed from any licensed place covered by this environmental authority (other than by a release as permitted under another schedule of this environmental authority), the holder of this environmental authority must monitor and keep records of the following:

(a) the date, quantity and type of waste removed; and
(b) name of the waste transporter and/or disposal operator that removed the waste; and
(c) the intended treatment/disposal destination of the waste.

Construction of Disposal Areas

(G9) The holder of this environmental authority must ensure that any active waste disposal area is constructed with ramps to allow plant and machinery access so that wastes can be effectively consolidated, compacted and covered.

(G10) Where an active disposal area or any part thereof is installed above ground the embankments must be maintained to ensure the stability and integrity of construction.

Soil Permeability

(G11) Soils or other materials used in the construction of any waste disposal cells, above ground embankments, storage ponds and final cover must achieve an insitu hydraulic conductivity which is sufficiently impervious so as to prevent or minimise the release of leachate from the waste disposal area.

Active Waste Disposal Area Management

(G12) The holder of this environmental authority must ensure that waste disposal activities do not extend beyond the boundary of the licensed place.

(G13) The holder of this environmental authority must ensure that all wastes accepted for disposal at the licensed place are not disposed of:

(a) beyond any active waste disposal area; and
(b) into waters or leachate; and
(c) beyond the catchment of any leachate collection drains if installed as part of a leachate collection system.

(G14) The holder of this environmental authority must ensure that exposed wastes are confined to the operating face of the active waste disposal area and that the operating face is maintained at a minimum practicable size at all times.

(G15) The active waste disposal areas must be constructed in such a manner that the base of the disposal area is graded downward from the operating face to a collection sump to enable accumulations of contaminated stormwater and leachate to be removed during the operation.

Problem Wastes

(G16) Problematic wastes such as large metal articles which must be effectively compacted before burial and motor vehicle tyres should be disposed of at the base of the operating face.

(G17) The holder of this environmental authority must ensure that all asbestos wastes disposed at the waste disposal facility must be buried within the landfill not less than 2 metres from the surface.

Cover Material

(G18) A stockpile of inert earthen material or other inert synthetic material must be made readily available at all times at the licensed place in sufficient quantities to effectively cover and contain wastes exposed in the active disposal area.

(G19) The holder of this environmental authority must ensure that wastes deposited in the active disposal area are consolidated, compacted and covered with a layer of inert earthen material or other inert synthetic material as often as is necessary to effectively minimise the quantity of wind blown litter, odour and fly nuisance.

Mechanical Plant

(G20) Every lift of waste deposited within the waste disposal facility must be evenly and properly consolidated and compacted by sufficient passes of mechanical plant of an appropriate weight and type over the deposited waste as soon as practicable after the deposition of the waste on the operating face of the waste disposal facility.

Leachate Management

(G21) The holder of this environmental authority must ensure that all reasonable and practical measures are taken to ensure the disposal area is operated and managed so as to minimise the generation of leachate.

(G22) Leachate generated on the licensed place must only be disposed of so that there is no direct or indirect release of contaminants to any groundwater, stormwater drain, roadside gutter or surface watercourse.

(G23) The holder of this environmental authority must ensure that any leachate or contaminated stormwater generated on the licensed place is collected and:

a) conveyed to a leachate storage dam or pond; and/or
b) disposed of in accordance with condition (G24)

(G24) Leachate or contaminated stormwater which is intercepted and collected on the licensed place may be disposed of:

a) by evaporation; or
b) by recirculation back into the areas of the licensed place where waste disposal is taking place; or
c) by spray irrigation over exposed wastes; or
d) by disposal to sewer.

Leachate Attenuation - Collinsville and Mt Coolon Waste Disposal Sites

(G25) The holder of this environmental authority must ensure that any active disposal trench is excavated into low permeability soils of sufficient thickness and appropriate characteristics to effectively attenuate landfill leachate percolating from the trench to an extent that the migration of landfill leachate shall not cause environmental harm or environmental nuisance.

(G26) The holder of this environmental authority must ensure that the base of any disposal trench is sufficiently separated from any groundwater to prevent the migration of landfill leachate to groundwater.

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Leachate Collection System - Bowen Waste Disposal Site

(G27) The holder of this environmental authority must ensure that the design of any newly constructed waste disposal cells incorporates an effective liner system to capture and minimise the direct or indirect release of contaminants to any groundwater, stormwater drain, roadside gutter or surface watercourse. The liner system must be constructed of:

a) an engineered earthen liner of at least 0.6 metres thickness, placed in at least two layers, achieving a maximum permeability of no greater than 1 x 10-9 metres/second; or
b) a geosynthetic clay liner achieving a maximum permeability of no greater than 1 x 10-10 metres/second; or
c) an alternative lining system as approved by the administering authority which will achieve the same level of leachate and contaminant containment as that described in either sub-section a) or b); and
d) a leachate collection system which is managed so as to effectively maintain a level of leachate head of no more than 0.3 metre over the uppermost layer in the lining system.

Note: This condition only applies to any waste disposal cells constructed within a horizontal expansion of the "footprint" of the active waste disposal area that occur after the issue of this environmental authority.

Leachate Storage Ponds or Dams

(G28) The holder of this environmental authority must ensure that any pond or dam installed at the licensed place which is used for the collection and storage of leachate or contaminated stormwater must be:

a) constructed of low permeability soils or other material so as to prevent any direct or indirect release of contaminants through the base or embankments; and
b) maintained to ensure the stability and integrity of construction.
c) constructed and managed so that a freeboard capable of preventing overspill is maintained to store excess volume when annual rainfall of a 1 in 10 year recurrence period occurs.

Public Health Issues

(G29) The holder of this environmental authority must ensure that the operation of the waste disposal area does not create a public health problem.

(G30) The holder of the environmental authority must take all practical measures to ensure that the environmentally relevant activity is conducted at all times in a nuisance free manner, particularly regarding fly breeding, mosquito breeding and rat harbourage and breeding.

(G31) The holder of the environmental authority must carry out any works required by the administering authority to prevent or abate any public health problem or nuisance which may arise as a result of the operation of the licensed place.

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Information

(G32) The holder of this environmental authority must cause signs, maintained in good repair, written in a language appropriate for the user population and giving the following information, to be erected at the entrance to the site and/or in prominent locations on the site:

(a) the name of the site and a telephone contact for site information;
(b) the hours and days the site will be open for receiving wastes;
(c) waste acceptance criteria for which the site is authorised to receive;
(d) a schedule of wastes not permitted to be dumped and information regarding appropriate disposal method for these wastes;
(e) advise that when the site is closed to the public that unauthorised dumping of waste is prohibited (citing the penalty) and give the location of the nearest waste disposal facility;
(f) on-site arrangements for tipping of wastes and any arrangements and/or facilities for recycling and reuse of materials;
(g) controls over scavenging, lighting of fires littering and illegal dumping.

Access

(G33) The holder of this environmental authority must ensure that all weather access roads are constructed and maintained so that at all times whilst the licensed place is open for receipt of wastes vehicles have access to any active waste disposal area.

(G34) The holder of this environmental authority must ensure that access roads are constructed and maintained so as to minimise dirt and mud being carried off the licensed place by vehicles leaving the licensed place.

Site Security - Bowen Waste Disposal Site

(G35) By 1 January 1998 any active waste disposal area and waste storage area must be enclosed by a fence with lockable gates which must be installed and maintained to a standard that will prevent access by stock and unauthorised vehicles when the licensed place is not open for receipt of wastes.

(G36) The holder of this environmental authority must ensure that all gates to the licensed place are kept locked when it is not open for receipt of wastes.

Site Security - Collinsville Waste Disposal Site

(G37) By 1 January 1999 any active waste disposal area and waste storage area must be enclosed by a fence with lockable gates which must be installed and maintained to a standard that will prevent access by stock and unauthorised vehicles when the licensed place is not open for receipt of wastes.

(G38) The holder of this environmental authority must ensure that all gates to the licensed place are kept locked when it is not open for receipt of wastes.

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Site Supervision - Bowen Waste Disposal Site

(G39) The holder of this environmental authority must ensure that, at all times while the licensed place is open for the receipt of wastes, that the site must be supervised by at least one person who is responsible for ensuring that the only wastes accepted or disposed of at the licensed place are those permitted under this environmental authority.

Site Supervision- Collinsville and Mt Coolon Waste Disposal Sites

(G40) The holder of this environmental authority must ensure that the licensed place is inspected by a trained operator as often as is necessary so as to ensure compliance with this environmental authority.

Fire Control

(G41) The holder of this environmental authority must ensure a fire break is established around the active waste disposal area as designated in the site development plan to prevent fires from spreading to adjoining land.

(G42) The holder of this environmental authority must prepare an emergency fire contingency plan for the licensed place and ensure that it is implemented as soon as practicable upon notification of a fire at the licensed place.

(G43) The holder of this environmental authority must act to ensure that any unauthorised fire on the licensed place is promptly extinguished.

Litter Control

(G44) The holder of this environmental authority must ensure that the movement of litter off the licensed place does not cause environmental harm or nuisance beyond the boundary of the licensed place.

(G45) Relocatable litter screens or other methods of litter control must be provided around the active waste disposal area in order to effectively capture wind blown litter generated by activities on the licensed place.

(G46) The holder of the environmental authority must ensure a regular programme of litter collection is conducted so that the licensed place, all fences, gates, access roads and any litter screens are kept in a tidy condition and neighbouring properties and roadside are kept free of litter generated by activities carried out on the licensed place.

Site Amenity

(G47) The holder of this environmental authority must ensure that the visual amenity of the land surrounding the licensed place is protected and enhanced by the provision of vegetation screens and/or other suitable visual barriers.

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Recycling - Bowen Waste Disposal Site & Collinsville Waste Disposal Site

(G48) The holder of this environmental authority must ensure that an area is set aside for the segregation and storage of recyclable solid wastes where such services are viable.

(G49) The holder of this environmental authority must ensure that reasonable and practicable steps are taken to ensure recyclable wastes are not deposited in the general waste stream.

NOTE: Such steps may include, but not be limited to, provision of receptacles, suitable signage, and promotion of public awareness of the recycling service.

Scavenging

(G50) Scavenging of recyclable materials from the licensed place is prohibited except where a written agreement exists between the holder of this environmental authority and an approved scavenging contractor.

(G51) The holder of this environmental authority must ensure that food, clothing, bedding, toiletries and other personal effects are not permitted to be salvaged from the licensed place.

Tyre Storage

(G52) Waste tyres may be stored in temporary above ground heaps on the licensed place provided that there are no more than 500 waste tyres in each heap.

(G53) Where there is more than one heap of waste tyres a separation distance between the heaps or other methods must be established and maintained so as to effectively prevent fire from spreading:

(a) from one tyre storage heap to another;
(b) to other waste stored or disposed of at the licensed place.

Battery Storage

(G54) Used wet cell batteries may only be stored temporarily on the licensed place in a covered enclosure which is bunded to contain spillages and leakage.

Oil Storage

(G55) Waste oil may only be stored temporarily at the licensed place in containers which:

(i) are stored in an area which is designated for this purpose and identified by appropriate information signs; and
(ii) bunded to contain spillage and leakage; and
(iii) are securely sealed when full to prevent rainwater entry and spillage; and
(iv) have a filling mechanism which prevents rainwater entry and minimises spillage.

Vehicle Cleaning

(G56) The maintenance and cleaning of vehicles and other equipment or plant must be carried out so that there is no direct or indirect release of contaminants to any groundwater, stormwater drain, roadside gutter or surface watercourse.

Site Rehabilitation

(G57) The holder of this environmental authority shall ensure that completed waste disposal areas are progressively capped with a final cover system consisting of such layers of suitable material of appropriate thickness, placed and compacted as necessary to:

(i) prevent the exposure of deposited wastes due to erosion;
(ii) prevent as far as practicable the infiltration of water through the cover system; and
(iii) support vegetation types appropriate to post-closure land use, and which will not cause the disruption of the integrity of the final cover system.

(G58) The final surface of the final cover system referred to in condition G57 shall be graded and or terraced, equipped with surface drains, and vegetated as soon as practicable after installation of the final cover system so as to:

(i) prevent damage to earthworks and cover systems due to erosion;
(ii) divert stormwater away from the completed disposal area; and
(iii) prevent ponding of stormwater over any area of the final cover system.

Site Closure and Post-Closure Care

(G59) Within12 months of the completion of waste disposal activities at the waste disposal facility, the holder of this environmental authority must submit to the administering authority a closure plan and a post-closure care and maintenance plan.

(G60) The closure plan referred to in condition G59 must describe the proposed actions of the holder of the environmental authority in relation to:-

(i) final cover system;
(ii) final surface contours (including allowances for land subsidence);
(iii) land use in post-closure;
(iv) surface drainage;
(vi) leachate management.

(G61) The holder of this environmental authority must commence closure activities no less than 3 months after the date on which the waste disposal facility ceases to receive waste.

(G62) The post-closure care and maintenance plan referred to in condition G59 must describe the licensee's proposed action in relation to:-

(i) maintenance of the integrity of the site including the final cover system and any associated vegetation; and
(ii) maintenance of any leachate management systems.

(G63) The holder of this environmental authority shall conduct post-closure care of the waste disposal facility for 30 years, or until it can be demonstrated to the administering authority that the site is geotechnically stable and will not release contaminants to the environment which result in environmental harm or nuisance. Such care must include, but shall not be limited to:

(i) maintenance of the integrity and effectiveness of final cover systems; and
(ii) maintenance and operation of any leachate collection system; and
(iii) the continuation of any monitoring program required as a condition of this environmental authority.

End of Conditions for Schedule G

SCHEDULE H - MONITORING AND REPORTING

Complaint Recording

(H1) All complaints received by the holder of this environmental authority relating to releases of contaminants from operations at the licensed places must be recorded and kept with the following details:

(a) time, date, *licensed place to which the complaint refers* and nature of complaint;
(b) type of communication (telephone, letter, personal etc.);
(c) name, contact address and contact telephone number of complainant (Note: if the complainant does not wish to be identified then "Not identified" is to be recorded);
(d) response and investigation undertaken as a result of the complaint;
(e) name of person responsible for investigating complaint; and
(f) action taken as a result of the complaint investigation and signature of responsible person.

Recording of Monitoring Program Results

(H2) The holder of this environmental authority must keep a written record of the results of all monitoring programs required under this environmental authority. This record must:

(a) record the results of all analyses, measurements and observations;
(b) record the date and time of sampling;
(c) be endorsed by a person or body possessing appropriate experience and qualifications to perform the required measurements on all the records of analysis results;
(d) have all records of analyses, measurements and observations signed by a responsible officer; and
(e) be made available upon request to any authorised person who must be permitted to make copies thereof.

Report Submission

(H3) The holder of this environmental authority must submit a report to the administering authority with the Annual Return which shall include but not be limited to:

(a) a summary of the previous twelve month's monitoring results obtained under any monitoring programs required under this environmental authority and, in graphical form, a comparison of the previous twelve month's monitoring results to both the licence limits and to relevant prior results;
(b) an evaluation/explanation of the data from the monitoring programs; and
(c) a summary of any record of quantities of discharge required to be kept under this environmental authority; and
(d) a summary of the record of equipment failures or events recorded for any licensed place under condition H4; and
(e) an outline of actions taken or proposed to minimise the environmental risk from any deficiency identified by the monitoring or recording programs; and

Environmental Event Recording

(H4) The holder of this environmental authority must keep a record, in the form of a log, of any equipment failures or events likely to have adversely affected the environmental performance of the licensed place whilst still complying with this licence. This log must include at least the following details:

(a) time, date and nature of event;
(b) response and investigation undertaken to deal with the event;
(c) name of person responsible for investigating the event; and
(d) action taken as a result of the event investigation, and signature of responsible person; and
(e) must be made available upon request to any authorised person who shall be permitted to make copies thereof.

(H5) For all licensed places under this environmental authority, the record of environmental events and equipment failures required under condition, (H4) must also include any of the following events:

(a) any unauthorised fire within a waste disposal facility; and
(b) the release of leachate or stormwater runoff contaminated by wastes or leachate to groundwater, roadside gutter; stormwater drain or surface waters from any waste disposal facility; and
(c) the discovery of unauthorised disposal of wastes at any waste disposal facility; and
(d) any stormwater or groundwater infiltration of trenches at any waste disposal facility; and
(e) any breakdown of plant and equipment used at any waste disposal facility where such breakdown is likely to adversely affect the licensed place's environmental performance.

Notification of Emergencies and Incidents

(H6) Where the holder of this environmental authority has not given notification to the administering authority under section 37 of the Environmental Protection Act, as soon as practicable after becoming aware of any emergency or incident which results in the release of contaminants not in accordance, or reasonably expected to be not in accordance with the conditions of this environmental authority, the holder of this environmental authority must notify the administering authority of the release by telephone or facsimile.

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(H7) Where the holder of this environmental authority has not given notification to administering authority under section 37 of the Environmental Protection Act, notification of emergencies or incidents as required by condition number (H6) include but not be limited to the following:

(a) the holder of the environmental authority;
(b) the location of the emergency or incident;
(c) the number of the environmental authority;
(d) the name and telephone number of the designated contact person;
(e) the time of the release;
(f) the time the holder of the environmental authority became aware of the r
(g) the suspected cause of the release;
(h) the environmental harm and or environmental nuisance caused, threatene be caused by the release; and
(i) actions taken to prevent further any release and mitigate any environmen and or environmental nuisance caused by the release.

(H8) Where the holder of this environmental authority has not given notification to tl administering authority under section 37 of the Environmental Protection Act, r than fourteen (14) days following the initial notification of an emergency or inc the holder of this environmental authority must provide written advice of the information supplied in accordance with condition number (H7) in addition to:

(a) proposed actions to prevent a recurrence of the emergency or incident;
(b) outcomes of actions taken at the time to prevent or minimise environment and or environmental nuisance.

Exception Reporting

(H9) The holder of this environmental authority must notify the administering authori writing of any monitoring result which indicates an exceedance of any environm authority limit within twenty-eight (28) days of completion of analysis.

(H10) The written notification required by condition number (H9) above must include:

(a) the full analysis results, and
(b) details of investigation or corrective actions taken, and
(c) *results of* any subsequent analysis *carried out to verify the success of any co actions taken.*

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Detection Monitoring Program - Bowen Waste Disposal Site & Collinsville Waste Disposal Site

Note: The grounds for requiring a detection monitoring program are that in the application for an environmental authority and/or any other supporting submission that:

a) ***Council has not provided evidence that there is no groundwater aquifer and/or surface water that could be reasonably expected to be detrimentally affected by the release of any contaminants from the waste disposal site; or***

b) ***if there is evidence of the presence of any groundwater aquifer and/or surface water that could be reasonably expected to be detrimentally affected by the release of any contaminants from the waste disposal site, and Council has provided no evidence that the construction and/or operation (past and present) of the waste disposal site is such that it could be reasonably expected that there would be no release of any contaminant from the waste disposal site.***

(H11) The holder of this environmental authority must by the first Annual Return date develop and implement a Detection Monitoring Program for each of the licensed places, which will effectively detect any release of contaminants from the licensed place to groundwater and/or surface waters.

(H12) The Detection Monitoring Program referred to in condition (H11) must be developed by a person possessing appropriate qualifications and experience in the fields of hydrogeology and groundwater monitoring program design to be able to competently make recommendations about these matters.

(H13) The Detection Monitoring Program must include:

(a) sufficient monitoring points and/or wells to obtain representative samples of groundwater and surface waters both upgradient and down gradient of the potential influence of the licensed place; and

(b) monitoring and measurement techniques that will yield representative samples; and

(c) analysis of a sufficient number of indicator parameters whereby significant change of these parameters from upgradient to downgradient will indicate the presence of a release of contaminants from the licensed place; and

(d) sampling with sufficient spatial and temporal replication to make statistically valid conclusions about the presence or absence of a release from the licensed place with at least an eighty percent chance of detecting any release of contaminants from the licensed place if one exists.

(H14) All determinations of the quality of groundwater and receiving surface water must be performed by a person or body possessing appropriate experience and qualifications to perform the required determinations.

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(H15) All sampling and field testing of contaminants, receiving waters and groundwaters and preservation of samples must be carried out in accordance with methods prescribed in the Department of Environment Water Quality Sampling Manual, 2nd Edition, February 1995, or more recent additions or supplements to that document as such become available.

(H16) On any occasion that samples are obtained in accordance with condition (H15), the holder of this environmental authority must measure and record standing groundwater levels in metres, accurate to 0.01 metre. The elevation of the reference point, relative to Australian Height Datum, for use in any groundwater level measurement must be determined to an accuracy of 0.005 metre.

(H17) Measurement of groundwater levels required in condition (H11) must be undertaken prior to any disturbance by sampling, and must be reported as the depth in metres from the established reference point to the water surface within the bore.

(H18) Any groundwater monitoring bore installed under this environmental authority must be fitted with a lockable cap which must be locked at all times other than at the time of sampling.

(H19) By the first annual return date the holder of this environmental authority must lodge a submission which outlines the proposed Detection Monitoring Program and any technical documentation necessary to assess its appropriateness, with the administering authority for its review and comment. The submission must address at least:

(i) the type and location of all environmental monitoring facilities; and
(ii) monitoring frequencies; and
(iii) sampling and monitoring procedures; and
(iv) clear and understandable explanation of the methodology to be used in the assessment of the monitoring results (including statistical tests to be used in the interpretation of data); and
(v) the proposed responses in the event of detection by the monitoring program of any release of contaminants not likely to be in accordance with the conditions of this environmental authority.

(H20) A copy of the Detection Monitoring Program must be kept at the office of the holder of this environmental authority.

(H21) Records must be kept of the results of all monitoring carried out under the Detection Monitoring Program for a period of at least 5 years.

End of Conditions for Schedule H

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SCHEDULE I - DEFINITIONS

(I1) "active waste disposal area" means an area currently being used for the disposal and burial of waste accepted under a condition of this environmental authority.

(I2) "attenuate" means the decrease in concentration of chemical species present in liquid, eg the decrease in concentration of pollutants in liquid migrating from the base of a landfill as a result of its movement through soil.

(I3) "aquifer" means a subsurface zone or formation of rock which contains exploitable resources of groundwater.

(I4) "compaction" means increasing the density of solid waste in landfills by the repeated passage of heavy machinery over its surface.

(I5) "cover" means material used to cover solid wastes deposited in landfills.

(I6) "Capping" means the covering of a landfill with impervious material to inhibit penetration by liquids.

(I7) "commercial place" means a place used as an office or for business or commercial purposes.

(I8) "freeboard" means the vertical distance between the water surface and any overflow point.

(I9) "licensed place" means Bowen Waste Disposal Site Collinsville Road Bowen; Collinsville Waste Disposal Site Walker Street Collinsville; Mt Coolon Waste Disposal Site Collinsville Mt Coolon Road.

(I10) "leachate" means contaminated water which has been generated in or percolated through or drain from municipal wastes.

(I11) "leachate recirculation" means the practice of returning leachate to the upper layers of a landfill, from which it has been abstracted, usually by direct spraying or pump well injection.

(I12) "lower explosive limit" means the lowest percentage by volume of a mixture of explosive gases in air that will propagate a flame at 25 ^{0}C and atmospheric pressure.

(I13) "permeability" means a measure of the rate at which a fluid will pass through a medium. The coefficient of permeability of a given fluid is an expression of the rate of flow through unit area and thickness under unit differential pressure at a given temperature. Synonymous with hydraulic conductivity when the fluid is water.

(I14) "putrescible waste" means waste food or waste animal matter (including dead animals) and any mixture of such wastes.

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Specific Noise Definitions

(I15) "noise sensitive place" means:

(a) a dwelling, mobile home or caravan park, residential marina or other residentia premises; or
(b) a motel, hotel or hostel; or
(c) a kindergarten, school, university or other educational institution; or
(d) a medical centre or hospital; or
(e) a protected area; or
(f) a park or gardens.

(I16) "L(Amax adj,T)" means the average maximum A-weighted sound pressure level, adjusted for noise character and measured over a time period of not less than 15 minutes, using Fast response.

(I17) "Background noise level" means:
L (A90,T) being the A-weighted sound pressure level exceeded for 90 percent of the time period not less than 15 minutes, using Fast response,

(I18) "MaxL (pA,T)" means the maximum A-weighted sound pressure level measured over time period of not less than 15 minutes, using Fast response.

End of Conditions for Schedule I

End of Environmental Authority

APPENDIX B

Important Information

IMPORTANT INFORMATION RELATING TO THIS REPORT

The document ("Report") to which this page is attached and which this page forms a part of, has been issued by Golder Associates Pty Ltd ("Golder") subject to the important limitations and other qualifications set out below.

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Having regard to the matters referred to in the previous paragraphs on this page in particular, carrying out the Services has allowed Golder to form no more than an opinion as to the actual conditions at any relevant location. That opinion is necessarily constrained by the extent of the information collected by Golder or otherwise made available to Golder. Further, the passage of time may affect the accuracy, applicability or usefulness of the opinions, assessments or other information in this Report. This Report is based upon the information and other circumstances that existed and were known to Golder when the Services were performed and this Report was prepared. Golder has not considered the effect of any possible future developments including physical changes to any relevant location or changes to any laws or regulations relevant to such location.

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Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification.

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Golder Associates

DRAFT IMPACT ASSESSMENT STUDY



Kelsey Creek Road Landfill Extension, Proserpine

Volume II • Figures and Technical Appendices

Document No. A3201273/0001
May 1999

Woodward-Clyde
A division of URS Corporation

Appendix K
Sampling Quality Plan - Kelsey Creek Road Landfill Environmental Monitoring Programme - 27 October 1998

SAMPLING QUALITY PLAN - KELSEY CREEK ROAD LANDFILL ENVIRONMENTAL MONITORING PROGRAM

Prepared for
WHITSUNDAY SHIRE COUNCIL

27 October 1998

Woodward-Clyde

AGC WOODWARD-CLYDE PTY LIMITED
ACN 000 691 690
49 Park Road, MILTON QLD 4064 Australia
Tel: (07) 3364 7444 • Fax: (07) 3364 7477
A3201273/0007/R001-A.DOC

27 October 1998
Project No. A3201273/0007

The Chief Executive Officer
Whitsunday Shire Council
PO Box 104
PROSERPINE QLD 4800

Attention: Mr Peter Day

Dear Peter,

Subject: **SAMPLING QUALITY PLAN - KELSEY CREEK ROAD LANDFILL ENVIRONMENTAL MONITORING PROGRAM**

AGC Woodward-Clyde Pty Limited is pleased to provide two (2) copies of our Sampling Quality Plan for the Kelsey Creek Road Landfill Environmental Monitoring Program.

Should you have any questions, please contact Mr Peter McGurgan or Ms Fiona Kennedy of the Brisbane office.

Yours faithfully,
AGC WOODWARD-CLYDE PTY LIMITED

PETER McGURGAN
Senior Environmental/Geotechnical Technician

FIONA KENNEDY
Senior Town Planner

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1.0
INTRODUCTION

1.1 BACKGROUND

A suite of groundwater monitoring wells has been established by Whitsunday Shire Council at the Kelsey Creek Road Landfill. This Quality Plan - Sampling provides guidance to obtain effective monitoring data from the existing bores.

This Quality Plan-Sampling presents specific quality assurance and quality control details to be employed as part of the ongoing landfill environmental monitoring and includes:

- project organisation and responsibilities;
- field procedures including:
  - documentation;
  - field equipment;
  - groundwater and surface water monitoring;
  - decontamination;
- laboratory analysis program including:
  - analytes and analytical procedures;
  - laboratories used;
  - sample handling, preservation and storage;
  - analytical QA/QC.
- data reduction, storage and retrieval; and
- health and safety.

Protocols are required to obtain representative samples and defensible results. Protocols detailed in various Australian and international guidance documents have been referred to in the development of the Quality Plan-Sampling. Key examples of these documents include:

- *A Preliminary Guide to the Standard Operating Procedures for Sampling Contaminated Groundwater*, Australian Water Resources Council, Water Resources Management Committee Occasional Paper WRMC No. 2, September 1991.
- *A compendium of Superfund Field Operations Methods*, US EPA Publication 540 P87 001.1987.
- *Field Sampling Procedures Manual*, New Jersey Department of Environmental Protection, February 1998.
- *Australian Standard Nos 2031.1 (1986) and 2031.2 (1987). Selection of Containers and Preservation of Water Samples for Chemical and Microbiological Analysis.*
- *Standard Methods for the Examination of Water and Wastewater, 19 ed*, American Public Health Association, American Water Works Association and the Water Pollution Control Federation, 1995.
- *Test Methods for the Evaluation of Hazardous Wastes*, US EPA Publication SW 846, updated to November 1991.
- *Water Quality Sampling Manual*, Queensland Department of Environment and Heritage, Second Edition AS203, February 1995.

In general, appropriate sample packaging and preservation methods from the options presented in the above publications are selected in consultation with the laboratory undertaking the analyses so as to suit analytical procedures.

1.2 SITE DESCRIPTION

The site is located within the Whitsunday Shire local government area, approximately 3.5 kilometres to the west of Proserpine town centre.

The site comprises the existing landfill on the eastern portion and the remainder is the proposed extension to the landfill. Previous use of this area was low intensity grazing. Lagoon Creek traverses the western portion of the site.

Kelsey Creek Road forms the northern boundary of the site. The southern boundary abuts cane land. The eastern boundary adjoins a tributary of Lagoon Creek while the western boundary is immediately adjacent a road reservation which is an unformed road.

The topography of the site area is gently undulating, with elevation of approximately RL 14.0 m.

2.0 PROJECT ORGANISATION AND RESPONSIBILITY

2.1 GENERAL

A Project Director or equivalent should be assigned that has the overall responsibility for the monitoring program. The Project Director will assist other staff, as necessary, in defining the scope of work and ensuring that appropriate and sufficient resources are made available for the successful completion of the project. The Director will also assist in monitoring the project budget and schedule.

The structure of the team administering and performing the monitoring program should be established to ensure that responsibilities for specific tasks are understood. The overall responsibility for the program should be assigned to a Project Director or equivalent. The Project Director should ensure that the scope of work is defined and appropriate and sufficient resources are made available. The Project Director should also delegate responsibilities to appropriate personnel to undertake the following tasks:

- Quality Assurance - which includes implementation of the Quality Plan, conducting quality assurance performance audits and reporting on audit findings.

- Health and Safety - interface with management on Health and Safety matters, develop a Health and Safety Plan for the program, monitor compliance with the Health and Safety Plan, ensure proper Health and Safety equipment is available and to approve suitably trained personnel to work on the site.

- Field Work - task leaders responsible for their area of professional expertise or technical task.

All staff members, whether with professional, technical, or administrative duties, have quality assurance responsibilities. Their responsibilities include:

- being familiar with the requirements of the quality assurance plan;
- being familiar with the project-specific quality assurance program or procedures manual applicable to their assignment;
- conducting specific project assignments according to the applicable requirements of the quality assurance program;
- participating in assigned QA training and orientation programs; and
- initiating a nonconformance and corrective procedures report.

3.1 DOCUMENTATION

3.1.1 General Field Activities Documentation

All field data and observations will be recorded on field data sheets or in field logbooks. All field logbooks and field data sheets will be prepared in blue or black permanent ink. Errant entries in field logbooks and on field data sheets will be marked with a single slash and initialled. All original copies of the field notebooks and field data sheets will be registered to a central filing location for the project.

Bound field logbooks with consecutively numbered pages will provide the means for recording most field activity records and observations. The aim of the documentation within the field logbooks is to allow future reconstruction of field activities without relying on the recollection of field team members. To supplement the information and data collected during sample collection and field testing, field data sheets may also be completed.

Items that will be recorded into the field logbook include:

- all aspects of sample collection;
- field measurements;
- health and safety documentation;
- equipment calibration documentation; and
- aspects of the field management.

Field documentation will include, at a minimum, the following information as is applicable to the specific task at hand:

- date, time, weather conditions;
- personnel present;
- sampling location;
- type of sample;
- sampling method;
- sample number and time of collection;
- sample depths, total depth of borings, as appropriate;
- visual descriptions of the sample;
- air quality readings;
- sample container type, shipping and analysis requirements;
- photograph number (where applicable); and
- other information and observations (such as the condition of the area surface contaminants, condition of the standpipe, lock, concrete, etc).

Other field information and data may be collected and recorded on specific field data sheets. These data sheets may include boring logs, bore construction data sheets and surface water sampling sheets.

3.1.2 Sample Location Designation

All locations where groundwater and surface water samples are collected will have a unique location designation. All sampling locations are shown on Figures 1 and 2 in Schedule I - Kelsey Creek Road Landfill - Monitoring Locations.

3.1.3 Sample Labelling

Each sample container will be clearly labelled and marked with ink in the field. All container labels will be taped over with clear tape to seal out (as much as possible) moisture from the sample label. Sample labels will include the following information:

- project /program name;
- sampling date;
- sample point number/designation (e.g. BH18, or SW1);
- sample depth (if appropriate); and
- comments, as required.

Groundwater samples collected from groundwater monitoring bores will be designated with both the project / program name monitoring bore location and the date of sampling [BH18 (15/9/95)].

3.1.4 Chain of Custody Protocols

Samples collected in the field will be traceable from the time of collection until they are received by the analytical laboratory. To maintain and document sample possession, chain-of-custody (COC) procedures shall be followed.

A COC record shall be utilised by field personnel to document possession of all samples collected for chemical analysis.

COC records shall include, but is not limited to, the following information:

- project / program name and number;
- time and date of collection;
- name(s) of sampler;
- sample type, identification number and location;
- number and type of containers;
- preservatives used;

- required analyses;
- receiving analytical laboratory;
- courier;
- names and signatures documenting; and
- change of sample custody.

The ice chest containing the samples will be sealed with tape and secured with a signed custody seal. The custody seal will provide an indication of whether the cooler was opened by unauthorised personnel. During sampling events partially filled and unfilled coolers will be kept within sight of the sample custodian or locked in a vehicle. The sample custodian will be a designated member of the sampling team.

COC records will accompany samples at all times once the samples are collected. When transferring possession of the samples, the individuals relinquishing and receiving the samples will sign, date, and note the time of transfer on the COC record.

The original COC record will accompany the samples to the analytical laboratory and should be returned to the person responsible for Quality Assurance within 24 hours of sample receipt. The original or a copy of the original COC record will be placed in the central project file. External laboratories will be contacted to return (by fax) appropriately signed COC records within 24 hours to confirm sample delivery.

Copies of acceptable COC forms are provided in Appendix A. There is a typed paper copy and a version of a typical COC form.

3.2 FIELD EQUIPMENT

3.2.1 Field Equipment Requirements

Field equipment required to effectively perform tasks includes, but is not limited to the following:

- 50mm or less acrylic bailers for purging;
- 50mm teflon or stainless steel bailers for sampling;
- Meter(s) for field pH, EC, DO, redox measurements;
- Demineralised water; and
- Tap water.

(If available, a dedicated sampling pump could be used).

3.2.2 Equipment Calibration and Maintenance

All field instrumentation, sampling equipment and accessories will be maintained in accordance with the manufacturers recommendations and specifications and established field practice.

The calibration and general maintenance of field instruments is the responsibility of the designated field personnel using established procedures, as specified by equipment manufacturers.

The calibration documentation for each instrument will include:

- date and time of calibration;
- reference standard used for calibration;
- name of person conducting the calibration; and
- results of calibration performed.

Field calibration will be performed following the manufacturer's directions and using standard calibration solutions. Calibration solutions will be certified standards and will carry certificates of analysis where appropriate.

Field instruments that fail calibration or become questionable or inoperable during use, will be removed from service, segregated to prevent inadvertent utilisation and repaired where possible.

Equipment that will be calibrated as part of field practice includes, but is not necessarily limited to:

- electrical conductivity meters;
- dissolved oxygen meters;
- redox potential meters;
- pH meters;
- thermometers / temperature sensors; and
- sediment sampler.

3.3 GROUNDWATER MONITORING

A systematic designation of groundwater monitoring bore locations has been used at Kelsey Creek to facilitate sample labelling, data evaluation and reporting.

Completed groundwater monitoring bores are to be labelled on the PVC inner casing cap or by means of an indelible tag attached to the outside of the surface cover structure.

Groundwater bores selected for monitoring in Schedule 1 - Kelsey Creek Road Landfill Monitoring Locations are listed in Table S1-1 and shown on Figure 2.

3.3.1 Monitoring Bore Purging

All monitoring bores will have been developed during installation. Development is the removal of water from the bore to increase yield and to remove fluids that may have been introduced during drilling operations.

Purging is the removal of water from the bore prior to sampling. Bores will be sampled within 24 hours of being purged. Prior to each sampling event and on the same day, nonaqueous phase liquids thickness (if present), static groundwater levels and total depth of all monitoring bores will be measured and recorded.

Purging will consist of bailing or pumping groundwater from the bore until:

1. there is no more than 10 percent difference in individual field chemical parameters (temperature, pH, dissolved oxygen and electrical conductivity) measured in water sampled from three consecutively removed bore volumes, and;

2. water being removed from the bore is of uniform turbidity, and;

3. three bore volumes have been removed or water levels in the bore do not recover within a reasonable time (i.e. bore is able to be pumped "dry").

One bore volume is defined as the volume of water contained within both the bore screen and the gravel/sand pack of the outer annulus. Indicative bore volumes for different screen, depth and diameter bore configurations are provided in Table 1.

TABLE 1
Bore Purging Guide

Hole Diameter (mm) including gravel pack	Volume to be purged (L)				
	1m[1,2]	2m[1,2]	5m[1,2]	10m[1,2]	20m[1,2]
100	8	16	39	79	157
150	18	35	88	177	353
200	31	63	157	314	628
250	49	98	245	491	982

(1) Volume is the equivalent of 3 bore volumes

(2) Depth of water in Well

Decontaminated teflon or stainless steel bailers, decontaminated pumps or dedicated equipment will be used to purge each bore. The time of initiating and stopping bailing and/or pumping activities will be recorded on a field data sheet or in a field logbook. Purged water could be discharged onto the ground without adversely affecting groundwater quality.

3.3.2 Groundwater Sampling

Groundwater samples will be collected in accordance with the following procedures:

1. Bores will be sampled using a teflon or stainless steel bailers or sampling pump. Bores with observable nonaqueous phase liquids (NAPLs) will be sampled in a manner which will attempt to minimise NAPLs from the sample containers as much as possible. The sampling procedure may involve allowing time for the phases to separate by suspending the sampling bailer for a period of time following removal from the bore. A sample would then be obtained from the bottom of the bailer. It should be noted that it may not be possible to obtain a representative groundwater sample (with respect to the dissolved phase) from a bore where a separate phase layer is present on the groundwater surface, due to the potential for contamination of the groundwater by contact with the separate layer as a result of sampling. A more representative sample of groundwater may have to be obtained by installation of an additional bore, constructed to place the slotted casing (screen) below the groundwater/separate phase liquid interface.

2. A representative groundwater sample will be collected in a clean container for measurement of field chemical parameters. The measurements will be recorded on a field data sheet.

3. Once sampling is commenced and where applicable, the first bailer of groundwater removed from the bore will be used to fill the volatile organic analysis (VOA) container (if required). Transfer the water from the bailer or sample pump discharge to the container in a manner that will limit the amount of agitation and minimise any loss of volatile organics from the sample. The VOA vials will be filled so that a meniscus is formed on the rim of the vial and carefully capped. Invert and inspect the capped container for air bubbles. Should any noticeable air bubbles appear, repeat the process until a bubble-free sample is obtained.

4. At least 500ml of groundwater would be set aside subsequently to allow settlement of suspended solids to occur. This should enable easier filtering of the sample for metals analysis (described in Step 6).

5. Subsequent bailers will be used to fill the remaining sample containers. To ensure the collection of samples representative of the entire volume removed during sampling, the sample container(s) will be filled by directing a small portion of groundwater from each bailer into each container alternatively until all the containers are full.

6. Filter the groundwater set aside, directly into the container designated for metals analysis, using a 0.45μm pore size filter.

7. All groundwater samples will be appropriately preserved, packed, stored and transported in an insulated container, with freezer blocks, after decontamination of the outside of the sample containers.

8. All information gathered during sampling will be recorded on a separate field data sheet and/or in the field logbook or data logger.

A summary of the groundwater sample containers, sample size, preservation requirements, holding time and storage methods appears in Appendix B.

All non-dedicated equipment used during bore purging and sampling will be decontaminated in accordance with the procedures detailed in Section 3.5.

Additional samples of groundwater are to be collected in order to enable a range of quality control analyses, required as part of this project, to be conducted by the analytical laboratory. Specific details of the types of samples to be collected and the QC analyses to be conducted for this project are described in Section 4. Information relating to the collection of QA/QC samples shall be recorded.

3.3.3 Field Measurements

Field measurements to be performed on all groundwater samples as part of the Kelsey Creek Road Landfill monitoring program include:

- electrical conductivity (EC);
- pH;
- redox potential;
- temperature;
- dissolved oxygen.

Field measurements are to be performed in accordance with manufacturer's instructions.

3.4 SURFACE WATER MONITORING

3.4.1 Surface Water Sample Locations

Six (6) surface water locations have been identified upstream and downstream of the site on Lagoon Creek and the tributary flowing adjacent to the site.

Surface water samples are to be collected at locations SW1, SW2, SW3, SW4, SW5, and SW6, as shown on Figure 1 in Schedule 1.

During the first sampling round a permanent marker should be erected on the creek bank adjacent to the surface water monitoring site. Samples should always be collected from the same location at each monitoring event.

At the surface sample locations, representative water samples are to be collected in the middle of the stream flow. As for creek waters, a one litre container is to be rinsed three times prior to final sample collection.

Surface water samples are then decanted into the appropriate sample container and stored as outlined in Appendix B.

Each container shall be labelled as outlined in Section 3.1.3 and the chain of custody procedures specified in Section 3.1.4 followed.

3.4.2 Surface Water Sample Collection

Samples will be collected using a sample bottle or high density polyethylene beaker, mounted on the end of a telescopic aluminium pole.

If there is any doubt regarding the homogeneity of the distribution of determinants at the site, another site should be chosen. Should this not be possible because of location requirements, samples should be collected from a number of points at the site. These samples may then be combined to form one single composite sample representative of the quality at the sampling location.

However, the combination of samples in this way cannot be undertaken when sampling for dissolved gases or other volatile constituents. In general, samples from streams should be collected from mid-stream, 10-20cm below the water surface. Be careful to avoid inclusion of surface scums and other floating material. Care should also be taken to not disturb bottom sediments or scums, which may contaminate subsequent aliquots from the site.

Approximately 500mL of water should be set aside to allow settlement of suspended solids to occur, prior to filtration for metals analysis.

Other sample containers, as required, will be filled completely and preserved as described in Appendix B.

The water initially set aside will be filtered, through a 0.45 micron membrane, directly into a metals analysis bottle. It will be preserved immediately by acidification as per Appendix B and mixed by inversion three times.

3.4.3 Field Parameters

These will be measured using dedicated meter(s), previously calibrated as per manual instructions. It is preferable to record the parameters *in-situ*, either within the bore, or using a flow cell supplied with the instrument, rather than collect a sample for measurement in a bucket or other container. However, conditions of accessibility may preclude this and measurements in a bucket or other container may be made if care is taken to minimise gain or loss of oxygen by agitation, and the readings are completed immediately after collection of the sample. Readings are to be recorded directly onto the relevant field data sheets.

3.4.4 Laboratory Receipt of Samples

All samples presented to a laboratory will be accompanied by a chain of custody form. Any additional analysis other than those agreed with the external laboratory should be specified separately.

All samples will be checked against the above forms to ensure that no samples are missing and that the correct containers have been used.

Chain of custody forms are to be completed by the person receiving the samples and returned to the person responsible for Quality Assurance.

All samples will be logged in to a secure laboratory data information system, immediately on receipt.

Each sample container will be marked in permanent ink, on its label or on the body of the container (**not the lid**), with a laboratory reference number which will allow traceability of all results generated.

All samples will be stored in accordance with the relevant requirements (see section 4.3.2).

3.5 DECONTAMINATION PROCEDURES

All equipment coming in contact with soil, sediment, surface water and groundwater will be decontaminated prior to commencement of field work, prior to each sampling event, between sampling locations and at completion of the field work. This will minimise the potential for sample cross-contamination and transport of the contamination off-site. It is recommended that all repeatedly used equipment is thoroughly decontaminated after each sampling event and stored in a proper manner. However, it should not be assumed that stored equipment is "clean" and initial decontamination prior to first use is necessary.

Equipment used during the field investigation comprises:

- small hand held equipment items such as:
  - tape measures
  - sample/purge pump(s)
  - stainless steel utensils
  - groundwater bailer(s)
  - groundwater level probe(s)
  - meters

Small equipment will be decontaminated (where appropriate) using the following procedures:

- scrub (where appropriate) with a brush using Decon 90 cleaning solution (or equivalent) and potable water;

- rinse with potable water; and
- final rinse with deionised or distilled water.

Decontaminated equipment will be stored on clean polyethylene sheeting, or equivalent, or wrapped in aluminium foil or plastic between use. Following decontamination, the equipment will not be allowed to touch the ground surface prior to use.

For equipment exposed to heavy hydrocarbon materials (if present), methanol may be used before and during the cleaning solution step followed by a potable water and deionise/distilled water rinse.

4.0
LABORATORY ANALYSIS TECHNOLOGIES

4.1 ANALYTES AND ANALYTICAL PROCEDURES

The physical and chemical parameters are detailed in Schedule 2. The list of parameters is likely to change over time as data is reviewed and the program is modified. As the Monitoring Program may be subject to modification, the latest version should always be referred to.

Laboratory methods are to be approved by the Project Director. Any changes to approved methods due to modifications of the parameter list or laboratory improvements are to be approved by the Project Director.

Detection limits are to be sufficiently low to meet the monitoring objectives and are to be approved by the Project Director.

4.2 LABORATORIES USED

The analytical laboratories to be utilised for the Kelsey Creek Road Landfill Monitoring Program will be at the discretion of the Project Director.

Laboratories will employ analytical procedures that are either registered with the National Association of Testing Authorities (NATA) or are approved by the Project Director.

4.3 SAMPLE HANDLING, PRESERVATION AND STORAGE

This section outlines the general procedures necessary for sample custody that are to be performed by the laboratory. It is understood that besides those sample custody and management procedures described, the laboratory will act in full accordance with the terms of its NATA Registration for Chemical Testing where applicable.

The selection of the appropriate sample containers, preservation procedures, sample storage requirements and holding times will be in strict accordance with those recommended by the US EPA in the document "Test Methods For Evaluating Solid Waste (SW-846), Revision A, July 1992". Samples and associated QA samples will be shipped to the laboratory within the specified holding times.

The laboratory will be notified to be prepared to receive a shipment of samples. Samples will be packed in styrofoam or bubble wrap to minimise breakage. Details of specific sample container requirements, preservation procedures, storage and holding times are presented in Appendix B.

4.3.1 Laboratory Receipt of Samples

Field samples will be delivered to the laboratory pre-contained and pre- preserved in accordance with laboratory procedures. Sample containers used for the collection of field samples are, wherever possible, to be supplied by the relevant analytical laboratory, pre-cleaned and inspected. Accompanying each delivery of samples will be a Chain of Custody (COC) Record.

The following items are checked and performed upon receipt of samples with the COC:

- the custody seals and tape on the cooler are unbroken and uncut;

- the signature on the external custody seal matches one of the sampler(s) signature(s) on the internal COC;
- an examination is made to determine if samples have been maintained at the appropriate temperature during shipment;
- the sample containers within the cooler are intact;
- the identification on the sample containers correspond to the entries on the COC;
- the number of sample containers received is equal to the number of samples listed on the COC;
- if sample custody is valid, the samples are logged in by the laboratory as per the standard operating procedure;
- the shaded area on the COC is completed by the laboratory; and
- a copy of the COC is delivered to the COC originator within 1 working day.

If COC discrepancies exist, appropriate notes (signed and dated) are made on the COC and the COC originator is notified by the laboratory. In the event that the laboratory Sample Custodian judges the sample custody (or part thereof) to be invalid (e.g. samples arrive damaged or custody seals are broken), the COC originator will be advised immediately and the samples will not be analysed until authority is obtained.

Any problem with a sample will be noted on the COC Record.

4.3.2 Preanalysis Storage

After the Sample Custodian has logged in the samples, they are placed in temporary refrigerated storage and maintained at a temperature of 4^0C or less until analyses are performed. Sample analyses are scheduled based on project needs and are consistent with analyte holding times.

Immediately prior to sample preparation, samples in which preservative has been added by the sampler will be checked to see if they have been properly preserved. If proper preservation is absent, this fact will be noted on the COC. The COC originator will be notified immediately and analysis will not continue until approval is received by the laboratory.

Analyses are to be performed within the holding times specified in Appendix B.

4.3.3 Postanalysis Storage and Holding Times

After analysis, sediment samples will be stored by the laboratory for a period not less than three months or as directed. The samples will remain refrigerated, if storage room permits. After a three month storage period, the final disposition of any remaining samples will be determined.

4.4 ANALYTICAL QUALITY ASSURANCE/QUALITY CONTROL

Specific mechanisms for checking the accuracy and precision of analytical data in order to ensure that data quality objectives are being met, involve the analysis of the laboratory and field QA check samples.

4.4.1 Laboratory QA samples

Laboratory quality assurance will be implemented by the following

Only NATA accredited laboratories will be used for analysis of samples related to this monitoring program. All NATA accredited laboratories are required to have procedures in place for ensuring the validity of their results, and the following requirements must be met.

Analytical Procedures : Only documented, validated procedures are to be used for determination of analytes

Replicates : at least one sample in every ten must be replicated non-contiguously, and the replicate results must lie within the ranges established for replicates for that analysis. Should this not be possible, the cause of the problem is to be investigated and corrected, and the batch of samples repeated.

Spiking : every sample batch must contain a spike of known concentration in order to ascertain recovery of analytes under varying matrix conditions. Recoveries must be within the nominated range for the analyte (usually 85 - 115%). Should this not be possible, the cause of the problem is to be investigated and corrected, and the batch of samples repeated.

Standard Reference Materials (SRMs) : Where SRMs are available for given analytes, every batch processed must contain a relevant SRM. The results of analysis of the SRM must lie within the acceptable range for the material, as stated on the analysis certificate.

Data Checking : Laboratories will have formal procedures in place for checking of calculations and data transcriptions.

Instrumentation : All instrumentation used will have documented calibration and maintenance records.

4.4.2 Field QA Samples

Field QA samples will be collected at the ratio of 1:20. QA samples will include the following:

- field blanks;
- trip blanks; and
- field duplicates.

Field Blanks - samples of analyte free media prepared by sampling personnel in the same manner as regular samples. Field blank water samples consist of purified water supplied or recommended for use by the respective laboratories used to rinse the sample collection device after decontamination. The rinsate is collected directly into the same types of containers used for regular samples.

The collection of field blanks enables the measurement of incidental or accidental contamination during the whole process (sampling, transport, sample preparation and analysis).

Trip Blanks - are used to monitor the cross-contamination of volatile organic compounds of sample containers during transport, handling and storage. Analyte-free media are taken from the laboratory to the sampling site in appropriate sealed containers and returned to the laboratory unopened for analysis.

Field Duplicates - Samples prepared in the field by splitting a field sample, then submitting to the laboratory as two independent samples. Field duplicates are used to measure the precision of the whole process (sampling, sample preparation and analysis). Significant variation in field duplicate results is often observed (particularly for solid matrix samples) due to sample heterogeneity.

4.4.3 Data Handling

All analytical data generated by the analytical laboratory will be appropriately reduced and undergo comprehensive validation prior to reporting. Records and numerical calculations will be legible and complete enough to permit reconstruction of the work by a qualified individual other than the originator.

The originating analyst will reduce and validate a given data package to ensure that:

- holding times have been met;
- appropriate standard operating procedures have been followed;
- field sample results are correct and complete;
- QA check sample results are correct and complete;
- QA check sample results are within established control limits and data quality objectives; and
- documentation is complete.

Each page of manual calculations and checks will be signed and dated by the originating analyst.

If the originating analyst finds that the validity of data is in doubt due to nonconformance with the above checklist, then the data is flagged and appropriate corrective procedures are initiated.

Once the originating analyst has reduced and validated the data package, it is then passed onto the appropriately qualified personnel for independent review.

The independent reviewer shall check at least 20 percent of all data for:

- appropriateness of equations used;
- correctness of numerical input;
- numerical correctness of all calculations; and
- correct interpretation of instrument recordings etc.

In the event that errors are found, a greater percentage of results checking will be required. These errors are to be flagged and to be brought to the attention of the originating analyst so that the cause of the errors can then be addressed.

The independent review is documented, and the signature of the reviewer and date of review recorded. If approved, the data is released and a draft report prepared. After the draft report is prepared, the reported results are checked against the reviewed, processed data so that transcription errors do not occur. A final review is then performed to determine if the report meets project requirements. These requirements are as follows:

- the format of the final report is in full accordance with NATA requirements for Chemical Testing, including the provision of a NATA stamp on the covering page if appropriate;

- a summary table of sample no., matrix, date sampled, date received, date prepared/extracted and date analysed is completed;

- all field sample results for each type of sample matrix, as listed on the COC, are reported collectively on separate tables noting sample ID, Laboratory ID and Laboratory sample Batch No;

- all QA check results, as specified in Section 4.4, are reported. Each type of sample matrix, as listed on the COC, is reported collectively on separate tables;

- all water matrix results are expressed as mg/L;

- all solid matrix results are expressed as mg/kg (dry weight);
- full reference to analytical procedures used is stated;
- modifications to procedures performed outside the requirements of this Quality Plan have been stated;
- nonconformances to any of the analytical Quality Plan requirements are clearly stated;
- a key to abbreviations is provided; and
- analyte nomenclature remains consistent throughout the entire program.

If complete, the final report is then signed by the appropriate NATA signatory and submitted.

In the event that a preliminary test report is issued, the degree to which the data has been validated by the laboratory must be clearly indicated and the final test report must contain an appropriate reference to the original one.

If, after the issuing of a report, data are found to be invalid, the original report must be withdrawn and replaced by one marked "Replacement for Report No...."

4.4.4 Analytical Data Validation

The primary objective of the data validation process is to ensure that the data reported can be used to achieve the project objectives.

The validity of all analytical data reported will be assessed by critical review of the QC check sample results. This will be performed in accordance with US EPA guidelines as presented in the document "National Functional Guidelines For Organic Data Review, Multimedia, Multiconcentration (OLMO 1.0) and Low Concentration Water (OLCO 1.0), June 1991", where appropriate.

Accuracy and precision measurements from the appropriate QC check samples will be compared with the analytical data quality objectives (DQOs) to assess the quality of the analytical data. If data is found to fall outside acceptable limits of precision and accuracy, appropriate corrective actions may be instigated.

Where a significant number of QA data (percentage recoveries and relative percent difference) is available, summary statistics will be reported and include the following:

- minimum;
- maximum;
- mean;
- standard error;
- median;
- mode;
- standard deviation;
- variance;
- kurtosis; and
- skewness.

In addition to the summary statistics of the QA data, t-Tests may be performed, and the data may be analysed using Thompson-Howarth plots.

4.4.5 Corrective Action

If data are found to fall outside the accepted limits of precision and accuracy established prior to the commencement of the field programme, then the following corrective actions may be instituted:

- reanalyse suspect samples, provided sample or extract holding times have not been exceeded;
- re-sampling and reanalysis;
- evaluate and amend sampling and/or analytical procedures;
- accept data with an acknowledged level of uncertainty;
- discard the data.

If data are still considered unacceptable after corrective action measures, the data will be reviewed to assess further corrective actions and/or potential use of the data.

5.0
HEALTH AND SAFETY

A Health and Safety Plan (HSP) is to be developed prior to commencement of fieldwork which should include but is not limited to the following:

- existing Whitsunday Shire Council Health and Safety requirements;
- chemical handling procedures;
- emergency procedures.

SCHEDULE 1

KELSEY CREEK ROAD LANDFILL

MONITORING LOCATIONS

Comprises:

Table S1-1 - Groundwater Sampling Locations

Table S1-2 - Surface Water Sampling Locations

Figure 1 - Surface Water Monitoring Locations

Figure 2 - Groundwater Monitoring Well Locations

SURFACE WATER AND GROUNDWATER SAMPLING LOCATIONS

The following Tables S1-1 and S1-2 list the selected locations for monitoring. The locations are shown on Figures 1 and 2.

TABLE S1-1
Groundwater Sampling Locations

GROUNDWATER				
Location	**Status**	**Monitoring Data Required**		
		Depth to Water	**Field Data and Selected Analysis[1]**	**Full Suite Analysis[2]**
MW1	OK	quarterly	quarterly	annually
MW2S	OK	quarterly	quarterly	annually
MW2D	OK	quarterly	quarterly	annually
MW3	OK	quarterly	quarterly	annually
MW4	OK	quarterly	quarterly	annually
MW5	OK	quarterly	quarterly	annually
MW6	OK	quarterly	quarterly	annually
MW7	OK	quarterly	quarterly	annually
MW8	OK	quarterly	quarterly	annually

(1) Selected analysis includes Ammonia-N, Nitrate-Nitrite, Total Phosphorous, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD). Field Data includes Redox potential, Electric conductivity, pH and temperature.

(2) Full suite includes all major and minor elements listed in Table S2-1.

TABLE S1-2

Surface Water Sampling Locations

SURFACE WATER			
Location	**Monitoring Data Required**		
	Field Data - Comments[1]	**Field Data and Selected Analysis[2]**	**Full Suite Analysis[3]**
SW1	eg. flow levels, turbidity, quarterly	quarterly	annually
SW2	eg. flow levels, turbidity, quarterly	quarterly	annually
SW3	eg. flow levels, turbidity quarterly	quarterly	annually
SW4	eg. flow levels, turbidity quarterly	quarterly	annually
SW5	eg. flow levels, turbidity quarterly	quarterly	annually
SW6	eg. flow levels, turbidity quarterly	quarterly	annually

Note. Analytical parameters are specified in Table S2-1.

(1) Field Data - Comments - include field observations to be recorded on the Field Data Sheet, e.g. turbidity, colour and odour

(2) Selected analysis includes Ammonia-N, Nitrate-Nitrite, Total Phosphorous, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD). Field Data includes Redox potential, Electric conductivity, pH and temperature.

(3) Full suite analysis includes all major and minor elements listed in Table S2-1.

SCHEDULE 2

ANALYTICAL PARAMETERS

Comprises:

Table S2-1 - Proposed Laboratory Monitoring Analytes

TABLE S2-1

Proposed Laboratory Monitoring Analytes

Analytes		Ground Water	Surface Water
Major Parameters			
	pH	√	√
	Electrical Conductivity (EC)	√	√
Major Cations			
	Sodium (Na^+)	√	√
	Calcium (Ca^{2+})	√	√
	Magnesium (Mg^{2+})	√	√
	Potassium (K^+)	√	√
Major Anions			
	Chloride (Cl^-)	√	√
	Sulphate (SO_4^{2-})	√	√
	Carbonate (CO_3^-)	√	√
	Bicarbonate (HCO_3^-)	√	√
Metals			
	Arsenic (As)	√	√
	Cadmium (Cd)	√	√
	Chromium (Cr)	√	√
	Copper (Cu)	√	√
	Lead (Pb)	√	√
	Mercury (Hg)	√	√
	Nickel (Ni)	√	√
	Zinc (Zn)	√	√
Nutrients			
	Ammonia-N (NH_4^+)	√	√
	Nitrate-Nitrite	√	√
	Total Phosphorous	√	√
Organics			
	Total Petroleum Hydrocarbons, by fraction (T.P.H.)	√	√
	Aromatic Hydrocarbons - benzene, toluene, ethyl benzene, xylene (BTEX)	√	√
Other			
	Chemical Oxygen Demand (COD)	√	√
	Biochemical Oxygen Demand (BOD)	√	√

ATTACHMENT A

- CHAIN OF CUSTODY FORM
- FIELD DATA SHEET

FROM:	TO: Australian Laboratory Services Pty Ltd 32 Shand Street Stafford, QLD, 4053 Attention: Paul Vogel

CHAIN OF CUSTODY RECORD

PROJECT :	ANALYSES (* denotes analysis required)	NUMBER OF CONTAINERS	REMARKS
SAMPLER/S: (Signature/s)			(Sample preservation, handling, procedures)

DATE	TIME	SAMPLE NUMBER								Please perform the following:

TABLE A1
Groundwater and Surface Water Sampling - Field Data Sheet

Borehole _____
Date _____
Starting Time _____
Sampled By _____
Standing Water Level _____
Total Depth of Bore _____

BAILING
No. of Bails _____
Est. Volume Removed (L) _____

PURGING
Pump Type _____
Discharge Rate _____
Est. Volume Removed (L) _____

(minutes)	Cumulative Vol. Removed (L)	EC (µS/cm)	pH	Temp. (C^{O})	Redox (mV)	DO (mg/L)	Comments Turbidity, Colour, Odour

SAMPLING SCHEDULE:

Location	Sample No.	Analysis Required	Container + Preservatives	Comments

EQUIPMENT:

Instrument	Name	Calibrant	Calibrated (Date/Time)
EC			
pH			
Redox			
DO			

SIGNATURE: _____

ATTACHMENT B

SAMPLE PRESERVATION, STORAGE AND CONTAINERS

Sample Preservation, Storage and Analysis

The following list is more comprehensive than required for the proposed analyses but is provided as information for future modifications if and when required.

Analyte	Preservation	Container	Holding Time (preserved)	Method Reference (APHA)[1]	LOR
pH	read on-site	N/A	N/A	N/A	0.01
Redox Potential	read on-site	N/A	N/A	N/A	0.1
Electrical Cond.	read on-site	N/A	N/A	N/A	
Salinity	read on-site	N/A	N/A	N/A	4 g/kg
Temperature	read on-site	N/A	N/A	N/A	
Dissolved Oxygen	read on-site	N/A	N/A	N/A	0.1
Suspended Solids (surface waters only)	4° C	P	24hr	2540D	1
Biochemical Oxygen Demand	4° C	P	24hr	5210B	2
Chemical Oxygen Demand	Sulphuric Acid, 4°C	G	7 days	5220B	1
Calcium	filter on site : acidify to pH 1-2 with nitric	P	7 days	ICPAES[2]	1
Magnesium	filter on site : acidify to pH 1-2 with nitric	P	7 days	ICPAES	1
Sodium	filter on site : acidify to pH 1-2 with nitric	P	7 days	ICPAES	1
Potassium	filter on site : acidify to pH 1-2 with nitric	P	7 days	ICPAES	1

Analyte	Preservation	Container	Holding Time (preserved)	Method Reference (APHA)[1]	LOR
Chloride	4° C	P	6 months	4500B-Cl	1
Sulphate	4° C	P	7 days	3500	1
Carbonate Alkalinity	4° C	P	24 hr	2320B	1
Bicarbonate Alkalinity	4° C	P	24 hr	2320B	1
Antimony	filter on site: acidify to pH 1-2 with nitric	P	28 Days	ICPMS[3]	0.001
Arsenic	filter on site : acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.001
Barium	filter on site: acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.001
Beryllium	filter on site: acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.001
Boron	none required	P	28 Days	ICPAES	0.2
Cadmium	filter on site : acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.0005
Chromium (tot)	filter on site : acidify to pH 1-2 with nitric	P	28 days	ICPMS	0.001
Chromium (6+)	4° C	P	24hr	ICPMS	0.001
Cobalt	filter on site : acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.001
Copper	4° C	P	28 Days	ICPMS	0.001
Fluoride	4° C	P	28 Days	4500C-F	0.1
Lead	filter on site : acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.001

Analyte	Preservation	Container	Holding Time (preserved)	Method Reference (APHA)[1]	LOR
Molybdenum	filter on site : acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.001
Mercury	acidify to pH 1-2 with nitric: add pot dichromate to yellow	G	3 days	3500B - Hg	0.0001
Nickel	filter on site : acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.001
Selenium	filter on site : acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.01
Strontium	filter on site : acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.001
Thallium	filter on site : acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.001
Thorium	filter on site : acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.001
Tin	filter on site : acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.001
Uranium	filter on site : acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.0001
Vanadium	filter on site : acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.01
Zinc	filter on site : acidify to pH 1-2 with nitric	P	28 Days	ICPMS	0.001
Cyanide	NaOH to pH>12: +cadmium nitrate if sulphide present	P	24 hrs	4500	0.01

Analyte	Preservation	Container	Holding Time (preserved)	Method Reference (APHA)[1]	LOR
Nitrate+Nitrite	4° C	P	7 days	4500	0.01
NH_3-N	4° C	P	7 days	4500	0.01
TKN- N	4° C	P	7 days	4500	0.01
Total Phosphorus	4° C	P	7 days	4500B	0.01
Ortho Phosphorus	4° C	P	7 days	4500B	0.01
Total Petroleum Hydrocarbons (TPH)	4° C	G	7 days	GC FID[4]	20-100
Total Organic Carbon	H_2SO_4 to pH 1-2; 4° C	G	2 days	5310B	1
Volatile Organics	4° C	G (vial)	7 days	GCMS[5]	0.001-0.002
Semi-volatile Organics	4° C	G	7 days	GC MS	will vary

P = Plastic (polyethylene)
G = Glass
(1) = American Public Health Association
(2) = Inductively Coupled Plasma Atomic Emission Spectrometry
(3) = Inductively Coupled Plasma Mass Spectrometry
(4) = Gas Chromatography / Flame Ionisation Detector
(5) = Gas Chromatography / Mass Spectrometry
LOR = Level of Reporting. The LOR for all chemical analyses are reported in milligrams per litre.

ATTACHMENT C

DATA MANAGEMENT

DATA MANAGEMENT AND REPORTING

For this monitoring program, an environmental data management plan (EDMP) should be developed which identifies project-specific data management procedures including naming conventions, verification and reporting requirements.

Woodward-Clyde has developed a database system called Site Manager Pro (SMPro) that could be used. This database maintains data security and will allow for quick and efficient data queries and sorting to assist in data assessment, presentation and reporting.

ATTACHMENT D

TECHNICAL NOTES ON THE MEASUREMENT OF FIELD PARAMETERS

REPORT

TECHNICAL NOTES ON THE MEASUREMENT OF FIELD PARAMETERS

Prepared for
WHITSUNDAY SHIRE COUNCIL

20 October 1998

Woodward-Clyde

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The following notes provide some background information on the field parameters:

- pH
- Electrical Conductivity (EC)
- Redox Potential (Er or Eh)
- Dissolved Oxygen (DO)
- Temperature

These measurements, when taken correctly, provide information on gross water quality. For many site investigations, such as around landfill sites, sewage treatment works etc., the field parameter measurements can be critical indicators of water contamination and at least as important as laboratory analyses.

An understanding of the chemical principles behind these measurements often allows some assessment to be made of the nature and contamination status of waters at the time of sampling and detection of potential errors. This quick assessment may allow, for example, on-the-spot alterations to sampling programs such as:

- extra care in decontamination after sampling of bores with suspect contamination;
- selection of locations for collection of duplicate samples;
- storage of suspect contaminated samples in separate eskies; or
- altering the intensity of sampling at different locations within a site.

Some knowledge of "normal" values for these measurements is also important in deciding whether field equipment is working correctly.

These notes are not meant as a comprehensive guide to the use of the field parameters in the assessment of water quality. More detailed references on water chemistry should be sought and referred to. A good example of a good reference book which is readily available is:

- Hem, J.D., 1989. *Study and Interpretation of the Chemical Characteristics of Natural Water*, Third Edition, U.S. Geological Survey Water Supply Paper 2254, United States Government Printing Office, Washington D.C.

General points to note in regard to all the field parameter measurements are as follows:

- If the necessary instruments are unavailable or not functional, then careful consideration should be given as to whether or not to continue with the water sampling program. Reference should be made to the project data quality objectives before proceeding.
- In most cases minimum, field measurements would be pH and EC. However, in many cases DO and redox potential can be key indicators of contamination status and may be essential to the project objectives.
- **Never** record measurements taken with equipment that is not correctly calibrated, whether this is due to instrument malfunction or a lack of calibrant solutions. It is better to report no data than misleading data.
- Measure field parameters immediately or as soon as possible after sample collection, except dissolved oxygen which should be measured *in situ*.

3.1 REASONS FOR MEASUREMENT

pH should be measured in the field due to the potential for relatively large changes after collection of samples and prior to laboratory analysis. Common causes of pH changes are photosynthesis and respiration by aquatic organisms, oxidation of dissolved Fe^{2-} and, degassing of dissolved gases in partiocular CO_2. Changes in pH of >1 unit within days to weeks after sample collection are not uncommon, with more rapid changes possible in groundwaters affected by degassing.

Ideally laboratory measurements of pH should be undertaken as a matter of course and these results compared with the field measurements. Significant differences (>0.5 pH units) are important in assessing the hydrochemical nature of the water or determining in hindsight whether accurate field measurements were made.

3.2 MEASUREMENT

Calibration and use of field pH meters is fairly straight-forward and adequately described in the equipment manuals. Checking and/or calibration of pH meters should be undertaken daily and after any measurements producing results suspected of being erroneous. Remeber no data is better than wrong data.

The field pH measurements made using a pH meter should be accurate to 0.1 pH units and should accordingly be reported to only 1 decimal place.

Whilst pH measurement using paper strips is less accurate, papers can be obtained that provide accuracy to within 0.5 units. Papers provide an appropriate alternative in the event of instrument malfunction

3.3 ANALYSIS AND INTERPRETATION OF RESULTS

In general, natural waters have pH values in the range 5.5 to 8.5, although values outside this range do occur.

pH values outside of this range may be indicative of:

- contamination;
- instrument malfunction; or
- normal conditions.

pH values greater than 9 in groundwaters are rare as natural occurerences, however, not unknown. Excessive pH values in groundwater (pH >10) can be indicative of a problem with bore construction with the water being affected by cement. Under these circumstances, the waters may remain effected indefinitely. Analysis of major cations and anions can be used to assist in identifying whether the alkalnity is due to the presence of cement.

In comparison of field and laboratory pH values, some thought should be given to reasons for large (>0.5 unit) differences in pH values. In general, the pH of water samples from unconfined groundwater aquifers will tend to decrease after the water is sampled and bought into contact with atmospheric oxygen. This is more likely for reducing waters where falls in pH may occur as a result of the oxidation of dissolved iron or manganese. For groundwater from confined aquifers, pH may rise as a result of degassing of CO_2.

For surface water, pH may alter due to photosynthesis (pH↑) or respiration (pH↓) by aquatic organisms. These changes can occur diurnally, and changes after sample collection can be very rapid, i.e. changes of 1 to 2 pH units within hours after transfer of samples from light to dark or vice versa. In shallow nutrient rich surface water (e.g leachate pond), the effects of photsynthesis can result in pH values greater than 9 and respiration result in pH less than 4. As photosynthesis occurs during the day and respiration at night, the pH values can fluctuate over this range during a 24 hour period.

pH values less than 4 particularly in surface waters, is a key indicator of the presence of acid either from acid sulphate soils or associated with acid mine drainage or industrial source of .

However, as always, the interpretation of water quality data requires a good understanding of background conditions.

4.1 REASONS FOR MEASUREMENT

An electrical conductivity (EC) measurement is an indicator of the total concentration of charged ionic species in solution and as such provides an appropriate measure of salinity. Salinities of samples of natural waters are unlikely to change substantially after sampling, and the field measurement of EC is generally taken to provide immediate information on the hydrochemical nature of the water and stability during purging of groundwater bores.

Despite measurement of EC in the field, laboratory measurements of EC and total dissolved solids (TDS, by gravimetric analysis) should, ideally, be undertaken as a matter of course and these results compared with the field measurements.

4.2 MEASUREMENT

Calibration and use of field EC meters is fairly straight-forward and adequately described in the operators manuals. Checking and/or calibration of EC meters should be undertaken daily and after any measurements producing results suspected of being erroneous.

The standard units for recording of EC measurements is micro-Siemens per centimetre (µS/cm) although other units used are µS/m, mS/cm and mS/m. The unit "mhos" is sometimes seen in place of Siemens and the two units are directly interchangeable. **The units of measurement of EC must always be specified.**

The field EC measurements made using an EC meter are accurate to +/-2 to 5%. Results should accordingly be reported to only 2 significant figures. Taste is also a good indicator of salinity, however, this techniques should not be used.

4.3 ANALYSIS AND INTERPRETATION OF RESULTS

The easiest way to interpret EC measurements is to make an approximate conversion to salinity (as total dissolved solids). Conversion factors for conductivity to salinity vary according to the ionic composition of the water and the total ionic concentration. In general, for a sodium chloride type water of salinity (as TDS) less than about 10 000 mg/L, an approximation of TDS is made by multiplication of EC in µS/cm by 0.6. Actual conversion factors for natural waters generally range between 0.55 and 0.75, and laboratory determination of TDS is necessary for accurate measurement of salinity, if this is required.

The following approximate salinity criteria may be useful when assessing salinity values. The ANZECC (1992) water quality guidelines provide a more definitive definition of salinity in realtion to a wide range of beneficial end uses eg. irrigation, industrial use etc.

Criterion	Salinity (as mg/L TDS)
Rainwater	20 to 30
Potable Water	<1 500
"Taste the salt"	1 500 to 2 500
"Water the garden with it"	<2 000
"Sheep can drink it"	<4 000 - 6 000
Sea water	approx 35 000

5.1 REASONS FOR MEASUREMENT

The redox potential of a water sample is an indicator of the chemical equilibrium of oxidation and reduction processes within the water body. Wheras pH provides a measure of the activity (concentration) of hydrogen ions (protons), redox potential provides a measure of the activity of electrons. By measurement of the redox potential the "position" of this equilibrium can be assessed and used (along with other parameter measurements) as a basis for:

- comparison of the hydrochemical nature of waters from different sampling locations;
- supposition on the chemical influences acting on the water body, including it's contamination status with particular compounds; and
- supposition on the chemical reactions in a water when the environment of that water is changed, for example the precipitation of iron oxides and nitrification of ammonia nitrogen when groundwater is bought into contact with the atmosphere.

The redox potential is measured in the field due to the possibility of variability in the parameter once the water sample is exposed to atmospheric oxygen. Exposure to air enables oxidation of the chemical constituents of the water which control the redox equilibrium, most notably dissolved iron, manganese and sulphatic compounds/ions.

5.2 MEASUREMENT

The field measurements of redox potential are made using a redox probe with a platinum electrode and silver/silver chloride reference electrode. These give a reversible cell potential commonly expressed as an **Er** value in mV. **Remember to change probes on the pH/mV meter before taking redox potential measurements pH probes cannot be used to make redox measurements.**

For redox potential measurements, the pH/mV meter is checked rather than calibrated before use. This check should be performed after calibration for pH. Two possible checks are as follows:

- Immerse the redox probe in a qinhydrone solution (generous pinch to 50 to 100 mL). The meter should read between 200 and 250 mV.
- Immerse the redox electrode sequentially in pH 4 and pH 7 buffer solutions. The difference between the readings should be 175 +/- 10 mV.
- If this check fails then the meter should be serviced before further use. **Remember no data is better than wrong data.**

5.3 ANALYSIS AND INTERPRETATION OF RESULTS

For interpretation of the Er results they need to be converted to an **Eh** value (again in mV) which relates to the value than would be obtained with an hydrogen reference electrode. Literature relating to redox properties of waters generally talks in terms of Eh values, and Eh is the standard way of expressing results, similar to "benzene equivalents" for microtip readings, "calcium carbonate equivalents" for alkalinity etc.

The approximate conversion is: Eh (mV) = Er (mV) + 230

Alternatively redox conditions may also be expressed as a pE value (the antilog electron activity) similar to pH.

Wherever results of redox potential measurements are presented, the basis of measurement should be specified, i.e. the type of electrodes in the measurement device and details of any conversion of Er to Eh.

When results of redox potential measurements have been converted to Eh, some sort of semi-quantitative analysis of the results can be made. This also needs to take into account the pH of the water which influences the redox reactions that might take place in the water. Ideally, concentrations of redox-related ions (Fe(II), S) are also considered although this is becoming a bit academic. When analysing water-quality data, pH-Eh diagrams should be used to analyse the Eh data and discern differences in redox potential between samples of varying pH and Eh measurements. These diagrams can be found in Hem (1989). For a rough interpretation of results as should be undertaken in the field, the following notes should be adequate.

For a near-neutral water (pH 6.5 to 7.5) an **Eh** of 400 mV or greater is indicative of a well aerated water, such as a free-flowing surface water. For these waters, a high DO level (6 to 8 mg/L) would be expected, i.e. near saturation (8 - 9 mg/L) with respect to oxygen. For such a water, however, the **Er** meter would probably give a highly erratic reading and you would wonder if it is working properly. These waters would be described as *oxidising*.

For the same near-neutral water, an **Eh** of between 0 and 400 mV indicates the water is sufficiently reducing to be in the "ferrous/ferric window" where concentrations of dissolved ferrous iron in the milligram per litre range can be expected. It is at these Eh values that you start to ask the question "Is my water naturally reducing or have I got contamination from readily oxidisable materials such as low molecular weight organics or ammonia from a landfill?" DO levels of 2 to 3 mg/L may still be measured for these waters. These waters would be described as *mildly to moderately reducing*.

As the waters become still further reducing, i.e. **Eh** less than 0 mV, the water may enter the sulphate/sulphide window, and, if still more reducing, the methane window. These waters are relatively uncommon for natural systems and are characterised by sulphide odours. DO levels for these waters would be expected to be very low. These waters would be described as *strongly to very strongly reducing*.

At lower pHs, the "signal" Eh levels move up the scale. So, at a pH of 5 the ferrous/ferric window is at about Eh = 200 to 600 mV. A well aerated water would give an Eh of 700 mV or greater, and in this case (i.e. lower pH) the meter reading would probably be quite stable.

At higher pHs, the "signal" Eh levels more down the scale. So, at a pH of 8 to 9, the ferrous/ferric window is at about Eh = -200 to 100 mV.

For field measurements, the following should be noted:

- DO and redox potential measurements serve as a bit of a check on each other (and vice versa) when it comes to interpreting field results. A further check is colorimetric ferrous test strips which can be very useful in their own right.
- Redox potential measurements are pretty much useless without a reliable pH measurement.

6.1 REASONS FOR MEASUREMENT

The dissolved oxygen (DO) concentration in a water provides an indication of the presence within the water of readily oxidisable materials which can result in the depletion of dissolved oxygen. Reliable DO measurements can constitute an important indicator of contamination with such materials in situations such as landfills or eutrophic surface waters.

DO is measured in the field due to the potential for large and reasonably rapid changes in DO concentrations when, for example, groundwater is bought into contact with air, or a surface water is enclosed within a sampling bottle.

6.2 MEASUREMENT

If the Do meter is properly maintained and calibrated, then the measurements should be accurate to +/- 0.5 mg/L or 5%.

The recommended calibration method for DO meters involves the use of a sodium sulphite (**not** sulphate) solution. The general procedure is as follows. Instructions for the specific meters should be refereed to for detail.

- Turn the DO meter on for 15 minutes.
- Dissolve approximately 1 g (half a teaspoon) of sodium sulphite in 100 mL od water. Add a dash of cobalt chloride. The sulphite exhausts the oxygen in the water with the cobalt acting as a catalyst. Allow a couple of minutes for the reaction to reach completion.
- Use this solution to calibrate the meter to a zero DO concentration.
- Calibrate the meter in moist air as described in the relevant instruction booklet.
- If the probe cannot be successfully calibrated (i.e. insufficient instrument adjustment) the probe membrane should be changed.

DO measurements should be taken of the water *in situ* due to potential for almost immediate changes in DO concentrations when water is brought into contact with the atmosphere.

When measuring DO concentrations, the probe should be kept gently moving.

6.3 ANALYSIS AND INTERPRETATION OF RESULTS

Water in contact with air will develop an equilibrium DO concentration that is directly proportional to the air pressure on the water surface and inversely proportional to the water temperature. The DO concentration is also slightly inversely proportional to the total concentration of solutes in the water. Approximate equilibrium DO concentrations for fresh to moderately saline waters (<10 000 mg/L TDS) are listed below. These equilibrium correspond to the 100% concentrations.

Water Temperature (°C)	Equilibrium DO (mg/L)
0	14
5	12
10	11
15	10
20	9
25	8
30	7.5

Uncontaminated water in contact with air, such as rainwater or a "babbling brook" will generally have a DO concentration near the equilibrium value. For water entering a groundwater aquifer, the DO concentration will decrease at a rate dependant on the concentration of readily oxidisable material in the water or aquifer. This may be extremely rapid (days to weeks) or extremely slow (millennia) even under natural conditions. Groundwater DO concentrations are generally less than 5 mg/L, with 5 mg/L considered as well oxygenated, and <1 mg/L as poorly oxygenated. It should be noted that the absolute DO concentration is not in itself a reliable indicator of contamination, but comparative values between bores within a local sampling area may be.

For a surface water, DO values of substantially greater than 100% may occur in waters with a high level of photosynthetic activity.

7.1 REASONS FOR MEASUREMENT

In the "old" days, the temperature of water samples was routinely measured to allow correction of other field measurements (pH, redox potential and DO) to be corrected for temperature. In these modern times of field meters with automatic temperature correction, this requirement no longer exists. As a result, measurement of temperature is now more by convention than need. For deep groundwater bodies, temperature may still be an important gross water-quality parameter. Some of the field meters (such as the Hanna pH/Er meters) have a manual adjustment for solution temperature which can be used if the accuracy of temperature measurement by the instrument is doubted.

For surface waters, temperature may be an important parameter for description of variability in water quality within a single water body. This includes temperature stratification and inflows of higher or lower temperature water from sources such as wastewater outlets. Recording of the temperature of samples can be important in analysis of other analytical results, e.g. explaining differences in dissolved oxygen concentrations between warmer and cooler zones of a water body.

7.2 MEASUREMENT

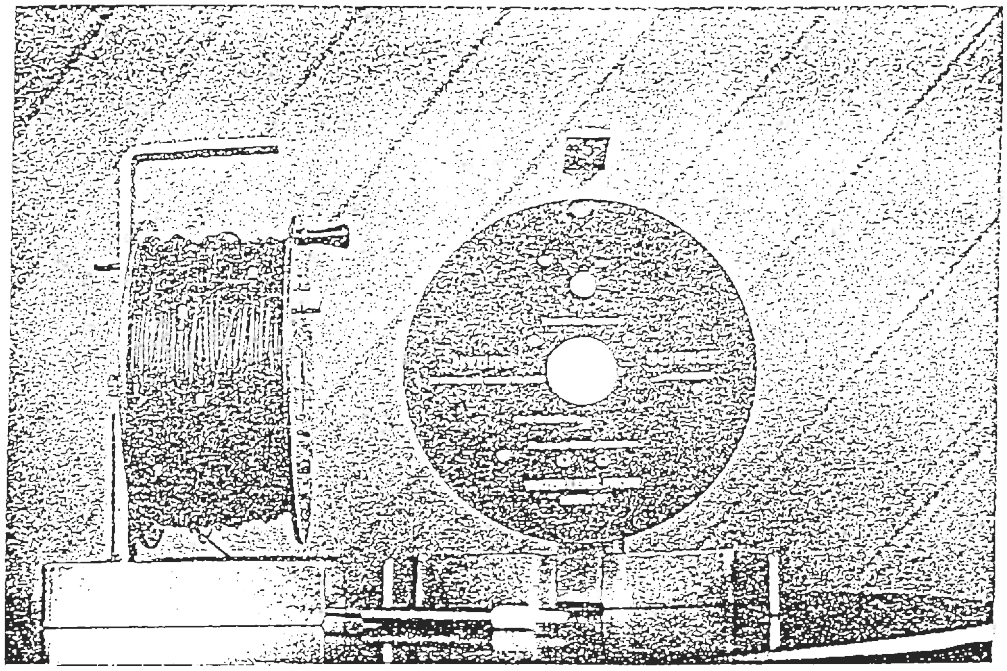
The pH and EC meters currently used by the office include temperature probes which can provide a temperature measurement accurate to +/- 1 to 2°C. Where more accurate measurement of temperature is required the "old-fashioned" mercury or alcohol thermometers should be resorted to.

ATTACHMENT E

PRODUCT INFORMATION FOR SAMPLING EQUIPMENT

WATER LEVEL PROBE

HYDROSCIENCE MARK IV



The Mark IV water level probe is the result of many years of field experience with other unsatisfactory forms of water level measuring in water wells. The Mark IV can be used in the widest range of salinities from fresh water to saturated brines and, because of its unique solution conductivity adjustment, will give accurate signals at all times. We are the first users of this product and we know very well the range of environments in which this instrument is called upon.

When measurements are taken inside a poly pipe conduit, as during a pumping test, it is necessary to have a small diameter cable and a small diameter sensor to reduce the friction within the conduit. Mark IV has a 3.2mm diameter round rather than flat cable and a 12mm diameter sensor. The friction of, say, sixty or seventy metres of cable in the conduit is often so great that ordinary cables can stretch considerably or break. Mark IV has a custom made coaxial cable with a certified breaking strength of 70kg, more than enough to rightly claim to be the strongest around. Other cables have centimetre and metre markings, but we have sacrificed that detailed marking in favour of a considerably stronger cable. Mark IV cables are marked in one metre intervals by permanently bonded, easily read numbers.

A visible and audio signal is produced when the sensor touches the water. A battery charge indicator warns that the battery is getting low. Emergency connectors allow the use of the cable should any component of the transistorized circuit fail.

All internal components are moisture and dust proofed, making the Mark IV a strong, tough, reliable instrument and, last but not least, the most economic on the market.

The standard unit has 100m of cable, but 200m and 300m or more are available on request. In addition, a specially modified briefcase model with 50m of cable is also available.

The purpose of groundwater sampling is to retrieve a water sample that exactly represents the in-situ chemical characteristics of water below the ground surface. Sampling techniques range from simple to highly sophisticated to match the extent of analysis performed in the laboratory.

Sampling, then, is the critical step linking field conditions to laboratory results. Choosing the correct equipment is essential in developing an accurate and cost effective sampling program.

STAINLESS STEEL BAILERS

One-piece body design leaves no debris traps thus minimising chances for sample error. Ports at the top of the bailer allows easy "flow-through" for a nearly exact sample of the water at any given point in the well. A removable closed top contains the sample and prevents mixing of waters from different strata as it is withdrawn from the well. The top is tapered to reduce hang-ups on well casing joints and incorporates a bailer cord attachment.

A specially sized sample port allows the sample to be easily and accurately poured into a container with minimal spill. Features a time saving "Quick Purge". Use the included purge rod to unseat the check ball and quickly empty the bailer's contents.

Each Stainless Steel Bailer comes supplied with a nylon bristle cleaning brush and purge rod as standard.

PRODUCT	DESCRIPTION	PRICE
TB-242	STAINLESS STEEL BAILER, 60.96MM	$239.95
TB-243	STAINLESS STEEL BAILER, 91.44MM	$299.95
TB-245	NYLON BRISTLE CLEANING BRUSH	$18.95
TB-246	PURGE ROD	$12.95
TB-248	TEFLON CHECK BALL	$29.95



TB-242

TRANSPARENT PVC BAILERS

Brainard*Kilman™ Transparent PVC Bailers are ideal for detecting hydrocarbon contamination in monitoring wells. They are constructed of lightweight, transparent PVC which is less costly and more durable than Lexane or acrylic. The clear PVC allows for sample inspection to determine the presence of product. Each Bailer has a removable check ball assembly for easy cleaning and an attached ring for secured lowering and raising of the bailer. Brainard*Kilman™ Transparent PVC Bailers are top and bottom loading, available in various lengths to fit 50mm well or larger.

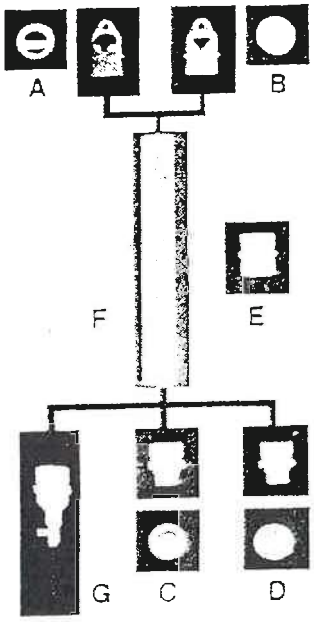


STANDARD PVC BAILERS

Brainard*Kilman™ Standard PVC Bailers offer a simple, economical method for evacuating well volumes or sample collection. Each has an attached lowering ring for security and a computer machined check ball assembly to prevent leakage. Removable bottoms for easy cleaning. Brainard*Kilman Standard Bailers are top and bottom loading available in 33.4mm, 42.1mm., 60.3mm. and 88.9mm. O.D. and allow bailing of 50mm. and larger wells.

PRODUCT	DESCRIPTION	PRICE
TB-218	STANDARD - 33.4MM X 914.4 MM VOL:460CC	$69.00
TB-217	STANDARD - 42.1MM X 762MM VOL:600CC	$65.00
TB-219	STANDARD - 42.1MM X 1524MM VOL:1085CC	$79.00
TB-220	STANDARD - 60.3MM X 1524MM VOL:3087CC	$109.00
TB-233	STANDARD - 88.9MM X 914.4MM VOL:4170CC	$149.00
TB-235	STANDARD - 88.9MM X 1524MM VOL:6950CC	$199.00
TB-212	TRANSPARENT - 42.1MM X 609.6MM VOL:480CC	$99.00
TB-213	TRANSPARENT - 42.1MM X 914.4MM VOL:725CC	$159.00
TB-215	TRANSPARENT - 42.1MM X 1524MM VOL:1200CC	$199.00

NORWELL TEFLON BAILERS



The Norwell Bailer is used where Teflon is the material of choice for maintaining sample integrity. The exceptionally versatile design allows customized bailer assembly, from individually selected components, to meet specific sampling applications. The Teflon Bailers are ideal in either dedicated or portable applications.

All Norwell components are made from chemically inert, 100% virgin Teflon and contain no filters or plasticizers. All surfaces resist corrosion and are non-leaching to minimize sample bias. Norwell precision machined, interchangeable parts allow quick reassembly after cleaning. Each top and bottom has a machined chafe guard for bailer tube protection from wear and abrasion. A top, a tube, and a bottom must be selected separately to customize each bailer.

(A) Standard Top has "V" notch opening for accurate pouring, round thread for easy cleaning and chafe guard for wear and abrasion protection.

(B) Point Sampling Top is similar to the Standard Top but has an added check valve that closes during sample retrieval to isolate samples taken at specific depths.

(C) Extension Coupling joins bailer components. Has round thread design and chafe guard.

(D) Bailer Bodies are transparent for easy viewing of contents and come in three lengths. Bailer capacity can be increased by adding extension sections and couplings.

(E) Controlled Flow Bottom Emptying Assembly controls the flow rate from a slow drip to a rapid emptying flow, minimizing agitation, aeration and exposure to air. Can be attached directly to sample container for emptying.

(F) Standard Bottom has round thread and chafe guard. Precision ground ball stays confined to bottom section, preventing sample loss. Seat design eliminates leakage and premature opening.

(G) Bottom Emptying Check Assembly for rapid purging of well. Valve opens when plunger contacts sample vessel.

(H) Hypo-Fil "B" Sample Transfer Device creates a closed sampling system between a dedicated bladder pump or bailer and a 40 mL vial. Minimizes sample variability, gas liquid interaction, sample transfer bias and eliminates potential of atmospheric contaminants. Made of 100% Teflon body with two 304 stainless steel needles.

COMPLETE BAILERS

PRODUCT	DESCRIPTION	PRICE	SALES TAX	FREIGHT
NOR-D865-3005	STANDARD 1050CC 90CM BAILER (A,D,F)	$ 578.00	EXCLUDED	EXCLUDED
NOR-D865-3055	1050CC STD. BAILER W/ CONTROLLED BOTTOM (A,D,E)	$ 699.00	EXCLUDED	EXCLUDED
NOR-D865-3025	1050CC STD. BAILER W/ BOTTOM EMPTYING CHECK (A,D,G)	$ 649.00	EXCLUDED	EXCLUDED
NOR-D865-3035	1050CC STD BAILER W/ POINT SAMPLING TOP (B,D,F)	$ 689.00	EXCLUDED	EXCLUDED

TRANSPARENT BAILERS

TF-30110	STANDARD TEFLON TOP	$ 139.00	EXCLUDED	EXCLUDED
TF-32210	TEFLON POINT SAMPLE TOP	$ 239.00	EXCLUDED	EXCLUDED
TF-30100	TEFLON EXTENSION TUBE 30CM 350CC	$ 72.00	EXCLUDED	EXCLUDED
TF-30140	TEFLON EXTENSION TUBE 60CM 700CC	$ 150.00	EXCLUDED	EXCLUDED
TF-30150	TEFLON EXTENSION TUBE 90CM 1050CC	$ 310.00	EEXCLUDED	EXCLUDED
TF-30130	TEFLON EXTENSION COUPLING	$ 380.00	EXCLUDED	EXCLUDED
TF-32140	STANDARD TEFLON BOTTOM	$ 139.00	EXCLUDED	EXCLUDED
TF-32200	TEFLON BOTTOM EMPTYING DEVICE	$ 220.00	EXCLUDED	EXCLUDED
TF-32190	CONTROLLED FLOW BOTTOM EMPTYING DEVICE	$ 270.00	EXCLUDED	EXCLUDED
TF-30530	DEDICATED VALVE ASSEMBLY	$ 139.00	EXCLUDED	EXCLUDED
TF-31700	POSI-FILTER KIT	$ 399.00	EXCLUDED	EXCLUDED

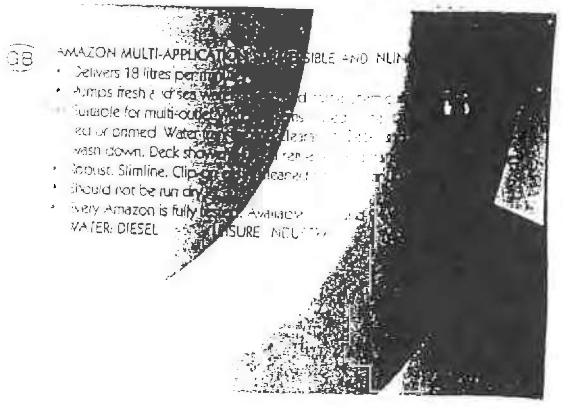
12V

PRODUCTS

"Powered by Technology"

AMAZON SUBMERSIBLE & INLINE PUMP

WATER : DIESEL LEISURE : INDUSTRY MULTI-APPLICATION



Model LVM 105
12 Volt DC CE

SPECIFICATION • DATEN • CARACTERISTIQUES TECHNIQUES • ESPECIFICACION • SPECIFICAZIONE					
Current Strom Courant Corriente Consumo	4.5 Amp LVM 105 2.3 Amp LVM 117	Head Kopfstuck Hauteur d'eau Altura de bombeo del agua Altezza	34ft 10m	Length Lange Longueur Longitud Misura altezza	166mm
Flow Rate Stromungsgeschwindigkeit Débit Velocidad de circulación Potenza	4 Imp.g/min 18 l/min	Body Gehause Boitier Caja Materiale	P.O.M.	Diameter Durchmesser Diamètre Diámetro Diametro	38mm
Pressure Druck Pression Presión Pressione	15 psi 1.0 kg/cm²	Cable Length Kabellange Longueur de câble Longitud de cable Cavo	4m	Weight Gewicht Poids Peso Peso	500g

(GB) INSTRUCTIONS:

Fit a length of 12.7mm (½") hose to the outlet spigot and immerse the complete pump in liquid. Connect the battery clips to battery terminals (+) positive (+) positive (-) negative to (-) negative. The Amazon will deliver immediately.

For an inline installation unclip the filter to expose the inlet spigot. Connect a length of 12.7mm hose between the tank and spigot. The Amazon must be fitted below the tank.

No serious damage should occur to your Amazon if it runs dry for a short period but it's life will be increased if you ensure that it is always pumping liquid.

(D) ANLEITUNGEN

Eine Länge von 12.7mm Schlauch wird an dem Ausflusszapfen befestigt und die gesamte Pumpe in die Flüssigkeit getaucht. Die Batterikabelschuhe werden wie folgt mit den Batterieklemmen verbunden: positiv an (+) positiv (+) negative (-) negative (-). Die Amazon-Pumpe wird sofort pumpen.

Um eine Dauerinstallation zu erhalten muss der Filter gelöst werden um den Eiflusszapfen freizulegen. Eine Schlauchlänge von 12.7mm wird vom Tank bis zum Zapfen verbunden. Die Amazon-Pumpe muss unter dem Tank befisft sein.

Ihre Amazon-Pumpe wird durch Trockenlauf während einer kurzen Periode keinen ernsthaften Schaden leiden aber ihre Functonsfähigkeit ist dauerhafter, wenn sie sichergehen dass sie ständig Flüssigkeit-durchpumpt.

(FR) INSTRUCTIONS:

Encastrer sur une longueur de 12.7mm un tuyau de diamtère 0.5 pouce dans l'emboîture de sortie et immerger la pompe entière dans le liquide. Connecter les pinces de batterie aux bornes de la batterie: le positif (+) au positif (+) et le négatif (-) au négatif (-). La pompe Amazon débitera immédiatement.

Pour une installation permanente, detacher le filtre afin de mettre l'emboîture d'entrée a jour. Connecter une longuer de tuyau de 12.7mm entre, le réservoir et l'emboîture. La pompe Amazon doit être montée sous le réservoir.

Aucun dégat sérieux ne devrait se produire sur vontre pompe Amazon si elle fonctionne à sec pour une courte durée: cependant sa durée de vie sera augementee si vous assurez qu'elle pompe toujours du liquid.

(I) INSTRUCCIONES

Acóplese una tubería de 12,7mm al vástago de salida y sumérjase la bomba completa en el líquido. Conéctense las pinzas de la batería a los terminales de la misma, el signo (+) positivo al signo (+) positivo y el signo (-) negativo al signo (-) negativo. La bomba Amazon efectuará una entrega inmediata.

Para una instalación en línea, sáquese el filtro para dejar al descubierto el vástego de admisión. Conéctese un tubo de 12,7mm entre el depósito y el vástago. La bomba Amazon debe acoplarse por debajo del depósito.

No se producirán averías graves en la bomba Amazon si funciona en seco durante un breve espacio de tiempo, pero su duración útil se aumentará si se asegura que bombee siempre liquidos.

(ES) ISTRUZIONI

Congiungere un tubo di gomma (12.7mm) al bocchettone d'uscita ed immergere la pompa nell'acua. Allacciare alla battena i morsetti (+) positivo (-) negativo. Il Amazon si metterà in funzione immediatamente.

Per l'istallazione in linea (a caduta) togliere il tappofiltro e congiungere un tubo (12.7mm) al bocchettone d'entrata fra il serbatoio e la pompa. Il Amazon non è autoadescante e pertanto richiede che la pompa e il tubo d'entrata siano sotto livello.

Se inavertitamente funzionasse a secco per brevissimo tempo non provocherebbe danni mentre si danneggerebbe irimedialmente continuando a funzionare a secco.

LVM PUMPS			
	Litres/Min	Liquids	Type
Congo	36	Water / Diesel	Submersible: Inline
Amazon	18	Water / Diesel	Submersible: Inline
Missouri	18	Water / Diesel	Inline Self-Priming
Nile	12	Water / Diesel	Submersible: Inline
Niagara	13	Water	Submersible: Inline
Zambezi	18	Water	Inline Water Pump
Power + Pump	7	Water	Submersible: Own Battery

LVM LTD., AEROGEN HOUSE, OLD OAK CLOSE. ARLESEY, BEDS. SG15 6XD.
TEL: (01462) 733336 FAX: (01462) 730466

APPENDIX H

Assessment Criteria

Kelsey Creek Landfill - Water Quality Objectives under EPP Water (2009)		Groundwater					Surface Water - Toxicants	Surface Water - Physico Chemical Indicators	
	Units	ANZECC 95% Toxicants - Freshwater lowland	Drinking Water - ADWG 2011 - Rev3.4 Oct 2017 (Treated Water)	Stock Watering Low risk Trigger Values for heavy metals & metalloids	Irrigation - Long Term Trigger Values	Irrigation - Short Term Trigger Value	ANZECC 95% Toxicants - Freshwater lowland	Prosperine River, Whitsunday & O'Connel River Basins - Lethebrook Subcatchment	QWQG - Central Coastal - Physico Chemical Lowland Stream
Nutrients									
Nitrate (NO3-N)	mg/L	0.7	50				0.7		-
Nitrite (NO2-N)									-
NOx (NO2+NO3)	mg/L								0.06
Ammonia (NH3-N)	mg/L	0.9	ID				0.9		0.02
Ammonium - by calculation from NH3									
Dissolved Inorganic Nitrogen (DIN) - NH3 + N02+N03	mg/L							0.008	
Organic N	mg/L								0.42
Total N	mg/L								0.5
FRP -	mg/L							0.008	0.02
Total P	mg/L								0.05
Field Characteristics									
EC	uS/cm							463	
Salnity	ppt								
pH			6.5-8.5					7.5-7.8	6.5-8.0
DO -%Sat	% Saturation							40-120	85-110
DO	mg/L								
Redox Potential	Eh								
Turbidity	NTU							1	50
Suspended Sediments / Total suspende	mg/L		<600					3	10
Sodium			20						
Calcium									
Magnesium									
Bicarbonate									
Chloride									
Sulfate			500						
Nitrate									
Hardness									
Metals - Total / Dissolved									
Aluminium				5	5	20			
As (III)	mg/L	0.024	0.01				0.024		
As(V)	mg/L	0.013					0.013		
Total Arsenic				0.5 -5	0.1	2			
Cd	mg/L	0.0002	0.002	0.01	0.01	0.05	0.0002		
Cr(III)	mg/L	-					-		
Cr(VI)	mg/L	0.001	0.05				0.001		
Total Cr				1	0.1	1			
Cu	mg/L	0.0014	2	0.4 -5	0.2	5	0.0014		
Pb	mg/L	0.0034	0.01	0.1	2	5	0.0034		
Hg (inorg)	mg/L	0.0006	0.001	0.002	0.002	0.002	0.0006		
Ni	mg/L	0.011	0.02	1	0.2	2	0.011		
Zn	mg/L	0.008	3	20	2	5	0.008		
Fe	mg/L	-	0.3 (aesthetic)	-	0.2	10	-		
Mn	mg/L	1.9	0.5	-	0.2	10	1.9		
Benzene			0.001						
Total Dissolved Solids (TDS)	mg/L		2000- 5000No adverse effects						
Pesticides		Not Detected in raw water							
Hardness	mg/L								
Alkalinity	mg/L								

If total As is less than As(V) Trigger Value it could be assumed that the EV
If total Chromium less than Cr(VI) Trigger Value it could be assumed that the
EV would be protected, otherwise, Cr(VI) speciation completed (lab re

APPENDIX I

Results Tables

Appendix I Kelsey Creek Analytical Results

		Field Parameters						Sample Qu													
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium	Magnesium (Filtered)	Sulphate (as SO4)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Contaminant Alert Trigger Values - Surface Water		6.8-8.0									180	180									
Lethe Brook fresh waters WQO*		7.5-7.8	463		40-120		1														
Location	**Sampled Date**																				
SW1	3/12/2003	7.00	305	29.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15/06/2004	7.10	289	21.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/02/2005	7.00	165	28.5	46.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2005	7.10	507	28.2	54.0	-	6.46	3.00	81.0	-	-	-	-	-	20.0	-	14.0	-	-	-	-
	13/12/2006	7.30	537	29.8	53.0	-	2.5	1.00	39.0	-	-	-	-	-	-	-	-	-	-	-	-
	23/04/2008	6.52	224	26.2	70.0	-	3.22	6.00	42.0	-	-	-	-	-	-	-	-	-	-	-	-
	7/09/2010	7.00	260	-	-	-	-	1.00	40.0	108.00	49.0	-	5.0	-	15.0	-	10.0	-	12.0	31.0	0.5
	27/04/2011	7.75	827	-	-	-	-	9.00	-	-	-	-	-	-	-	-	-	-	-	-	-
	21/09/2011	7.40	957	-	-	-	-	9.00	72.0	206.00	105.0	-	46.0	-	30.0	-	17.0	-	8.0	143.0	0.5
	24/04/2012	7.60	134	-	-	-	-	-	13.0	18.00	16.0	-	4.0	-	8.0	-	4.0	-	3.0	46.0	0.5
	14/11/2012	7.48	486	-	-	-	-	1.00	57.0	85.00	38.0	-	17.0	-	26.0	-	13.0	-	12.0	82.0	0.5
	1/05/2013	7.12	165	-	-	-	-	3.00	36.0	26.00	17.0	-	3.0	-	8.0	-	5.0	-	1.0	34.0	0.5
	13/11/2013	7.70	255	-	-	-	-	1.00	20.0	40.00	27.0	-	4.0	-	13.0	-	6.0	-	0.5	57.0	0.5
	31/07/2014	6.99	240	-	-	-	-	1.00	20.0	53.00	28.0	-	5.0	-	7.0	-	6.0	-	5.0	23.0	0.5
	7/05/2015	7.10	324	-	-	-	-	-	-	75.00	38.0	-	5.0	-	11.0	-	8.0	-	0.5	36.0	0.5
	18/12/2015	7.69	232	-	-	-	-	2.00	22.0	34.00	28.0	-	3.0	-	12.0	-	6.0	-	2.0	-	-
	18/05/2016	-	210	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/01/2017	6.80	320	-	-	-	-	2.00	108.0	-	-	-	-	-	-	-	-	-	-	-	-
	11/05/2017	7.10	210	24.0	68.0	-26	2.4	3.00	38.0	-	-	-	-	-	-	-	-	-	-	-	-
	30/08/2017	7.47	310	24.3	108.0	25.1	3.6	2.00	9.0	52.90	29.0	-	2.4	-	16.9	-	8.2	-	2.3	51.8	2.5
	16/11/2017	7.60	665	30.0	89.0	44	2.8	8.00	96.0	-	-	-	-	-	-	-	-	-	-	-	-
	14/03/2018	7.41	314	29.6	89.2	-28.7	5.3	5.00	16.0	-	-	-	-	-	-	-	-	-	-	-	-
	6/06/2018	7.38	307	19.7	82.0	237	0.5	2.00	8.0	56.50	32.0	27.8	2.5	2.2	17.2	16.0	8.9	8.0	1.7	52.9	2.5
Statistics:																					
	Maximum	7.75	957	30	108.0	237	6.46	9.00	108.0	206.00	105.0	27.8	46.0	2.2	30.0	16.0	17.0	8.0	12.0	143.0	2.5
	Minimum	6.52	134	19.7	46.0	-28.7	0.5	1.00	8.0	18.00	16.0	27.8	2.4	2.2	7.0	16.0	4.0	8.0	0.5	23.0	0.5
	Mean	7.255	358.4	26.47273	73.2	50.28	3.3475	3.47	42.2	68.58	37.0	27.8	8.8	2.2	15.3	16.0	8.8	8.0	4.4	55.7	0.9
	Median	7.21	305	28.2	70.0	25.1	3.01	2.00	38.0	53.00	29.0	27.8	4.0	2.2	14.0	16.0	8.1	8.0	2.3	48.9	0.5
	Rolling Median	7.40	308.50	27.20	76.00	ID	3.01	2.00	21.00	52.95	28.50	ID	3.50	ID	12.50	ID	7.0	ID	1.9	48.9	0.5
	Standard Deviation	0.320472	212.8851	3.59029	20.5	109.0806	1.836299	2.85	30.7	52.69	24.4	#DIV/0!	13.0	#DIV/0!	7.2	#DIV/0!	4.0	#DIV/0!	4.4	34.9	0.8

Notes:

Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.

"-" denotes the sample was not anaylsed for the specific analyte

* Lethe Brook fresh waters Water Quaity Objective for baseflow applies to surface water at Kelsey Creek

"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

uality Parameters

Total Alkalinity (as CaCO3)	Hydroxide Alkalinity as OH	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)	Cyanide (total)	Total Phosphorus (as P)	Total Anions	Total Cations	Ionic Balance (Lab)	Total Dissolved Solids @180°C (Filtered)	Arsenic (Total)	Arsenic (Filtered)	Cadmium (Total)	Cadmium (Filtered)	Chromium (Total)	Chromium (Filtered)	Copper (Total)	Copper (Filtered)	Iron (Total)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
		0.700	0.900			0.420	0.50		0.050				2000-5000	0.0130	0.0130	0.0002	0.0002	0.0010	0.0010	0.0014	0.0014	
			0.020	0.064																		
-	-	0.040	-	-	-	-	0.90	-	0.020	-	-	-	-	-	0.0005	-	0.0021	-	0.0005	-	0.0005	-
-	-	0.005	-	-	-	-	2.20	-	0.020	-	-	-	-	-	0.0005	-	0.0005	-	0.0005	-	0.0005	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0020	-	0.0010	-	0.0005	-	0.0010	-
-	-	0.005	-	-	-	-	1.50	-	0.050	-	-	-	-	-	0.0010	-	0.0001	-	0.0005	-	0.0010	-
-	-	0.020	0.075	0.095	-	-	-	-	0.050	-	-	-	-	-	0.0020	-	0.0001	-	0.0005	-	0.0005	-
-	-	0.014	0.060	0.074	-	-	-	-	0.005	-	-	-	-	-	0.0005	-	0.0002	-	0.0005	-	0.0020	-
31.0	0.5	0.090	0.030	0.120	0.60	0.60	0.70	0.002	0.070	3.92	3.88	-	166.0	-	0.0001	-	0.0005	-	0.0001	-	0.0005	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0060	-	0.0002	-	0.0010	-	0.0010	-
143.0	0.5	0.030	0.220	0.250	2.50	0.28	2.50	0.002	0.280	8.83	8.64	-	612.0	-	0.0010	-	0.0001	-	0.0005	-	0.0010	-
46.0	0.5	0.090	-	-	0.90	-	1.00	0.002	0.190	-	-	-	85.7	-	0.0010	-	0.0001	-	0.0005	-	0.0010	-
82.0	0.5	0.100	-	-	1.80	-	1.90	0.002	0.130	4.29	4.46	-	336.0	-	0.0020	-	0.0001	-	0.0005	-	0.0005	-
34.0	0.5	0.020	-	-	0.80	-	0.80	0.002	0.430	1.43	1.63	-	115.0	-	0.0005	-	0.0001	-	0.0005	-	0.0030	-
57.0	0.5	0.005	-	-	0.40	-	0.40	0.002	0.005	2.27	2.42	-	167.0	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-
23.0	0.5	0.020	-	-	0.70	-	0.70	0.002	0.100	2.06	2.19	-	156.0	-	0.0005	-	0.0001	-	0.0005	-	0.0020	-
36.0	0.5	0.005	-	-	0.90	-	0.90	0.002	0.160	2.83	2.99	-	222.0	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-
-	0.5	0.070	-	-	0.50	-	0.60	0.002	0.060	2.32	2.39	-	159.0	-	0.0005		0.0001		0.0010		0.0005	
-	-	-	-	-	-	-	-	-	-	-	-	-	134.0	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-
-	-	0.005	0.140	0.145	-	-	-	-	0.820	-	-	-	205.0	-	-	-	-	-	-	-	-	-
-	-	0.005	0.040	0.045	-	-	-	-	0.150	-	-	-	-	-	-	-	-	-	-	-	-	-
84.9	-	0.005	0.010	0.015	-	-	-	-	-	-	-	-	201.0	-	-	0.0001	-	0.0005	-	0.0005	-	-
-	-	0.005	0.220	0.225	-	-	-	-	0.200	-	-	-	432.0	-	-	-	-	-	-	-	-	-
-	-	0.020	0.010	0.030	-	-	-	-	0.350	-	-	-	177.0	-	-	-	-	-	-	-	-	-
86.8	-	0.005	0.010	0.015	-	-	-	-	0.050	-	-	-	205.0	0.0005	-	0.0001	-	0.0005	-	0.0010	-	-
143.0	0.5	0.100	0.220	0.250	2.50	0.60	2.50	0.002	0.820	8.83	8.64	0.00	612.0	0.0005	0.0060	0.0001	0.0021	0.0005	0.0010	0.0010	0.0030	0.00
23.0	0.5	0.005	0.010	0.015	0.40	0.28	0.40	0.002	0.005	1.43	1.63	0.00	85.7	0.0005	0.0001	0.0001	0.0001	0.0005	0.0001	0.0005	0.0005	0.00
62.4	0.5	0.028	0.082	0.101	1.01	0.44	1.18	0.002	0.165	3.49	3.58	#DIV/0!	224.8	0.0005	0.0012	0.0001	0.0003	0.0005	0.0005	0.0008	0.0010	#DIV/0!
51.5	0.5	0.017	0.050	0.085	0.80	0.44	0.90	0.002	0.100	2.58	2.71	#NUM!	177.0	0.0005	0.0005	0.0001	0.0001	0.0005	0.0005	0.0008	0.0005	#NUM!
51.5	0.5	0.005	0.035	0.083	0.85	ID	0.85	0.002	0.155	2.58	2.71	#NUM!	203.0	ID	0.0005	ID	0.0001	ID	0.0005	ID	0.0005	ID
37.0	0.0	0.032	0.083	0.084	0.69	0.23	0.68	0.000	0.198	2.36	2.25	#DIV/0!	137.4	#DIV/0!	0.0014	0.0000	0.0005	0.0000	0.0002	0.0004	0.0007	#DIV/0!

Appendix I Kelsey Creek Analytical Results

Heavy Metals											B-TEX								PAH
Iron (Filtered)	Lead (Total)	Lead (Filtered)	Manganese (Total)	Manganese (Filtered)	Mercury (Total)	Mercury (Filtered)	Nickel (Total)	Nickel (Filtered)	Zinc (Total)	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Total BTEX (Calculated)	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Total MAHs (Lab Reported)	Naphthalene
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	0.0034	0.0034	1.900	1.900	0.00060	0.00060	0.0110	0.0110	0.0080	0.0080	0.9500					0.3500			0.016
-	-	0.0005	-	-	-	0.00005	-	0.0005	-	0.0080	-	-	-	-	-	-	-	-	-
-	-	0.0005	-	-	-	0.00005	-	0.0005	-	0.0070	-	-	-	-	-	-	-	-	-
-	-	0.0005	-	-	-	0.00050	-	0.0010	-	0.0170	-	-	-	-	-	-	-	-	-
-	-	0.0005	-	-	-	0.00005	-	0.0010	-	0.0090	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-
-	-	0.0005	-	-	-	0.00005	-	0.0005	-	0.0025	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-
-	-	0.0020	-	-	-	0.00005	-	0.0005	-	0.0070	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-
0.10	-	0.0005	-	0.147	-	0.00005	-	0.0005	-	0.0050	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025
0.42	-	0.0100	-	0.206	-	0.00005	-	0.0050	-	0.0120	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	-	0.0055	0.0025
0.03	-	0.0005	-	3.360	-	0.00005	-	0.0020	-	0.0090	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-
0.80	-	0.0960	-	1.190	-	0.00005	-	0.0005	-	0.0270	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-
0.62	-	0.0040	-	0.711	-	0.00005	-	0.0005	-	0.0070	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025
0.23	-	0.0005	-	0.079	-	0.00005	-	0.0020	-	0.0250	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025
0.40	-	0.0005	-	0.141	-	0.00005	-	0.0005	-	0.0025	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025
0.15	-	0.0020	-	0.062	-	0.00005	-	0.0005	-	0.0025	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025
0.06	-	0.0005	-	0.004	-	0.00005	-	0.0005	-	0.0025	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025
0.39		0.0580	-	0.078	-	0.00005	-	0.0005	-	0.0060	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025
-	-	0.0005	-	-	-	0.00005	-	-	-	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0005	-	-	-	0.00030	-	0.0005	-	0.0025	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0005	-	-	-	0.00030	-	0.0005	-	0.0025	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025
0.80	0.0005	0.0960	0.000	3.360	0.00030	0.00050	0.0005	0.0050	0.0025	0.0270	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025
0.03	0.0005	0.0005	0.000	0.004	0.00030	0.00005	0.0005	0.0005	0.0025	0.0025	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025
0.32	0.0005	0.0104	#DIV/0!	0.598	0.00030	0.00008	0.0005	0.0010	0.0025	0.0093	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025
0.31	0.0005	0.0005	#NUM!	0.144	0.00030	0.00005	0.0005	0.0005	0.0025	0.0070	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025
0.39	ID	0.0013	ID	0.079	ID	0.00005	ID	0.0005	ID	0.0060	0.0005	0.0010	0.0010	ID	0.0010	0.0010	0.0010	ID	0.003
0.25	0.0000	0.0260	#DIV/0!	1.040	0.00000	0.00011	0.0000	0.0012	0.0000	0.0076	0.0000	0.0000	0.0000	#DIV/0!	0.0000	0.0000	0.0000	#DIV/0!	4.54848E-19

Total Petroleum Hydrocarbons												Volatile Organic Compounds		
TRH C10 - C36 (Sum, Lab Reported)	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Calculated)	TRH C6 - C10 Fraction F1	TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4	Carbon tetrachloride	Chloroethane	Vinyl chloride
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
												0.0065	0.0065	0.0065
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.010	0.375	1.000	0.625	-	-	-	-	-	-	-	-	-	-
-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-
-	0.020	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-
-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.010	0.025	0.050	0.025	0.025	-	0.05	-	-	-	-	-	-	-
-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	-	-	-	-	-	-	-	0.01	0.05	0.05	0.05	-	-	-
-	0.010	0.025	0.050	0.025	-	0.05	-	-	0.05	0.05	0.05	-	-	-
-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.010	0.025	0.050	0.025	-	0.03	-	0.01	0.05	0.05	0.05	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.025	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-
0.025	0.020	0.375	1.000	0.625	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.025	0.010	0.025	0.050	0.025	0.025	0.03	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.025	0.011	0.048	0.113	0.065	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.025	0.010	0.025	0.050	0.025	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
ID	0.010	0.025	0.050	0.025	ID	0.05	ID	0.01	0.05	0.05	0.05	ID	ID	ID
#DIV/0!	0.003	0.090	0.245	0.155	#DIV/0!	0.01	#DIV/0!	0.00	0.00	0.00	0.00	0.0000	0.000	0.000

Appendix I Kelsey Creek Analytical Results

		Field Parameters						Sample Quality Parameters																		
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium	Magnesium (Filtered)	Sulphate (as SO4)	Sulphate (as SO4) (Filtered)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Hydroxide Alkalinity as OH
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Contaminant Alert Trigger Values - Surface Water		6.8-8.0									180	180													
Lethe Brook fresh waters WQO*		7.5-7.8	463		40-120		1																		
Location	**Sampled Date**																								
SW2	3/12/2003	7.20	284	32.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15/06/2004	7.30	284	21.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/02/2005	7.30	178	27.2	36.0	-	-	-	-	-	-	-	-	-	8.0	-	5.0	-	-	-	-	-	-	-	-
	13/12/2005	6.80	483	27.3	70.0	-	44.6	-	-	-	-	-	-	-	15.0	-	15.0	-	-	-	-	-	-	-	-
	13/12/2006	7.40	536	29.1	66.0	-	3.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/04/2008	6.65	235	25.8	84.0	-	5.14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7/09/2010	7.10	250	-	-	-	-	1.00	40.0	106.00	48.0	-	5.0	-	15.0	-	10.0	-	2.0	-	39.0	0.5	-	39.0	0.5
	27/04/2011	7.17	136	-	-	-	-	4.00	34.0	20.00	-	14.0	-	1.0	-	6.0	-	3.0	-	1.0	23.0	0.5	0.5	23.0	-
	21/09/2011	7.05	712	-	-	-	-	-	-	42.00	22.0	-	7.0	-	8.0	-	5.0	-	0.5	-	38.0	0.5	-	38.0	0.5
	24/04/2012	6.96	119	-	-	-	-	-	-	25.00	14.0	-	3.0	-	6.0	-	4.0	-	1.0	-	28.0	0.5	-	28.0	0.5
	14/11/2012	7.49	440	-	-	-	-	-	-	102.00	46.0	-	11.0	-	15.0	-	10.0	-	0.5	-	45.0	0.5	-	45.0	0.5
	1/05/2013	7.23	236	-	-	-	-	-	-	18.00	17.0	-	4.0	-	16.0	-	7.0	-	43.0	-	39.0	0.5	-	39.0	0.5
	13/11/2013	7.70	197	-	-	-	-	-	-	22.00	20.0	-	3.0	-	11.0	-	5.0	-	0.5	-	58.0	0.5	-	58.0	0.5
	31/07/2014	7.40	335	-	-	-	-	-	-	56.00	32.0	-	11.0	-	15.0	-	9.0	-	3.0	-	71.0	0.5	-	71.0	0.5
	7/05/2015	7.20	267	-	-	-	-	-	-	40.00	29.0	-	6.0	-	12.0	-	7.0	-	0.5	-	69.0	0.5	-	69.0	0.5
	18/12/2015	7.78	210	-	-	-	-	-	-	28.00	26.0	-	2.0	-	11.0	-	5.0	-	0.5	-	-	-	-	-	0.5
	18/05/2016	-	80	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/01/2017	6.80	320	-	-	-	-	0.50	107.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	11/05/2017	7.10	210	24.0	58.0	-15	2.8	2.00	34.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	30/08/2017	7.67	309	24.5	115.0	-13	3.6	2.00	5.0	52.70	28.7	-	2.4	-	17.7	-	8.3	-	2.3	-	52.2	2.5	-	85.5	-
	16/11/2017	7.70	655	28.4	78.0	32	3.6	7.00	94.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/03/2018	7.16	308	28.2	58.9	-30.6	5.2	3.00	30.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6/06/2018	7.48	308	20.1	91.3	195	0.6	2.00	8.0	55.50	30.3	27.6	2.3	2.0	16.9	16.1	8.6	7.9	1.5	-	53.5	2.5	-	87.7	-
Statistics:																									
	Maximum	7.78	712	32.9	115.0	195	44.6	7.00	107.0	106.00	48.0	27.6	11.0	2.0	17.7	16.1	15.0	7.9	43.0	1.0	71.0	2.5	0.5	87.7	0.5
	Minimum	6.65	80	20.1	36.0	-30.6	0.6	0.50	5.0	18.00	14.0	14.0	2.0	1.0	6.0	6.0	4.0	3.0	0.5	1.0	23.0	0.5	0.5	23.0	0.5
	Mean	7.256364	308.313	26.27273	73.0	33.68	8.6175	2.69	44.0	47.27	28.5	20.8	5.2	1.5	12.8	11.1	7.6	5.5	5.0	1.0	46.9	0.9	0.5	53.0	0.5
	Median	7.215	284	27.2	70.0	-13	3.6	2.00	34.0	41.00	28.7	20.8	4.0	1.5	15.0	11.1	7.0	5.5	1.0	1.0	45.0	0.5	0.5	45.0	0.5
	Rolling Median	7.34	308	26.55	74.00	ID	ID	2.00	34.00	46.35	28.85	ID	3.50	ID	15.00	ID	7.65	ID	1.00	ID	52.85	0.50	ID	63.50	0.5
	Standard Deviation	0.306742	160.5559	3.626042	22.6	93.14994	14.61022	2.05	37.2	29.86	10.8	9.6	3.3	0.7	3.8	7.1	3.0	3.5	12.6	#DIV/0!	15.5	0.8	#DIV/0!	22.5	0.0

Notes:

Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.

"-" denotes the sample was not anaylsed for the specific analyte

* Lethe Brook fresh waters Water Quaity Objective for baseflow applies to surface water at Kelsey Creek

"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

Appendix I Kelsey Creek Analytical Results

GOLDER

												Heavy Metals																	
Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)	Cyanide (total)	Total Phosphorus (as P)	Total Anions	Total Cations	Ionic Balance (Lab)	Total Dissolved Solids @180°C (Filtered)	Arsenic (Total)	Arsenic (Filtered)	Cadmium (Total)	Cadmium (Filtered)	Chromium (Total)	Chromium (Filtered)	Copper (Total)	Copper (Filtered)	Iron (Total)	Iron (Filtered)	Lead (Total)	Lead (Filtered)	Manganese (Total)	Manganese (Filtered)	Mercury (Total)	Mercury (Filtered)	Nickel (Total)	Nickel (Filtered)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.7	0.90		0.50		0.050		0.05				2000-5000	0.0130	0.0130	0.0002	0.0002	0.0010	0.0010	0.0014	0.0014			0.0034	0.0034	1.900	1.900	0.00060	0.00060	0.0110	0.0110
	0.02	0.064																											
0.080	-	-	-	-	0.80	-	0.020	-	-	-	-	-	0.0005	-	0.0655	-	0.0005	-	0.0020	-	-	-	0.0005	-	-	-	0.00005	-	0.0005
0.005	-	-	-	-	0.05	-	0.030	-	-	-	-	-	0.0005	-	0.0001	-	0.0050	-	0.0020	-	-	-	0.0005	-	-	-	0.00005	-	0.0010
-	-	-	-	-	-	-	-	-	-	-	-	-	0.0010	-	0.0006	-	0.0010	-	0.0010	-	-	-	0.0005	-	-	-	0.00050	-	0.0010
0.005	-	-	-	-	2.80	-	0.420	-	-	-	-	-	0.0020	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00005	-	0.0005
0.019	-	-	-	-	-	-	-	-	-	-	-	-	0.0010	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00005	-	0.0005
-	-	-	-	-	-	-	-	-	-	-	-	-	0.0010	-	0.0003	-	0.0005	-	0.4140	-	-	-	0.0630	-	-	-	0.00005	-	0.0020
0.260	0.050	0.310	0.80	0.70	1.10	0.002	0.050	3.80	3.82	-	160.0	-	0.0005	-	0.0001	-	0.1880	-	0.0005	-	0.22	-	0.0005	-	0.631	-	0.00005	-	0.0005
0.140	0.020	0.160	0.70	0.60	0.80	0.002	0.010	1.06	1.22	-	169.0	-	0.0005	-	0.0001	-	0.0005	-	0.0010	-	0.36	-	0.0050	-	0.056	-	0.00005	-	0.0020
-	-	-	-	-	-	0.002	-	1.94	1.95	-	456.0	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	0.09	-	0.0005	-	0.080	-	0.00005	-	0.0005
-	-	-	-	-	-	0.002	-	1.29	1.31	-	76.1	-	0.0005	-	0.0001	-	0.0005	-	0.0010	-	0.47	-	0.0950	-	0.036	-	0.00005	-	0.0005
-	-	-	-	-	-	0.002	-	3.78	3.85	-	302.0	-	0.0005	-	0.0001	-	0.0005	-	0.0010	-	0.18	-	0.0005	-	0.182	-	0.00005	-	0.0005
-	-	-	-	-	-	0.002	-	2.18	2.22	-	155.0	-	0.0005	-	0.0001	-	0.0005	-	0.0030	-	0.17	-	0.0080	-	0.070	-	0.00005	-	0.0010
-	-	-	-	-	-	0.002	-	1.78	1.91	-	132.0	-	0.0005	-	0.0001	-	0.0005	-	0.0020	-	0.48	-	0.0040	-	0.112	-	0.00005	-	0.0005
-	-	-	-	-	-	0.002	-	3.06	3.16	-	188.0	-	0.0005	-	0.0001	-	0.0005	-	0.0010	-	0.48	-	0.0140	-	0.676	-	0.00005	-	0.0005
-	-	-	-	-	-	0.002	-	2.51	2.59	-	147.0	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	0.07	-	0.0005	-	0.002	-	0.00005	-	0.0005
-	-	-	-	-	-	0.002	-	2.13	2.14	-	140.0	0.0005	-	0.0001	-	0.0005	-	0.0005	-	0.30	-	0.0640	-	0.060	-	0.00005	-	0.0005	-
-	-	-	-	-	-	-	-	-	-	-	51.0	0.0005	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00005	-	-	-
0.005	0.160	0.165	-	-	-	-	0.910	-	-	-	205.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.005	0.010	0.015	-	-	-	-	0.140	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.005	0.010	0.015	-	-	-	-	-	-	-	-	201.0	-	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00030	-	0.0005	-
0.005	0.170	0.175	-	-	-	-	0.220	-	-	-	426.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.030	0.010	0.040	-	-	-	-	0.340	-	-	-	178.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.005	0.010	0.015	-	-	-	-	0.050	-	-	-	204.0	0.0005	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00030	-	0.0005	-
0.260	0.170	0.310	0.80	0.70	2.80	0.002	0.910	3.80	3.85	0.00	456.0	0.0005	0.0020	0.0001	0.0655	0.0005	0.1880	0.0005	0.4140	0.30	0.48	0.0640	0.0950	0.060	0.676	0.00030	0.00050	0.0005	0.0020
0.005	0.010	0.015	0.70	0.60	0.05	0.002	0.010	1.06	1.22	0.00	51.0	0.0005	0.0005	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.30	0.07	0.0005	0.0005	0.060	0.002	0.00005	0.00005	0.0005	0.0005
0.047	0.055	0.112	0.75	0.65	1.11	0.002	0.219	2.35	2.42	#DIV/0!	199.4	0.0005	0.0007	0.0001	0.0045	0.0005	0.0133	0.0005	0.0287	0.30	0.28	0.0164	0.0129	0.060	0.205	0.00018	0.00008	0.0005	0.0008
0.005	0.015	0.100	0.75	0.65	0.80	0.002	0.095	2.16	2.18	#NUM!	173.5	0.0005	0.0005	0.0001	0.0001	0.0005	0.0005	0.0005	0.0010	0.30	0.22	0.0005	0.0005	0.060	0.080	0.00018	0.00005	0.0005	0.0005
0.005	0.015	0.100	ID	ID	ID	0.00	0.180	2.16	2.18	ID	189.50	ID	0.0005	ID	0.0001	ID	0.0005	ID	0.0010	ID	0.27	ID	0.0045	ID	0.075	ID	0.00005	ID	0.0005
0.079	0.069	0.108	0.07	0.07	1.02	0.000	0.282	0.94	0.93	#DIV/0!	109.8	0.0000	0.0004	0.0000	0.0169	0.0000	0.0483	0.0000	0.1066	#DIV/0!	0.17	0.0318	0.0278	#DIV/0!	0.259	0.00014	0.00012	0.0000	0.0005

Appendix I Kelsey Creek Analytical Results

GOLDER

		B-TEX								PAH	Total Petroleum Hydrocarbons												Volatile Organic Compounds		
Zinc (Total)	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Total BTEX (Calculated)	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Total MAHs (Lab Reported)	Naphthalene	TRH C10 - C36 (Sum, Lab Reported) SG Cleanup	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Calculated)	TRH C6 - C10 Fraction F1	TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4	Carbon tetrachloride	Chloroethane	Vinyl chloride
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.0080	0.0080	0.9500					0.3500			0.016													0.0065	0.0065	0.0065
-	0.0160	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0140	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0080	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-	0.010	0.375	1.000	0.500	-	-	-	-	-	-	-	-	-	-
-	0.0025	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-
-	0.3650	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0060	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.0100	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	-	0.0055	0.0025	-	0.010	0.025	0.050	0.025	0.025	-	0.05	-	-	-	-	-	-	-
-	0.0070	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.0160	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.0200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0170	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0250	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0025	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0025	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0025	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.120	0.025	-	0.14	-	0.01	0.05	0.14	0.05	0.0025	0.025	0.025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0060	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.03	-	0.01	0.05	0.05	0.05	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0025	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	0.025	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-
0.0060	0.3650	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	0.025	0.010	0.375	1.000	0.500	0.025	0.14	0.05	0.01	0.05	0.14	0.05	0.0025	0.025	0.025
0.0025	0.0025	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	0.025	0.010	0.025	0.050	0.025	0.025	0.03	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0037	0.0349	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	0.025	0.010	0.064	0.163	0.078	0.025	0.06	0.05	0.01	0.05	0.07	0.05	0.0025	0.025	0.025
0.0025	0.0120	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	0.025	0.010	0.025	0.050	0.025	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
ID	0.0130	0.0005	0.0010	0.0010	ID	0.0010	0.0010	0.0010	ID	ID	ID	0.0100	0.025	0.0500	0.0250	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
0.0020	0.0916	0.0000	0.0000	0.0000	#DIV/0!	0.0000	0.0000	0.0000	#DIV/0!	0	#DIV/0!	0.000	0.117	0.315	0.158	#DIV/0!	0.04	#DIV/0!	0.00	0.00	0.04	0.00	0.0000	0.000	0.000

Appendix I Kelsey Creek Analytical Results

		Field Parameters						Sample Quality Parameters																
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium	Magnesium (Filtered)	Sulphate (as SO4)	Sulphate (as SO4) (Filtered)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Contaminant Alert Trigger Values - Surface Water		6.8-8.0									180.0	180.0												0.7
Lethe Brook fresh waters WQO*		7.5-7.8	463		40-120		1																	
Location	**Sampled Date**																							
SW3	3/12/2003	6.80	265	30.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15/06/2004	8.00	298	22.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/02/2005	7.20	171	28.2	57.0	-	-	1.50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2005	6.90	456	28.2	40.0	-	33.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2006	7.00	477	26.9	26.0	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/04/2008	7.83	302	28.5	105.0	-	14.53	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7/09/2010	7.40	250	-	-	-	-	6.00	46.0	89.00	46.0	-	6.0	-	21.0	-	9.0	-	1.0	-	77.0	0.5	-	77.0
	27/04/2011	7.06	139	-	-	-	-	-	-	21.00	-	14.0	-	1.0	-	6.0	-	3.0	-	4.0	21.0	0.5	0.5	21.0
	21/09/2011	7.30	481	-	-	-	-	-	-	87.00	27.0	-	47.0	-	18.0	-	9.0	-	2.0	-	80.0	0.5	-	80.0
	24/04/2012	7.36	131	-	-	-	-	-	-	25.00	15.0	-	3.0	-	9.0	-	4.0	-	0.5	-	38.0	0.5	-	38.0
	14/11/2012	7.70	449	-	-	-	-	-	-	96.00	43.0	-	11.0	-	18.0	-	10.0	-	0.5	-	58.0	0.5	-	58.0
	1/05/2013	7.32	211	-	-	-	-	-	-	19.00	17.0	-	4.0	-	13.0	-	6.0	-	32.0	-	39.0	0.5	-	39.0
	14/11/2013	7.47	222	-	-	-	-	-	-	28.00	23.0	-	4.0	-	12.0	-	6.0	-	3.0	-	59.0	0.5	-	59.0
	31/07/2014	7.42	271	-	-	-	-	-	-	50.00	29.0	-	5.0	-	11.0	-	7.0	-	3.0	-	43.0	0.5	-	43.0
	7/05/2015	7.20	324	-	-	-	-	-	-	71.00	35.0	-	5.0	-	13.0	-	8.0	-	0.5	-	49.0	0.5	-	49.0
	18/12/2015	7.65	218	-	-	-	-	-	-	29.00	25.0	-	2.0	-	11.0	-	6.0	-	1.0	-	-	-	-	-
	18/05/2016	-	115	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/01/2017	6.80	320	-	-	-	-	0.50	100.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	11/05/2017	7.30	220	24.0	81.0	2.1	3.8	3.00	34.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	30/08/2017	7.54	313	24.4	98.4	-906	3.9	2.00	17.0	53.50	30.9	-	2.6	-	17.4	-	8.5	-	2.3	-	51.3	2.5	-	84.0
	16/11/2017	7.50	655	28.7	86.0	23	2.9	3.00	87.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/03/2018	7.16	305	27.9	81.0	-25.1	5.8	3.00	27.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6/06/2018	7.55	308	20.0	96.3	192	0.5	2.00	6.0	55.10	30.5	27.2	2.2	2.1	17.5	15.9	8.8	7.8	1.5	-	52.9	2.5	-	86.8
Statistics:																								
	Maximum	8	655	30.5	105.0	192	33.7	6.00	100.0	96.00	46.0	27.2	47.0	2.1	21.0	15.9	10.0	7.8	32.0	4.0	80.0	2.5	0.5	86.8
	Minimum	6.8	115	20	26.0	-906	0.5	0.50	6.0	19.00	15.0	14.0	2.0	1.0	9.0	6.0	4.0	3.0	0.5	4.0	21.0	0.5	0.5	21.0
	Mean	7.339091	300	26.35455	74.5	-142.8	8.64125	2.63	45.3	51.97	29.2	20.6	8.3	1.6	14.6	11.0	7.5	5.4	4.3	4.0	51.7	0.9	0.5	57.7
	Median	7.34	298	27.9	81.0	2.1	3.95	2.50	34.0	51.75	29.0	20.6	4.0	1.6	13.0	11.0	8.0	5.4	1.5	4.0	51.3	0.5	0.5	58.0
	Rolling Median	7.40	307	27.40	83.50	2.10	3.95	2.50	30.50	53.50	30.50	ID	2.20	ID	17.40	ID	8.50	ID	1.50	ID	52.10	2.50	ID	85.40
	Standard Deviation	0.31505	131	3.17218	27.5	435.0012	10.93743	1.62	35.4	28.27	9.6	9.3	13.1	0.8	3.9	7.0	1.8	3.4	9.2	#DIV/0!	17.1	0.8	#DIV/0!	21.9

Notes:

Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.

"-" denotes the sample was not anaylsed for the specific analyte

* Lethe Brook fresh waters Water Quaity Objective for baseflow applies to surface water at Kelsey Creek

"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

GOLDER

												Heavy Metals															
Hydroxide Alkalinity as OH	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)	Cyanide (total)	Total Phosphorus (as P)	Total Anions	Total Cations	Total Dissolved Solids @180°C (Filtered)	Arsenic (Total)	Arsenic (Filtered)	Cadmium (Total)	Cadmium (Filtered)	Chromium (Total)	Chromium (Filtered)	Copper (Total)	Copper (Filtered)	Iron (Total)	Iron (Filtered)	Lead (Total)	Lead (Filtered)	Manganese (Total)	Manganese (Filtered)	Mercury (Total)	Mercury (Filtered)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
		0.900				0.50		0.050			2000-5000	0.0130	0.0130	0.0002	0.0010	0.0010	0.0010	0.0014	0.0014			0.0034	0.0034	1.900	1.900	0.00060	0.00060
		0.020	0.064																								
-	0.030	-	-	-	-	0.70	-	0.020	-	-	-	-	0.0005	-	0.0093	-	0.0005	-	0.0020	-	-	-	0.0005	-	-	-	0.00005
-	0.040	-	-	-	-	1.00	-	0.050	-	-	-	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00005
-	-	-	-	-	-	-	-	-	-	-	-	-	0.0010	-	0.0001	-	0.0005	-	0.0010	-	-	-	0.0005	-	-	-	0.00050
-	-	-	-	-	-	-	-	-	-	-	-	-	0.0005	-	0.0001	-	0.0020	-	0.0005	-	-	-	0.0005	-	-	-	0.00005
-	-	-	-	-	-	-	-	-	-	-	-	-	0.0010	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00005
-	-	-	-	-	-	-	-	-	-	-	-	-	0.0010	-	0.0010	-	0.0005	-	0.0260	-	-	-	0.0400	-	-	-	0.00005
0.5	0.100	0.050	0.150	1.30	1.20	1.40	0.002	0.150	4.08	3.96	160.0	-	0.0005	-	0.0024	-	0.0005	-	0.0005	-	0.36	-	0.0005	-	4.600	-	0.00005
-	-	-	-	-	-	-	0.002	-	1.11	1.21	124.0	-	0.0005	-	0.0001	-	0.0005	-	0.0010	-	0.32	-	0.0080	-	0.058	-	-
0.5	-	-	-	-	-	-	0.002	-	4.09	4.02	308.0	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	1.12	-	0.0005	-	2.580	-	0.00005
0.5	-	-	-	-	-	-	0.002	-	1.46	1.51	83.8	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	1.07	-	0.2590	-	0.459	-	0.00005
0.5	-	-	-	-	-	-	0.002	-	3.87	3.87	282.0	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	0.44	-	0.0010	-	0.283	-	0.00005
0.5	-	-	-	-	-	-	0.002	-	1.98	1.98	143.0	-	0.0005	-	0.0011	-	0.0005	-	0.0110	-	0.09	-	0.0060	-	0.143	-	0.00005
0.5	-	-	-	-	-	-	0.002	-	2.03	2.20	165.0	-	0.0010	-	0.0001	-	0.0010	-	0.0040	-	0.34	-	0.0020	-	0.361	-	0.00005
0.5	-	-	-	-	-	-	0.002	-	2.33	2.51	143.0	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	0.65	-	0.0005	-	0.695	-	0.00005
0.5	-	-	-	-	-	-	0.002	-	2.98	2.96	181.0	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	0.42	-	0.0005	-	0.259	-	0.00005
0.5	-	-	-	-	-	-	0.002	-	2.20	2.18	136.0	0.0005	-	0.0001	-	0.0005	-	0.0005	-	0.32	-	0.0020	-	0.067	-	0.00005	-
-	-	-	-	-	-	-	-	-	-	-	74.0	0.0005	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00005	-
-	0.005	0.140	0.145	-	-	-	-	0.920	-	-	205.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.020	0.040	0.060	-	-	-	-	0.180	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.005	0.010	0.015	-	-	-	-	-	-	-	204.0	-	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00030	-
-	0.005	0.170	0.175	-	-	-	-	0.210	-	-	425.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.030	0.010	0.040	-	-	-	-	0.330	-	-	177.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.005	0.010	0.015	-	-	-	-	0.050	-	-	205.0	0.0005	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00030	-
0.5	0.100	0.170	0.175	1.30	1.20	1.40	0.002	0.920	4.09	4.02	425.0	0.0005	0.0010	0.0001	0.0093	0.0005	0.0020	0.0005	0.0260	0.32	1.12	0.0020	0.2590	0.067	4.600	0.00030	0.00050
0.5	0.005	0.010	0.015	1.30	1.20	0.70	0.002	0.020	1.11	1.21	74.0	0.0005	0.0005	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.32	0.09	0.0005	0.0005	0.067	0.058	0.00005	0.00005
0.5	0.027	0.061	0.086	1.30	1.20	1.03	0.002	0.239	2.61	2.64	188.5	0.0005	0.0006	0.0001	0.0010	0.0005	0.0006	0.0005	0.0033	0.32	0.53	0.0009	0.0214	0.067	1.049	0.00018	0.00008
0.5	0.020	0.040	0.060	1.30	1.20	1.00	0.002	0.165	2.27	2.36	171.0	0.0005	0.0005	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.32	0.42	0.0005	0.0005	0.067	0.361	0.00018	0.00005
0.50	0.01	ID	ID	ID	ID	ID	0.00	0.21	2.20	2.18	204.00	ID	0.0005	ID	0.0001	ID	0.0005	ID	0.0005	ID	0.4300	ID	0.0015	ID	0.32	ID	0.00005
0.0	0.031	0.066	0.069	#DIV/0!	#DIV/0!	0.35	0.000	0.294	1.09	1.02	88.1	0.0000	0.0002	0.0000	0.0024	0.0000	0.0004	0.0000	0.0069	#DIV/0!	0.35	0.0008	0.0665	#DIV/0!	1.538	0.00014	0.00012

Appendix I Kelsey Creek Analytical Results

GOLDER

				B-TEX							PAH	Total Petroleum Hydrocarbons											Volatile Organic Compounds		
Nickel (Total)	Nickel (Filtered)	Zinc (Total)	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Total BTEX (Calculated)	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Naphthalene	TRH C10 - C36 (Sum, Lab Reported) SG Cleanup	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C40 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Calculated)	TRH C6 - C10 Fraction F1	TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4	Carbon tetrachloride	Chloroethane	Vinyl chloride
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.0110	0.0110	0.0080	0.0080	0.9500					0.3500		0.016												0.0065	0.0065	0.0065
-	0.0005	-	0.0220	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0005	-	0.0050	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0010	-	0.0120	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	0.010	0.025	0.100	0.070	-	-	-	-	-	-	-	-	-
-	0.0005	-	0.0025	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0005	-	0.0025	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0010	-	0.6170	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0005	-	0.0025	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	0.0025	-	0.010	0.025	0.050	0.025	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.0005	-	0.0050	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0005	-	0.0100	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	0.010	0.025	0.050	0.025	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.0005	-	0.0110	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	0.010	0.025	0.050	0.025	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.0005	-	0.0120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0040	-	0.1590	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0005	-	0.0290	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0005	-	0.0025	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0005	-	0.0025	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0005	-	0.0025	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	0.0025	-	0.010	0.025	0.050	0.025	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0005	-	0.0025	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	0.0025	-	0.010	0.025	0.050	0.025	0.03	-	0.01	0.05	0.05	0.05	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0005	-	0.0025	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	0.0025	0.025	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-
0.0005	0.0040	0.0025	0.6170	0.0005	0.0010	0.0010	0.0000	0.0010	0.0010	0.0010	0.0025	0.025	0.010	0.025	0.100	0.070	0.05	0.00	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0005	0.0005	0.0025	0.0025	0.0005	0.0010	0.0010	0.0000	0.0010	0.0010	0.0010	0.0025	0.025	0.010	0.025	0.050	0.025	0.03	0.00	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0005	0.0008	0.0025	0.0596	0.0005	0.0010	0.0010	#DIV/0!	0.0010	0.0010	0.0010	0.0025	0.025	0.010	0.025	0.057	0.031	0.05	#DIV/0!	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0005	0.0005	0.0025	0.0100	0.0005	0.0010	0.0010	#NUM!	0.0010	0.0010	0.0010	0.0025	0.025	0.010	0.025	0.050	0.025	0.05	#NUM!	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
ID	0.00050	ID	0.01050	0.00050	0.00100	0.00100	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
0.0000	0.0009	0.0000	0.1591	0.0000	0.0000	0.0000	#DIV/0!	0.0000	0.0000	0.0000	0	#DIV/0!	0.000	0.000	0.019	0.017	0.01	#DIV/0!	0.00	0.00	0.00	0.00	0.0000	0.000	0.000

		Field Parameters																		
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium	Magnesium (Filtered)	Sulphate (as SO4)	Sulphate (as SO4) (Filtered)
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Contaminant Alert Trigger Values - Surface Water		6.8-8.0									180	180								
Lethe Brook fresh waters WQO*		7.5-7.8	463		40-120		1													
Location	**Sampled Date**																			
SW4	3/12/2003	7.40	450	34.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15/06/2004	7.20	278	21.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/02/2005	7.10	195	28.9	36.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2005	7.00	333	25.9	32.0	-	21.9	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2006	7.10	522	28.0	30.0	-	4.4	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/04/2008	7.81	528	29.7	48.0	-	5.84	-	-	-	-	-	-	-	-	-	-	-	-	-
	7/09/2010	8.35	600	-	-	-	-	3.00	73.0	145.00	98.0	-	11.0	-	27.0	-	16.0	-	12.0	-
	27/04/2011	7.10	144	-	-	-	-	-	-	21.00	-	15.0	-	1.0	-	6.0	-	3.0	-	6.0
	21/09/2011	8.60	403	-	-	-	-	-	-	90.00	21.0	-	56.0	-	5.0	-	2.0	-	3.0	-
	24/04/2012	7.60	325	-	-	-	-	-	-	38.00	35.0	-	8.0	-	17.0	-	8.0	-	2.0	-
	14/11/2012	7.67	451	-	-	-	-	-	-	78.00	32.0	-	18.0	-	24.0	-	12.0	-	0.5	-
	13/11/2013	7.80	201	-	-	-	-	-	-	22.00	20.0	-	3.0	-	11.0	-	5.0	-	0.5	-
	31/07/2014	7.42	363	-	-	-	-	-	-	56.00	32.0	-	7.0	-	20.0	-	11.0	-	2.0	-
	7/05/2015	7.20	244	-	-	-	-	-	-	36.00	28.0	-	3.0	-	10.0	-	6.0	-	0.5	-
	18/12/2015	7.72	210	-	-	-	-	-	-	26.00	24.0	-	2.0	-	11.0	-	5.0	-	0.5	-
	18/05/2016	-	110	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/01/2017	7.20	278	-	-	-	-	4.00	105.0	-	-	-	-	-	-	-	-	-	-	-
	11/05/2017	8.40	225	24.0	129.0	-30	12.2	4.00	37.0	-	-	-	-	-	-	-	-	-	-	-
	30/08/2017	7.32	308	23.7	107.0	87	2.4	2.00	20.0	51.40	29.2	-	2.4	-	17.6	-	8.4	-	2.3	-
	16/11/2017	8.43	430	33.5	186.0	1.9	13	4.00	17.0	-	-	-	-	-	-	-	-	-	-	-
	14/03/2018	7.49	244	30.1	111.0	-29.5	29.3	3.00	20.0	-	-	-	-	-	-	-	-	-	-	-
	6/06/2018	7.46	306	20.0	94.2	274	0.3	2.00	6.0	54.50	29.4	28.2	2.1	2.0	17.1	16.8	8.4	8.2	1.6	-
Statistics:																				
	Maximum	8.6	600	34.5	186.0	274	29.3	4.00	105.0	145.00	98.0	28.2	56.0	2.0	27.0	16.8	16.0	8.2	12.0	6.0
	Minimum	7	110	20	30.0	-30	0.3	2.00	6.0	21.00	20.0	15.0	2.0	1.0	5.0	6.0	2.0	3.0	0.5	6.0
	Mean	7.589048	324.9045	27.24545	85.9	60.68	11.1675	3.14	39.7	56.17	34.9	21.6	11.3	1.5	16.0	11.4	8.2	5.6	2.5	6.0
	Median	7.46	307	28	94.2	1.9	9.02	3.00	20.0	51.40	29.3	21.6	5.0	1.5	17.1	11.4	8.2	5.6	1.8	6.0
	Rolling Median	7.48	278	27.0	100.6	ID	9.02	3.00	20.0	44.70	29.3	ID	3.0	ID	17.05	ID	8.20	ID	1.05	ID
	Standard Deviation	0.488097	130.6511	4.699013	53.6	128.4606	10.12459	0.90	36.1	36.86	22.7	9.3	16.5	0.7	6.8	7.6	4.0	3.7	3.5	#DIV/0!

Notes:

Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.

"-" denotes the sample was not anaylsed for the specific analyte

* Lethe Brook fresh waters Water Quaity Objective for baseflow applies to surface water at Kelsey Creek

"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

Sample Quality Parameters

Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Hydroxide Alkalinity as OH	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)	Cyanide (total)	Total Phosphorus (as P)	Total Anions	Total Cations	Total Dissolved Solids @180°C (Filtered)	Arsenic (Total)	Arsenic (Filtered)	Cadmium (Total)	Cadmium (Filtered)	Chromium (Total)	Chromium (Filtered)	Copper (Total)	Copper (Filtered)	Iron (Total)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
					0.700	0.900				0.50		0.050			2000-5000	0.013	0.0130	0.0002	0.0002	0.001	0.001	0.0014	0.0014	
						0.020	0.064																	
-	-	-	-	-	3.970	-	-	-	-	7.10	-	0.210	-	-	-	-	0.0010	-	0.0223	-	0.0005	-	0.0030	-
-	-	-	-	-	0.005	-	-	-	-	1.20	-	0.050	-	-	-	-	0.0005	-	0.0005	-	0.0005	-	0.0005	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0005	-	0.0002	-	0.0005	-	0.0030	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0020	-	0.0001	-	0.0010	-	0.0020	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0010	-	0.0001	-	0.0005	-	0.0005	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0010	-	0.0004	-	0.0005	-	0.0010	-
144.0	0.5	-	144.0	0.5	0.060	0.020	0.080	1.60	1.50	1.70	0.002	0.220	7.21	7.23	384.0	-	0.0005	-	0.0021	-	0.0005	-	0.0010	-
22.0	0.5	0.5	22.0	-	-	-	-	-	-	-	0.002	-	1.15	1.30	138.0	-	0.0005	-	0.0002	-	0.0005	-	0.0020	-
16.0	0.5	-	16.0	0.5	-	-	-	-	-	-	0.002	-	2.92	2.75	258.0	-	0.0010	-	0.0001	-	0.0005	-	0.0020	-
100.0	0.5	-	100.0	0.5	-	-	-	-	-	-	0.002	-	3.11	3.23	208.0	-	0.0010	-	0.0001	-	0.0005	-	0.0005	-
86.0	0.5	-	86.0	0.5	-	-	-	-	-	-	0.002	-	3.92	4.04	300.0	-	0.0040	-	0.0001	-	0.0005	-	0.0005	-
58.0	0.5	-	58.0	0.5	-	-	-	-	-	-	0.002	-	1.78	1.91	123.0	-	0.0005	-	0.0001	-	0.0005	-	0.0050	-
88.0	0.5	-	88.0	0.5	-	-	-	-	-	-	0.002	-	3.38	3.47	190.0	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-
66.0	0.5	-	66.0	0.5	-	-	-	-	-	-	0.002	-	2.33	2.29	138.0	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-
-	-	-	-	0.5	-	-	-	-	-	-	0.002	-	2.05	2.06	126.0	0.0005	-	0.0001	-	0.0005	-	0.0005	-	0.37
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	70.0	0.0010	-	0.0001	-	0.0010	-	0.0020	-	-
-	-	-	-	-	0.005	0.050	0.055	-	-	-	-	1.000	-	-	178.0	-	-	-	-	-	-	-	-	-
-	-	-	-	-	0.005	0.050	0.055	-	-	-	-	0.050	-	-	-	-	-	-	-	-	-	-	-	-
48.8	2.5	-	80.1	-	0.005	0.010	0.015	-	-	-	-	-	-	-	200.0	-	-	0.0001	-	0.0005	-	0.0005	-	-
-	-	-	-	-	0.005	0.140	0.145	-	-	-	-	0.050	-	-	280.0	-	-	-	-	-	-	-	-	-
-	-	-	-	-	0.005	0.010	0.015	-	-	-	-	0.350	-	-	137.0	-	-	-	-	-	-	-	-	-
54.0	2.5	-	88.6	-	0.005	0.010	0.015	-	-	-	-	0.050	-	-	204.0	0.0005	-	0.0001	-	0.0005	-	0.0010	-	-
144.0	2.5	0.5	144.0	0.5	3.970	0.140	0.145	1.60	1.50	7.10	0.002	1.000	7.21	7.23	384.0	0.0010	0.0040	0.0001	0.0223	0.0010	0.0010	0.0020	0.0050	0.37
16.0	0.5	0.5	16.0	0.5	0.005	0.010	0.015	1.60	1.50	1.20	0.002	0.050	1.15	1.30	70.0	0.0005	0.0005	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.37
68.3	0.9	0.5	74.9	0.5	0.452	0.041	0.054	1.60	1.50	3.33	0.002	0.248	3.09	3.14	195.6	0.0007	0.0010	0.0001	0.0019	0.0006	0.0005	0.0010	0.0016	0.37
62.0	0.5	0.5	83.1	0.5	0.005	0.020	0.055	1.60	1.50	1.70	0.002	0.130	2.92	2.75	190.0	0.0005	0.0008	0.0001	0.0001	0.0005	0.0005	0.0008	0.0010	0.37
62.00	0.50	ID	83.05	ID	0.005	ID	ID	ID	ID	ID	0.002	0.050	2.92	2.75	178.0	ID	0.0005	ID	0.0001	ID	0.0005	ID	0.0008	ID
38.0	0.8	#DIV/0!	37.3	0.0	1.320	0.047	0.047	#DIV/0!	#DIV/0!	3.27	0.000	0.324	1.76	1.75	81.9	0.0003	0.0009	0.0000	0.0059	0.0003	0.0001	0.0007	0.0014	#DIV/0!

Heavy Metals											B-TEX							
Iron (Filtered)	Lead (Total)	Lead (Filtered)	Manganese (Total)	Manganese (Filtered)	Mercury (Total)	Mercury (Filtered)	Nickel (Total)	Nickel (Filtered)	Zinc (Total)	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Total BTEX (Calculated)	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Vinyl chloride
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	0.0034	0.0034	1.900	1.900	0.0006	0.00060	0.011	0.011	0.008	0.0080	0.9500					0.3500		0.007
-	-	0.0005	-	-	-	0.00005	-	0.0005	-	0.0120	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-
-	-	0.0005	-	-	-	0.00005	-	0.0005	-	0.0040	0.0005	-	-	-	-	-	-	-
-	-	0.0005	-	-	-	0.00050	-	0.0005	-	0.0240	-	-	-	-	-	-	-	-
-	-	0.0220	-	-	-	0.00005	-	0.0030	-	0.0130	-	-	-	-	-	-	-	-
-	-	0.0005	-	-	-	0.00005	-	0.0005	-	0.0025	-	-	-	-	-	-	-	-
-	-	0.0005	-	-	-	0.00005	-	0.0020	-	0.0990	-	-	-	-	-	-	-	-
0.03	-	0.0005	-	1.040	-	0.00005	-	0.0020	-	0.0025	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	0.025
0.91	-	0.0180	-	0.326	-	-	-	0.0020	-	0.0100	-	-	-	-	-	-	-	-
0.89	-	0.0005	-	0.479	-	0.00005	-	0.0005	-	0.0090	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	0.025
0.31	-	0.2460	-	0.424	-	0.00005	-	0.0005	-	0.0080	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	0.025
4.16	-	0.0030	-	2.250	-	0.00005	-	0.0005	-	0.0100	-	-	-	-	-	-	-	-
0.35	-	0.0030	-	0.094	-	0.00005	-	0.0005	-	0.0480	-	-	-	-	-	-	-	-
2.08	-	0.1010	-	3.280	-	0.00005	-	0.0005	-	0.0025	-	-	-	-	-	-	-	-
0.13	-	0.0005	-	0.002	-	0.00005	-	0.0005	-	0.0025	-	-	-	-	-	-	-	-
-	0.0005	-	0.071	-	0.00005	-	0.0005	-	0.0070	-	-	-	-	-	-	-	-	-
-	0.0020	-	-	-	0.00005	-	-	-	-	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	0.025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0005	-	-	-	0.00030	-	0.0005	-	0.0025	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0005	-	-	-	0.00030	-	0.0005	-	0.0025	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-
4.16	0.0020	0.2460	0.071	3.280	0.00030	0.00050	0.0005	0.0030	0.0070	0.0990	0.0005	0.0010	0.0010	0.0000	0.0010	0.0010	0.0010	0.025
0.03	0.0005	0.0005	0.071	0.002	0.00005	0.00005	0.0005	0.0005	0.0025	0.0025	0.0005	0.0010	0.0010	0.0000	0.0010	0.0010	0.0010	0.025
1.11	0.0009	0.0284	0.071	0.987	0.00018	0.00008	0.0005	0.0010	0.0040	0.0176	0.0005	0.0010	0.0010	#DIV/0!	0.0010	0.0010	0.0010	0.025
0.62	0.0005	0.0005	0.071	0.452	0.00018	0.00005	0.0005	0.0005	0.0025	0.0095	0.0005	0.0010	0.0010	#NUM!	0.0010	0.0010	0.0010	0.025
0.62	ID	0.0030	ID	0.452	ID	0.00005	ID	0.00050	ID	0.0085	0.0005	0.0010	0.0010	ID	0.0010	0.0010	0.0010	ID
1.40	0.0008	0.0681	#DIV/0!	1.173	0.00014	0.00012	0.0000	0.0009	0.0026	0.0263	0.0000	0.0000	0.0000	#DIV/0!	0.0000	0.0000	0.0000	0.000

		Field Parameters						Sample Quality Parameters																							
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium	Magnesium (Filtered)	Sulphate (as SO4)	Sulphate (as SO4) (Filtered)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Hydroxide Alkalinity as OH	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Contaminant Alert Trigger Values - Surface Water		6.8-8.0									180.0	180.0																0.900	0.420			0.05
Lethe Brook fresh waters WQO*		7.5-7.8	463		40-120		1																					0.020	0.008			
Location	**Sampled Date**																															
SW5	3/12/2003	6.90	219	32.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.310	-	-	-	-	4.70
	15/06/2004	7.30	263	22.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	-	-	-	-	3.40
	23/02/2005	7.50	252	27.2	41.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2005	7.10	335	28.5	59.0	-	22.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2006	6.70	678	29.8	7.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.322	-	-	-	-
	23/04/2008	6.71	311	28.9	100.0	-	18.78	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7/09/2010	7.50	80	-	-	-	-	1.00	47.0	36.00	20.0	-	10.0	-	7.0	-	6.0	-	18.0	-	24.0	0.5	-	24.0	0.5	0.070	0.020	0.090	1.20	1.20	1.30
	27/04/2011	7.36	202	-	-	-	-	-	-	25.00	-	20.0	-	3.0	-	10.0	-	5.0	-	11.0	38.0	0.5	0.5	38.0	-	-	-	-	-	-	-
	21/09/2011	6.90	445	-	-	-	-	-	-	107.00	46.0	-	9.0	-	16.0	-	11.0	-	15.0	-	31.0	0.5	-	31.0	0.5	0.840	1.140	1.980	2.60	1.70	3.60
	24/04/2012	8.90	180	-	-	-	-	-	-	25.00	80.0	-	3.0	-	4.0	-	0.5	-	5.0	-	22.0	139.0	-	161.0	0.5	0.180	-	-	1.30	-	1.50
	14/11/2012	7.76	295	-	-	-	-	-	-	47.00	23.0	-	12.0	-	12.0	-	8.0	-	6.0	-	48.0	0.5	-	48.0	0.5	0.300	-	-	2.20	-	2.50
	2/05/2013	7.45	175	-	-	-	-	-	-	27.00	16.0	-	5.0	-	10.0	-	6.0	-	0.5	-	44.0	0.5	-	44.0	0.5	0.005	-	-	1.00	-	1.00
	13/11/2013	7.40	254	-	-	-	-	-	-	38.00	24.0	-	9.0	-	11.0	-	7.0	-	4.0	-	54.0	0.5	-	54.0	0.5	0.190	-	-	1.50	-	1.70
	31/07/2014	6.80	272	-	-	-	-	-	-	64.00	31.0	-	5.0	-	10.0	-	6.0	-	6.0	-	24.0	0.5	-	24.0	0.5	0.005	-	-	1.80	-	1.80
	7/05/2015	7.14	182	-	-	-	-	-	-	34.00	22.0	-	4.0	-	4.0	-	4.0	-	0.5	-	31.0	0.5	-	31.0	0.5	0.005	-	-	1.00	-	1.00
	17/12/2015	7.26	237	-	-	-	-	-	-	36.00	27.0	-	6.0	-	9.0	-	6.0	-	2.0	-	-	-	-	-	0.5	0.080	-	-	1.10	-	1.20
	17/05/2016	-	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/01/2017	6.75	265	-	-	-	-	10.00	154.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.080	0.085	-	-	-
	11/05/2017	8.00	140	23.0	88.0	-29	46	4.00	32.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.080	0.100	0.180	-	-	-
	30/08/2017	7.37	526	26.2	4.3	152	22.3	89.00	163.0	92.20	38.2	-	17.7	-	27.4	-	15.5	-	2.2	-	54.8	2.5	-	89.9	-	0.005	0.020	0.025	-	-	-
	16/11/2017	7.55	273	29.1	95.9	14	4.5	6.00	78.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.160	0.165	-	-	-
	14/03/2018	7.83	197	30.5	135.0	-37.5	34	12.00	65.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.010	0.015	-	-	-
	6/06/2018	7.59	339	21.5	116.5	87.2	11.1	5.00	28.0	81.40	31.7	29.0	8.9	8.5	11.7	11.0	7.0	6.5	8.6	-	20.7	2.5	-	34.0	-	0.240	0.210	0.450	-	-	-
Statistics:																															
	Maximum	8.9	678	32.5	135.0	152	46	89.00	163.0	107.00	80.0	29.0	17.7	8.5	27.4	11.0	15.5	6.5	18.0	11.0	54.8	139.0	0.5	161.0	0.5	2.310	1.140	1.980	2.60	1.70	4.70
	Minimum	6.7	80	21.5	4.3	-37.5	4.5	1.00	28.0	25.00	16.0	20.0	3.0	3.0	4.0	10.0	0.5	5.0	0.5	11.0	20.7	0.5	0.5	24.0	0.5	0.005	0.010	0.015	1.00	1.20	1.00
	Mean	7.353182	270	27.21818	71.9	37.34	22.78286	18.14	81.0	51.05	32.6	24.5	8.1	5.8	11.1	10.5	7.0	5.8	6.2	11.0	35.6	13.5	0.5	52.6	0.5	0.255	0.229	0.374	1.52	1.45	2.15
	Median	7.365	254	28.5	88.0	14	22.3	6.00	65.0	37.00	27.0	24.5	8.9	5.8	10.0	10.5	6.0	5.8	5.0	11.0	31.0	0.5	0.5	38.0	0.5	0.070	0.100	0.128	1.30	1.45	1.70
	Rolling Median	7.46	265	28.70	91.95	ID	ID	ID	ID	42.50	25.5	ID	7.5	ID	10.5	ID	6.5	ID	3.1	ID	37.5	0.5	ID	46.0	0.5	0.005	0.090	0.128	1.40	ID	1.60
	Standard Deviation	0.50689	135	3.606333	46.8	80.90073	13.85561	31.46	55.8	28.25	17.9	6.4	4.2	3.9	6.4	0.7	3.8	1.1	5.7	#DIV/0!	12.9	41.6	#DIV/0!	40.5	0.0	0.569	0.357	0.663	0.57	0.35	1.24

Notes:
Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.
"-" denotes the sample was not anaylsed for the specific analyte
* Lethe Brook fresh waters Water Quaity Objective for baseflow applies to surface water at Kelsey Creek
"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

						Heavy Metals																				B-TEX									
Cyanide (total)	Total Phosphorus (as P)	Total Anions	Total Cations	Ionic Balance (Lab)	Total Dissolved Solids @180°C (Filtered)	Arsenic (Total)	Arsenic (Filtered)	Cadmium (Total)	Cadmium (Filtered)	Chromium (Total)	Chromium (Filtered)	Copper (Total)	Copper (Filtered)	Iron (Total)	Iron (Filtered)	Lead (Total)	Lead (Filtered)	Manganese (Total)	Manganese (Filtered)	Mercury (Total)	Mercury (Filtered)	Nickel (Total)	Nickel (Filtered)	Zinc (Total)	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Total BTEX (Calculated)	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Total MAHs (Lab Reported)	Naphthalene	PAH (Sum of Common 16 PAHs - Lab Reported)
mg/L	mg/L	meq/L	meq/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	0.050				2000-5000			0.0010	0.0010			0.0014	0.0014			0.0034	0.0034	1.900	1.900	0.00060	0.00060	0.0110	0.0110	0.0080	0.0080	0.9500					0.3500			0.016	
-	0.380	-	-	-	-	-	0.0005	-	0.0002	-	0.0005	-	0.0030	-	-	-	0.0005	-	-	-	0.00005	-	0.0010	-	0.0070	-	-	-	-	-	-	-	-	-	-
-	0.390	-	-	-	-	0.0005	0.0005	0.0001	0.0005	0.0090	0.0005	0.0180	0.0010	-	-	0.0040	0.0005	-	-	0.00005	0.00005	0.0050	0.0005	0.0400	0.0080	0.0005	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	0.0005	-	0.0003	-	0.0005	-	0.0010	-	-	-	0.0005	-	-	-	0.00050	-	0.0010	-	0.0160	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-
-	-	-	-	-	-	-	0.0005	-	0.0001	-	0.0005	-	0.0020	-	-	-	0.0005	-	-	-	0.00005	-	0.0005	-	0.0060	-	-	-	-	-	-	-	-	-
-	0.570	-	-	-	-	-	0.0030	-	0.0001	-	0.0005	-	0.0010	-	-	-	0.0005	-	-	-	0.00005	-	0.0020	-	0.0060	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-
-	-	-	-	-	-	-	0.0005	-	0.0001	-	0.0005	-	0.0050	-	-	-	0.0050	-	-	-	0.00010	-	0.0005	-	0.0420	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-
0.002	0.290	1.86	1.97	-	51.2	-	0.0005	-	0.0032	-	0.0005	-	0.0020	-	0.57	-	0.0005	-	0.772	-	0.00005	-	0.0005	-	0.0050	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-
0.002	-	1.71	1.84	-	152.0	-	0.0005	-	0.0002	-	0.0005	-	0.0020	-	0.14	-	0.0130	-	0.030	-	-	-	0.0010	-	0.0060	-	-	-	-	-	-	-	-	-
0.002	0.340	3.95	3.93	-	285.0	-	0.0005	-	0.0001	-	0.0005	-	0.0030	-	0.11	-	0.0005	-	1.640	-	0.00005	-	0.0010	-	0.0090	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.200	4.03	3.76	-	115.0	-	0.0010	-	0.0001	-	0.0005	-	0.0020	-	0.37	-	0.0500	-	0.049	-	0.00005	-	0.0010	-	0.0060	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.360	2.41	2.56	-	204.0	-	0.0005	-	0.0001	-	0.0005	-	0.0020	-	1.41	-	0.0005	-	0.455	-	0.00005	-	0.0005	-	0.0200	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-
0.002	0.250	1.64	1.82	-	126.0	-	0.0020	-	0.0001	-	0.0005	-	0.0040	-	1.03	-	-	-	0.561	-	0.00005	-	0.0010	-	0.0140	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-
0.002	0.180	2.23	2.40	-	184.0	-	0.0020	-	0.0001	-	0.0020	-	0.0040	-	2.92	-	0.0020	-	1.100	-	0.00005	-	0.0010	-	0.0120	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-
0.002	0.290	2.41	2.47	-	293.0	-	0.0010	-	0.0001	-	0.0020	-	0.0080	-	5.21	-	0.0030	-	0.306	-	0.00005	-	0.0020	-	0.0090	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-
0.002	0.200	1.58	1.59	-	124.0	-	0.0005	-	0.0001	-	0.0005	-	0.0020	-	1.02	-	0.0080	-	0.008	-	0.00005	-	0.0005	-	0.0025	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-
0.002	0.350	2.22	2.27	-	157.0	0.0010	-	0.0001	-	0.0005	-	0.0020	-	1.06	-	0.0010	-	0.273	-	0.00005	-	0.0005	-	0.0060	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-
-	-	-	-	-	54.0	0.0005	-	0.0001	-	0.0005	-	0.0020	-	-	-	0.0005	-	-	-	0.00005	-	-	-	-	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-
-	1.200	-	-	-	170.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.230	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.750	-	-	-	341.0	0.0030	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00030	-	0.0020	-	0.0070	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-
-	0.200	-	-	-	177.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.590	-	-	-	110.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	-	219.0	0.0005	-	0.0002	-	0.0005	-	0.0020	-	-	-	0.0005	-	-	-	0.00030	-	0.0010	-	0.0025	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-
0.002	1.200	4.03	3.93	0.00	341.0	0.0030	0.0030	0.0002	0.0032	0.0090	0.0020	0.0180	0.0080	1.06	5.21	0.0040	0.0500	0.273	1.640	0.00030	0.00050	0.0050	0.0020	0.0400	0.0420	0.0005	0.0010	0.0010	0.0000	0.0010	0.0010	0.0010	0.0000	0.0025	0.00000
0.002	0.050	1.58	1.59	0.00	51.2	0.0005	0.0005	0.0001	0.0001	0.0005	0.0005	0.0005	0.0010	1.06	0.11	0.0005	0.0005	0.273	0.008	0.00005	0.00005	0.0005	0.0005	0.0025	0.0025	0.0005	0.0010	0.0010	0.0000	0.0010	0.0010	0.0010	0.0000	0.0025	0.00000
0.002	0.379	2.40	2.46	#DIV/0!	172.6	0.0011	0.0009	0.0001	0.0003	0.0022	0.0007	0.0049	0.0028	1.06	1.42	0.0013	0.0061	0.273	0.547	0.00015	0.00009	0.0021	0.0009	0.0139	0.0112	0.0005	0.0010	0.0010	#DIV/0!	0.0010	0.0010	0.0010	#DIV/0!	0.0025	#DIV/0!
0.002	0.315	2.23	2.34	#NUM!	163.5	0.0005	0.0005	0.0001	0.0001	0.0005	0.0005	0.0020	0.0020	1.06	1.02	0.0005	0.0005	0.273	0.455	0.00005	0.00005	0.0015	0.0010	0.0065	0.0080	0.0005	0.0010	0.0010	#NUM!	0.0010	0.0010	0.0010	#NUM!	0.0025	#NUM!
0.002	0.290	2.32	2.44	ID	163.5	ID	0.0008	ID	0.0001	ID	0.0005	ID	0.0025	ID	1.03	ID	0.0030	ID	0.3805	ID	0.00005	ID	0.0010	ID	0.0090	0.0005	0.0010	0.0010	ID	0.0010	0.0010	0.0010	ID	0.0025	ID
0.000	0.265	0.89	0.80	#DIV/0!	81.7	0.0011	0.0008	0.0001	0.0008	0.0038	0.0005	0.0074	0.0019	#DIV/0!	1.66	0.0015	0.0132	#DIV/0!	0.550	0.00014	0.00012	0.0020	0.0005	0.0175	0.0097	0.0000	0.0000	0.0000	#DIV/0!	0.0000	0.0000	0.0000	#DIV/0!	4.57E-19	#DIV/0!

Total Petroleum Hydrocarbons												Volatile Organic Compounds		
TRH C10 - C36 (Sum, Lab Reported) SG Cleanup	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Calculated)	TRH C6 - C10 Fraction F1	TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4	Carbon tetrachloride	Chloroethane	Vinyl chloride
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.010	0.025	0.100	0.025	-	-	-	-	-	-	-	-	-	-
-	0.010	0.025	0.100	0.090	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.010	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	-	-	-	-	-	-	-	0.01	0.05	0.05	0.05	-	-	-
-	0.010	0.025	0.050	0.025	-	0.05	-	-	0.05	0.05	0.05	-	-	-
-	0.010	0.025	0.110	0.025	-	0.12	-	0.01	0.05	0.12	0.05	-	-	-
-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.010	0.060	0.150	0.090	-	0.30	-	0.01	0.05	0.20	0.05	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.025	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-

0.025	0.010	0.060	0.150	0.090	0.000	0.30	0.00	0.01	0.05	0.20	0.05	0.0025	0.025	0.025
0.025	0.010	0.025	0.050	0.025	0.000	0.05	0.00	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.025	0.010	0.028	0.070	0.035	#DIV/0!	0.08	#DIV/0!	0.01	0.05	0.07	0.05	0.0025	0.025	0.025
0.025	0.010	0.025	0.050	0.025	#NUM!	0.05	#NUM!	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
ID	0.010	0.025	0.050	0.025	ID	0.05	ID	0.01	0.05	0.05	0.05	ID	ID	ID
#DIV/0!	0.000	0.010	0.033	0.024	#DIV/0!	0.08	#DIV/0!	0.00	0.00	0.05	0.00	0.0000	0.000	0.000

Appendix I Kelsey Creek Analytical Results

		Field Parameters						Sample Quality Parameters																	
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium	Magnesium (Filtered)	Sulphate (as SO4)	Sulphate (as SO4) (Filtered)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Hydroxide Alkalinity as OH
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Contaminant Alert Trigger Values - Surface Water		6.8-8.0									180.0	180.0													
Lethe Brook fresh waters WQO*		7.5-7.8	463		40-120		1																		
Location	**Sampled Date**																								
SW6	3/12/2003	7.00	467	28.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15/06/2004	6.80	340	21.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/02/2005	7.40	134	29.5	67.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2005	6.50	740	28.2	62.0	-	35.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2006	7.40	366	28.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/04/2008	7.54	378	23.9	78.0	-	3.75	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7/09/2010	6.10	580	-	-	-	-	1.00	75.0	213.00	80.0	-	10.0	-	28.0	-	18.0	-	10.0	-	24.0	0.5	-	24.0	0.5
	27/04/2011	7.25	334	-	-	-	-	-	-	57.00	-	24.0	-	4.0	-	17.0	-	11.0	-	1.0	63.0	0.5	0.5	63.0	-
	21/09/2011	-	-	-	-	-	-	-	-	111.00	32.0	-	39.0	-	10.0	-	8.0	-	2.0	-	25.0	0.5	-	25.0	0.5
	24/04/2012	7.20	134	-	-	-	-	-	-	24.00	17.0	-	2.0	-	8.0	-	5.0	-	0.5	-	33.0	0.5	-	33.0	0.5
	14/11/2012	7.41	547	-	-	-	-	-	-	151.00	67.0	-	6.0	-	17.0	-	11.0	-	3.0	-	28.0	0.5	-	28.0	0.5
	1/05/2013	7.09	195	-	-	-	-	-	-	34.00	19.0	-	2.0	-	9.0	-	6.0	-	0.5	-	33.0	0.5	-	33.0	0.5
	14/11/2013	7.49	597	-	-	-	-	-	-	155.00	67.0	-	8.0	-	22.0	-	13.0	-	2.0	-	52.0	0.5	-	52.0	0.5
	31/07/2014	6.87	280	-	-	-	-	-	-	64.00	33.0	-	5.0	-	9.0	-	7.0	-	4.0	-	30.0	0.5	-	30.0	0.5
	7/05/2015	7.08	308	-	-	-	-	-	-	71.00	36.0	-	5.0	-	10.0	-	7.0	-	0.5	-	40.0	0.5	-	40.0	0.5
	18/12/2015	7.20	389	-	-	-	-	-	-	87.00	43.0	-	8.0	-	15.0	-	9.0	-	4.0	-	-	-	-	-	0.5
	18/05/2016	-	190	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/01/2017	6.90	390	-	-	-	-	2.00	127.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	11/05/2017	7.53	540	23.0	102.0	34	2.7	5.00	45.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	16/11/2017	7.22	860	28.0	56.6	16.1	1	7.00	108.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/03/2018	7.55	475	26.4	91.0	-15.8	0	2.00	23.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6/06/2018	7.52	427	19.7	100.6	182	0.8	6.00	36.0	100.00	42.9	38.5	4.1	3.8	17.3	15.7	12.9	11.7	2.1	-	41.6	2.5	-	68.1	-
Statistics:																									
	Maximum	7.55	860	29.5	102.0	182	35.4	7.00	127.0	213.00	80.0	38.5	39.0	4.0	28.0	17.0	18.0	11.7	10.0	1.0	63.0	2.5	0.5	68.1	0.5
	Minimum	6.1	134	19.7	56.6	-15.8	0	1.00	23.0	24.00	17.0	24.0	2.0	3.8	8.0	15.7	5.0	11.0	0.5	1.0	24.0	0.5	0.5	24.0	0.5
	Mean	7.1525	413	25.67	79.6	54.075	7.275	3.83	69.0	97.00	43.7	31.3	8.9	3.9	14.5	16.4	9.7	11.4	2.9	1.0	37.0	0.7	0.5	39.6	0.5
	Median	7.21	389	27.2	78.0	25.05	1.85	3.50	60.0	87.00	39.5	31.3	5.5	3.9	12.5	16.4	8.5	11.4	2.1	1.0	33.0	0.5	0.5	33.0	0.5
	Rolling Median	7.21	409	27.20	ID	ID	ID	ID	ID	79.00	39.45	ID	5.0	ID	12.5	ID	8.0	ID	2.1	ID	33.0	0.5	ID	33.0	0.5
	Standard Deviation	0.379804	188	3.490957	18.6	87.73526	13.84629	2.48	41.7	57.19	21.2	10.3	10.9	0.1	6.6	0.9	4.0	0.5	2.8	#DIV/0!	12.5	0.6	#DIV/0!	15.9	0.0

Notes:

Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.

"-" denotes the sample was not anaylsed for the specific analyte

* Lethe Brook fresh waters Water Quaity Objective for baseflow applies to surface water at Kelsey Creek

"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

Appendix I Kelsey Creek Analytical Results

GOLDER

											Heavy Metals																	
Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)	Cyanide (total)	Total Phosphorus (as P)	Total Anions	Total Cations	Total Dissolved Solids @180°C (Filtered)	Arsenic (Total)	Arsenic (Filtered)	Cadmium (Total)	Cadmium (Filtered)	Chromium (Total)	Chromium (Filtered)	Copper (Total)	Copper (Filtered)	Iron (Total)	Iron (Filtered)	Lead (Total)	Lead (Filtered)	Manganese (Total)	Manganese (Filtered)	Mercury (Total)	Mercury (Filtered)	Nickel (Total)	Nickel (Filtered)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.700	0.900	0.420			0.05		0.050			2000-5000	0.013	0.0130	0.0002	0.0002	0.001	0.001	0.0014	0.0014			0.0034	0.0034	1.900	1.900	0.0006	0.00060	0.011	0.011
	0.020	0.008																										
0.050	-	-	-	-	1.80	-	0.320	-	-	-	-	0.0005	-	0.0042	-	0.0005	-	0.0030	-	-	-	0.0005	-	-	-	0.00005	-	0.0005
0.005	-	-	-	-	0.80	-	0.070	-	-	-	-	0.0005	-	0.0005	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00005	-	0.0005
-	-	-	-	-	-	-	-	-	-	-	-	0.0020	-	0.0001	-	0.0005	-	0.0010	-	-	-	0.0005	-	-	-	0.00050	-	0.0010
-	-	-	-	-	-	-	-	-	-	-	-	0.0005	-	0.0001	-	0.0040	-	0.0010	-	-	-	0.0005	-	-	-	0.00005	-	0.0005
-	-	-	-	-	-	-	-	-	-	-	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00005	-	0.0005
-	-	-	-	-	-	-	-	-	-	-	-	0.0005	-	0.0003	-	0.0005	-	0.0230	-	-	-	0.0100	-	-	-	0.00005	-	0.0070
0.020	0.020	0.040	1.00	0.90	1.00	0.002	0.130	6.70	6.62	371.0	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	0.08	-	0.0005	-	0.392	-	0.00005	-	0.0005
0.100	1.400	1.500	3.10	1.70	3.20	0.002	0.170	2.91	2.93	225.0	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	1.19	-	0.0010	-	3.100	-	0.00005	-	0.0005
-	-	-	-	-	-	0.002	-	3.67	3.55	-	-	-	-	-	-	-	-	-	-	0.10	-	-	-	0.158	-	-	-	-
-	-	-	-	-	-	0.002	-	1.34	1.60	85.7	-	-	-	-	-	0.0005	-	-	-	0.36	-	-	-	0.042	-	0.00005	-	0.0005
-	-	-	-	-	-	0.002	-	4.88	4.82	346.0	-	-	-	-	-	-	-	-	-	0.40	-	-	-	0.351	-	-	-	-
-	-	-	-	-	-	0.002	-	1.62	1.82	125.0	-	-	-	-	-	-	-	-	-	0.26	-	-	-	0.187	-	-	-	-
-	-	-	-	-	-	0.002	-	5.45	5.29	378.0	-	-	-	-	-	-	-	-	-	0.65	-	-	-	0.284	-	-	-	-
-	-	-	-	-	-	0.002	-	2.49	2.59	170.0	-	-	-	-	-	-	-	-	-	0.24	-	-	-	0.184	-	-	-	-
-	-	-	-	-	-	0.002	-	2.80	2.77	186.0	-	-	-	-	-	-	-	-	-	0.14	-	-	-	0.002	-	-	-	-
-	-	-	-	-	-	0.002	-	3.72	3.56	261.0	-	-	-	-	-	-	-	-	-	1.14	-	-	-	0.645	-	-	-	-
-	-	-	-	-	-	-	-	-	-	122.0	0.0005	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00005	-	-	-
0.005	0.097	0.102	-	-	-	-	1.200	-	-	250.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.005	0.130	0.135	-	-	-	-	0.050	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.005	0.170	0.175	-	-	-	-	0.140	-	-	558.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.005	0.010	0.015	-	-	-	-	0.180	-	-	283.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.005	0.010	0.015	-	-	-	-	0.100	-	-	286.0	0.0005	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00030	-	0.0005	-
0.100	1.400	1.500	3.10	1.70	3.20	0.002	1.200	6.70	6.62	558.0	0.0005	0.0020	0.0001	0.0042	0.0005	0.0040	0.0005	0.0230	0.00	1.19	0.0005	0.0100	0.000	3.100	0.00030	0.00050	0.0005	0.0070
0.005	0.010	0.015	1.00	0.90	0.80	0.002	0.050	1.34	1.60	85.7	0.0005	0.0005	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.00	0.08	0.0005	0.0005	0.000	0.002	0.00005	0.00005	0.0005	0.0005
0.022	0.262	0.283	2.05	1.30	1.70	0.002	0.262	3.56	3.56	260.5	0.0005	0.0007	0.0001	0.0007	0.0005	0.0009	0.0005	0.0038	#DIV/0!	0.46	0.0005	0.0018	#DIV/0!	0.535	0.00018	0.00010	0.0005	0.0013
0.005	0.097	0.102	2.05	1.30	1.40	0.002	0.140	3.29	3.24	255.5	0.0005	0.0005	0.0001	0.0001	0.0005	0.0005	0.0005	0.0008	#NUM!	0.31	0.0005	0.0005	#NUM!	0.236	0.00018	0.00005	0.0005	0.0005
0.005	0.097	ID	ID	ID	ID	0.002	0.135	3.24	3.16	255.5	ID	0.0005	ID	0.0001	ID	0.0005	ID	0.0008	#NUM!	0.31	ID	0.0005	#NUM!	0.186	ID	0.00005	ID	0.0005
0.033	0.506	0.540	1.48	0.57	1.09	0.000	0.360	1.70	1.59	125.9	0.0000	0.0005	0.0000	0.0014	0.0000	0.0012	0.0000	0.0078	#DIV/0!	0.41	0.0000	0.0033	#DIV/0!	0.920	0.00018	0.00015	#DIV/0!	0.0022

Appendix I Kelsey Creek Analytical Results

GOLDER

		B-TEX									Total Petroleum Hydrocarbons													Volatile Organic Compounds		
Zinc (Total)	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Total BTEX (Calculated)	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Total MAHs (Lab Reported)	Naphthalene	TRH C10 - C36 (Sum, Lab Reported) SG Cleanup	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Calculated)	TRH C6 - C10 Fraction F1	TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4	Carbon tetrachloride	Chloroethane	Vinyl chloride
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.008	0.0080	0.9500					0.3500			0.016															
-	0.0120	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0030	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0700	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0025	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-
-	0.0820	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-
-	0.0060	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.0080	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	-	0.0055	0.0025	-	0.010	0.025	0.050	0.025	0.025	-	0.05	-	-	-	-	-	-	-
-	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0025	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	0.025	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-
0.0025	0.0820	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	0.025	0.010	0.025	0.050	0.025	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0025	0.0025	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	0.025	0.010	0.025	0.050	0.025	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0025	0.0242	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	0.025	0.010	0.025	0.050	0.025	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0025	0.0090	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	0.025	0.010	0.025	0.050	0.025	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
ID	0.0090	0.0005	0.0010	0.0010	ID	0.0010	0.0010	0.0010	ID	ID	ID	0.010	0.025	0.050	0.025	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
#DIV/0!	0.0323	0.0000	0.0000	0.0000	#DIV/0!	0.0000	0.0000	0.0000	#DIV/0!	0	#DIV/0!	0.000	0.000	0.000	0.000	#DIV/0!	0.00	#DIV/0!	0.00	0.00	0.00	0.00	0.0000	0.000	0.000

		Field Parameters						Sample Quality Parameters															
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium	Magnesium (Filtered)	Sulphate (as SO4)	Sulphate (as SO4) (Filtered)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ANZECC 95% Toxicants - Freshwater lowland																							
Contaminant Alert Trigger Values - Groundwater		7.5-7.8	463								180	180											
Location	**Sampled Date**																						
MW1	3/12/2003	6.00	11,020	27.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15/06/2004	6.00	11,400	25.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/02/2005	6.10	10,800	26.9	-	-	-	-	-	-	-	-	-	-	105.0	-	151.0	-	-	-	-	-	-
	13/12/2005	5.90	11,400	29.2	-	-	6.84	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2006	5.90	12,400	28.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/04/2008	5.60	10,300	30.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7/09/2010	5.80	8,600	-	-	-	-	1.00	322.0	3060	1760	-	2.0	-	81.0	-	112.0	-	106	-	194.0	0.5	-
	21/09/2011	5.90	7,820	-	-	-	-	-	-	2860	1620	-	2.0	-	70.0	-	99.0	-	102	-	212.0	0.5	-
	24/04/2012	6.25	5,160	-	-	-	-	-	-	2390	1200	-	1.0	-	48.0	-	65.0	-	91	-	247.0	0.5	-
	14/11/2012	6.53	6,210	-	-	-	-	-	-	1910	1260	-	0.5	-	40.0	-	55.0	-	67	-	273.0	0.5	-
	2/05/2013	6.45	6,010	-	-	-	-	-	-	1690	1180	-	1.0	-	41.0	-	57.0	-	67	-	281.0	0.5	-
	13/11/2013	6.93	5,050	-	-	-	-	-	-	1570	1080	-	0.5	-	36.0	-	47.0	-	74	-	308.0	0.5	-
	31/07/2014	7.83	4,450	-	-	-	-	-	-	1170	909	-	1.0	-	23.0	-	31.0	-	37	-	354.0	0.5	-
	6/05/2015	6.55	4,520	-	-	-	-	-	-	1150	909	-	0.5	-	25.0	-	30.0	-	27	-	442.0	0.5	-
	17/12/2015	6.36	4,530	-	-	-	-	-	-	1350	1080	-	0.5	-	27.0	-	37.0	-	40	-	-	-	-
	18/05/2016	-	4,980	-	-	-	-	1.00	114.0	1120	863	-	3.0	-	21.0	-	26.0	-	30	-	401.0	0.5	-
	13/01/2017	5.90	4,640	-	-	-	-	0.50	166.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/07/2017	5.98	4,513	26.6	29.4	-21.2	17.6	2.00	204.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15/03/2018	6.16	4,962	27.0	37.7	13.9	11.2	7.00	137.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7/06/2018	5.93	4,276	26.3	29.6	65.6	65	3.00	125.0	962	783	687	0.6	0.4	19.6	17.8	25.3	22.1	18	-	319.0	2.5	-
Statistics:																							
	Maximum	7.83	12400	30.3	37.7	65.6	65	7.00	322.0	3060	1760	687	3.0	0.4	105.0	17.8	151.0	22.1	106	0.0	442.0	2.5	0.0
	Minimum	5.6	4276	25.9	29.4	-21.2	6.84	0.50	114.0	962	783	687	0.5	0.4	19.6	17.8	25.3	22.1	18	0.0	194.0	0.5	0.0
	Mean	6.214211	7152.05	27.48889	32.2	19.43333	25.16	2.42	178.0	1748	1149	687	1.1	0.4	44.7	17.8	61.3	22.1	60	#DIV/0!	303.1	0.7	#DIV/0!
	Median	6	5585	27	29.6	13.9	14.4	1.50	151.5	1570	1080	687	1.0	0.4	38.0	17.8	51.0	22.1	67	#NUM!	294.5	0.5	#NUM!
	Rolling Median	6.26	4525	27.0	ID	ID	ID	ID	ID	1260	995	ID	0.6	ID	26.0	ID	34.0	ID	39	ID	313.5	0.5	ID
	Standard Deviation	0.505572	2965.55	1.452966	4.7	43.66375	26.9251	2.42	77.6	728	308	#DIV/0!	0.8	#DIV/0!	27.1	#DIV/0!	39.7	#DIV/0!	31	#DIV/0!	79.2	0.6	#DIV/0!

Notes:

Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.

"-" denotes the sample was not anaylsed for the specific analyte

"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

													Heavy Metals													
Total Alkalinity (as CaCO3)	Hydroxide Alkalinity as OH	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)	Cyanide (total)	Total Phosphorus (as P)	Total Anions	Total Cations	Total Dissolved Solids @180°C (Filtered)	Arsenic (Total)	Arsenic (Filtered)	Cadmium (Total)	Cadmium (Filtered)	Chromium (Total)	Chromium (Filtered)	Copper (Total)	Copper (Filtered)	Iron (Total)	Lead (Total)	Lead (Filtered)	Manganese (Total)	Mercury (Total)	Mercury (Filtered')
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
		0.700	0.900										0.0130	0.0130	0.0002	0.0002	0.0010	0.0010	0.0014	0.0014		0.0034	0.0034	1.900	0.00060	0.00060
			0.0202	0.064			0.50		0.500			2000-5000														
-	-	0.040	-	-	-	-	0.05	-	0.040	-	-	-	-	0.0200	-	0.0006	-	0.0005	-	0.0050	-	-	0.0005	-	-	0.00005
-	-	0.005	-	-	-	-	0.60	-	0.020	-	-	-	0.0005	0.0005	0.0001	0.0001	0.0080	0.0020	0.0160	0.0120	-	0.0260	0.0120	0.00005	-	0.00005
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0010	-	0.0007	-	0.0010	-	0.0080	-	-	0.0005	-	-	0.00005
-	-	0.122	-	-	-	-	0.20	-	0.005	-	-	-	-	0.0005	-	0.0001	-	0.0020	-	0.0030	-	-	0.0030	-	-	0.00005
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0020	-	0.0001	-	0.0005	-	0.0030	-	-	0.0005	-	-	0.00005
-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.0005	-	0.0002	-	0.0010	-	0.0030	-	-	0.0020	-	-	0.00005
194	0.5	0.060	0.060	0.120	0.60	0.50	0.70	0.002	0.050	92.40	89.80	5500	-	0.0010	-	0.0006	-	0.0070	-	0.0020	-	0.26	0.0005	0.445	-	0.00005
212	0.5	-	-	-	-	-	-	0.002	-	87.00	82.20	5000	-	0.0005	-	0.0001	-	0.0005	-	0.0010	-	0.53	0.0005	0.346	-	0.00005
247	0.5	-	-	-	-	-	-	0.002	-	74.20	64.40	3300	-	0.0005	-	0.0007	-	0.0005	-	0.0070	-	1.72	0.0260	0.211	-	0.00005
273	0.5	-	-	-	-	-	-	0.002	-	60.70	61.30	3760	-	0.0030	-	0.0001	-	0.0005	-	0.0050	-	0.82	0.0290	0.242	-	0.00005
281	0.5	-	-	-	-	-	-	0.002	-	54.70	58.10	3690	-	0.0020	-	0.0001	-	0.0005	-	0.0040	-	0.73	0.0005	0.240	-	0.00005
308	0.5	-	-	-	-	-	-	0.002	-	52.00	52.60	3230	-	0.0020	-	0.0001	-	0.0005	-	0.0030	-	0.58	0.0005	0.222	-	0.00005
354	0.5	-	-	-	-	-	-	0.002	-	40.80	43.30	2410	-	0.0060	-	0.0001	-	0.0005	-	0.0020	-	0.89	0.1600	0.204	-	0.00005
442	0.5	-	-	-	-	-	-	0.002	-	41.80	43.20	2490	-	0.0110	-	0.0001	-	0.0005	-	0.0005	-	9.69	0.0005	0.330	-	0.00005
-	0.5	-	-	-	-	-	-	0.002	-	47.60	51.40	2680	-	0.0005	-	0.0001	-	0.0005	-	0.0020	-	0.03	0.0005	0.001	-	0.00005
401	0.5	0.005	0.120	0.125	-	-	-	-	0.110	40.20	40.80	3190	0.0080	-	0.0001	-	0.0010	-	0.0005	-	-	0.0005	-	0.00005	-	-
-	-	0.010	0.900	0.910	-	-	-	-	0.050	-	-	2970	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	0.180	0.290	0.470	-	-	-	-	0.050	-	-	2933	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	0.190	0.010	0.200	-	-	-	-	0.150	-	-	2927	-	-	-	-	-	-	-	-	-	-	-	-	-	-
523	-	0.005	0.350	0.355	-	-	-	-	0.130	-	-	2548	0.0130	0.0040	0.0001	0.0001	0.0005	0.0003	0.0180	0.0110	-	0.0060	0.0005	0.00030	0.00030	0.00030
523	0.5	0.190	0.900	0.910	0.60	0.50	0.70	0.002	0.150	92.40	89.80	5500	0.0130	0.0200	0.0001	0.0007	0.0080	0.0070	0.0180	0.0120	0.00	9.6900	0.1600	0.445	0.00030	0.00030
194	0.5	0.005	0.010	0.120	0.60	0.50	0.05	0.002	0.005	40.20	40.80	2410	0.0005	0.0005	0.0001	0.0001	0.0005	0.0003	0.0005	0.0005	0.00	0.0005	0.0005	0.000	0.00030	0.00005
324	0.5	0.069	0.288	0.363	0.60	0.50	0.39	0.002	0.067	59.14	58.71	3331	0.0072	0.0034	0.0001	0.0002	0.0032	0.0011	0.0115	0.0045	#DIV/0!	1.2731	0.0148	0.187	0.00030	0.00007
295	0.5	0.040	0.205	0.278	0.60	0.50	0.40	0.002	0.050	53.35	55.35	3080	0.0080	0.0015	0.0001	0.0001	0.0010	0.0005	0.0160	0.0030	#NUM!	0.5550	0.0005	0.217	0.00030	0.00005
331	0.5	0.035	ID	ID	ID	ID	ID	0.002	0.050	49.80	52.00	2804	ID	0.0025	ID	0.0001	ID	0.0005	ID	0.0035	ID	0.7300	0.0005	0.2130	ID	0.00005
106	0.0	0.076	0.327	0.301	#DIV/0!	#DIV/0!	0.31	0.000	0.050	19.18	16.49	915	0.0063	0.0052	0.0000	0.0003	0.0042	0.0016	0.0096	0.0034	#DIV/0!	2.6983	0.0398	0.154	#DIV/0!	0.00006

				B-TEX							Total Petroleum Hydrocarbons										Volatile Organic Compounds		
Nickel (Total)	Nickel (Filtered)	Zinc (Total)	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Naphthalene	TRH C10 - C36 (Sum, Lab Reported)	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C40 (Sum of total) (Lab Reported)	TRH C6 - C10 Fraction F1	TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4	Carbon tetrachloride	Chloroethane	Vinyl chloride
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.0110	0.0110	0.0080	0.0080	0.9500				0.3500		0.016											0.0065	0.0065	0.0065
-	0.0020	-	0.0780	0.0005	0.0010	0.0010	0.0010	0.0010	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-
0.0050	0.0010	0.2880	0.2200	0.0005	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-
-	0.0050	-	0.0930	0.0005	0.0010	0.0010	0.0010	0.0010	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-
-	0.0020	-	0.0510	0.0005	0.0010	0.0010	0.0010	0.0010	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-
-	0.0005	-	0.0025	0.0005	0.0010	0.0010	0.0010	0.0010	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-
-	0.0020	-	0.0210	0.0005	0.0010	0.0010	0.0010	0.0010	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-
-	0.0020	-	0.0260	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	-	-	0.010	0.025	0.050	0.025	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.0020	-	0.0170	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	-	-	0.010	0.025	0.050	0.025	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.0040	-	0.1530	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	-	-	0.010	0.025	0.050	0.025	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.0070	-	0.0420	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	-	0.010	0.025	0.050	0.025	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.0040	-	0.0300	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	-	0.010	0.060	0.170	0.025	0.16	0.01	0.05	0.16	0.05	0.0025	0.025	0.025
-	0.0060	-	0.0130	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	-	0.010	0.060	0.570	0.100	0.72	0.01	0.13	0.59	0.05	0.0025	0.025	0.025
-	0.0100	-	0.0390	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	-	-	-	-	-	-	0.01	0.24	1.05	0.17	0.0025	0.025	0.025
-	0.0140	-	0.0060	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	-	0.010	0.230	1.830	0.370	2.51	0.01	0.41	1.95	0.15	0.0025	0.025	0.025
-	0.0005	-	0.0025	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0005	-	0.010	0.230	1.560	0.500	2.46	0.01	0.39	1.73	0.34	0.0025	0.025	0.025
0.0140	-	0.0390	-	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	-	0.010	0.190	0.850	0.100	1.12	0.01	0.34	0.78	0.05	0.0025	0.025	0.025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0200	0.0170	0.0980	0.0720	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	0.320	0.010	0.070	0.250	0.025	-	-	-	-	-	-	-	-
0.0200	0.0170	0.2880	0.2200	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	0.320	0.010	0.230	1.830	0.500	2.51	0.01	0.41	1.95	0.34	0.0025	0.025	0.025
0.0050	0.0005	0.0390	0.0025	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0005	0.320	0.010	0.025	0.050	0.025	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0130	0.0049	0.1417	0.0541	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.00225	0.320	0.010	0.068	0.358	0.086	0.80	0.01	0.18	0.65	0.10	0.0025	0.025	0.025
0.0140	0.0030	0.0980	0.0345	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	0.320	0.010	0.025	0.050	0.025	0.16	0.01	0.09	0.38	0.05	0.0025	0.025	0.025
ID	0.0065	ID	0.0345	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	ID	0.010	0.065	0.410	0.063	0.44	0.01	0.19	0.69	0.05	0.0025	0.025	0.025
0.0075	0.0049	0.1301	0.0596	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.000707	#DIV/0!	0.000	0.076	0.571	0.141	1.03	0.00	0.15	0.72	0.10	0.0000	0.000	0.000

		Field Parameters						Sample Quality Parameters																							
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium	Magnesium (Filtered)	Sulphate (as SO4)	Sulphate (as SO4) (Filtered)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Hydroxide Alkalinity as OH	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ANZECC 95% Toxicants - Freshwater lowland																										0.700	0.900				
Contaminant Alert Trigger Values - Groundwater		7.5-7.8	463								180	180															0.0202	0.064			0.50
Location	**Sampled Date**																														
MW2D	3/12/2003	6.90	3200	26.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.120	-	-	-	-	0.2
	15/06/2004	6.50	3900	25.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.060	-	-	-	-	0.6
	23/02/2005	6.40	3800	26.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2005	6.20	4400	27.5	-	-	87.8	-	-	-	-	-	-	-	29.0	-	43.0	-	-	-	-	-	-	-	-	0.102	-	-	-	-	0.3
	13/12/2006	5.90	7700	27.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/04/2008	6.17	4200	27.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7/09/2010	5.90	6600	-	-	-	-	1.0	188	2,360	1,280	-	0.5	-	45.0	-	76.0	-	110.0	-	104	0.5	-	104	0.5	0.260	0.005	0.265	0.2	0.2	0.5
	27/04/2011	6.77	8280	-	-	-	-	-	-	2,870	-	1,650	-	2.0	-	67.0	-	94.0	-	94.0	232	0.5	0.5	232	-	-	-	-	-	-	-
	21/09/2011	5.80	5930	-	-	-	-	-	-	1,720	1,140	-	0.5	-	36.0	-	60.0	-	104.0	-	119	0.5	-	119	0.5	-	-	-	-	-	-
	24/04/2012	6.10	6170	-	-	-	-	-	-	1,860	1,100	-	0.5	-	37.0	-	60.0	-	102.0	-	120	0.5	-	120	0.5	-	-	-	-	-	-
	14/11/2012	6.71	6110	-	-	-	-	-	-	1,980	1,230	-	0.5	-	36.0	-	59.0	-	103.0	-	130	0.5	-	130	0.5	-	-	-	-	-	-
	1/05/2013	6.48	5760	-	-	-	-	-	-	1,800	1,120	-	0.5	-	38.0	-	62.0	-	101.0	-	144	0.5	-	144	0.5	-	-	-	-	-	-
	13/11/2013	7.00	5030	-	-	-	-	-	-	1,580	1,060	-	0.5	-	33.0	-	55.0	-	149.0	-	182	0.5	-	182	0.5	-	-	-	-	-	-
	31/07/2014	7.84	4830	-	-	-	-	-	-	1,310	928	-	0.5	-	27.0	-	44.0	-	100.0	-	184	0.5	-	184	0.5	-	-	-	-	-	-
	6/05/2015	6.91	5360	-	-	-	-	-	-	1,420	1,010	-	0.5	-	35.0	-	50.0	-	80.0	-	228	0.5	-	228	0.5	-	-	-	-	-	-
	17/12/2015	6.51	5300	-	-	-	-	-	-	1,740	946	-	0.5	-	37.0	-	49.0	-	96.0	-	-	-	-	-	0.5	-	-	-	-	-	-
	18/05/2016	-	6200	-	-	-	-	1.0	25	1,470	1,050	-	0.5	-	32.0	-	50.0	-	90.0	-	218	0.5	-	218	0.5	0.020	0.005	0.025	-	-	-
	13/01/2017	6.00	5055	-	-	-	-	0.5	41	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.010	0.020	-	-	-
	14/07/2017	5.98	4770	25.5	18.4	-56.9	36.2	1.0	54	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.010	0.015	-	-	-
	31/08/2017	6.21	4760	25.4	19.4	-52.0	1.7	0.5	16	1,340	915	-	0.4	-	30.0	-	43.8	-	78.5	-	173	2.5	-	283	-	0.005	0.010	0.015	-	-	-
	17/11/2017	6.00	4880	25.5	18.0	14.0	16	0.5	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.130	0.135	-	-	-
	15/03/2018	6.22	5098	25.7	25.4	23.9	3.2	4.0	27	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.010	0.015	-	-	-
	7/06/2018	6.00	4830	25.6	28.2	232.0	3.6	1.0	42	1,190	857	748	0.3	0.4	25.6	23.2	38.0	33.3	71.7	-	186	2.5	-	304	-	0.005	0.010	0.015	-	-	-
Statistics:																															
	Maximum	7.84	8280	27.5	28.2	232.0	87.8	4.0	188	2,870	1,280	1,650	0.5	2.0	45.0	67.0	76.0	94.0	149.0	94.0	232	2.5	0.5	304	0.5	0.260	0.130	0.265	0.2	0.2	0.6
	Minimum	5.8	3200	25.3	18.0	-56.9	1.7	0.5	16	1,190	857	748	0.3	0.4	25.6	23.2	38.0	33.3	71.7	94.0	104	0.5	0.5	104	0.5	0.005	0.005	0.015	0.2	0.2	0.2
	Mean	6.386364	5311	26.1	21.9	32.2	24.75	1.2	53	1,742	1,053	1,199	0.5	1.2	33.9	45.1	53.1	63.7	98.8	94.0	168	0.8	0.5	187	0.5	0.054	0.024	0.063	0.2	0.2	0.4
	Median	6.215	5055	25.7	19.4	14.0	9.8	1.0	36	1,720	1,055	1,199	0.5	1.2	35.0	45.1	50.0	63.7	100.5	94.0	178	0.5	0.5	183	0.5	0.010	0.010	0.018	0.2	0.2	0.4
	Rolling Median	6.11	4968	25.7	ID	ID	ID	1.0	31	1,445	978	ID	0.5	ID	32.5	ID	49.5	ID	93.0	ID	183	0.5	ID	201	0.5	0.005	0.010	0.018	ID	ID	ID
	Standard Deviation	0.486431	1190	0.8	4.6	117.6	33.54399	1.2	56	464	129	638	0.1	1.1	5.2	31.0	10.3	42.9	19.8	#DIV/0!	45	0.8	#DIV/0!	67	0.0	0.080	0.043	0.091	#DIV/0!	#DIV/0!	0.2

Notes:

Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.

"-" denotes the sample was not anaylsed for the specific analyte

"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

						Heavy Metals																				B-TEX								
Cyanide (total)	Total Phosphorus (as P)	Total Anions	Total Cations	Ionic Balance (Lab)	Total Dissolved Solids @180°C (Filtered)	Arsenic (Total)	Arsenic (Filtered)	Cadmium (Total)	Cadmium (Filtered)	Chromium (Total)	Chromium (Filtered)	Copper (Total)	Copper (Filtered)	Iron (Total)	Iron (Filtered)	Lead (Total)	Lead (Filtered)	Manganese (Total)	Manganese (Filtered)	Mercury (Total)	Mercury (Filtered)	Nickel (Total)	Nickel (Filtered)	Zinc (Total)	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Total BTEX (Calculated)	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Total MAHs (Lab Reported)	Acenaphthene
mg/L	mg/L	meq/L	meq/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
						0.0130	0.0130	0.0002	0.0002	0.001	0.001	0.0014	0.0014			0.0034	0.0034	1.900	1.900	0.00060	0.00060	0.0110	0.0110	0.0080	0.0080	0.9500					0.3500			
	0.500				2000-5000																													
-	0.020	-	-	-	-	-	0.0005	-	0.0006	-	0.0005	-	0.0080	-	-	-	0.0005	-	-	-	0.00005	-	0.0030	-	0.0350	-	-	-	-	-	-	-	-
-	0.050	-	-	-	-	-	0.0005	-	0.0001	-	0.0005	-	0.0080	-	-	-	0.0005	-	-	-	0.00020	-	0.0005	-	0.0290	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	0.0004	-	0.0005	-	0.1220	-	-	-	0.0050	-	-	-	0.00005	-	0.0130	-	0.1740	0.0005	0.001	0.001	-	0.0010	0.0010	-	-
-	0.005	-	-	-	-	-	0.0005	-	0.0001	-	0.0005	-	0.0020	-	-	-	0.0005	-	-	-	0.00005	-	0.0010	-	0.0210	0.0005	0.001	0.001	-	0.0010	0.0010	-	-
-	-	-	-	-	-	-	0.0010	-	0.0002	-	0.0005	-	0.0060	-	-	-	0.0050	-	-	-	0.00005	-	0.0005	-	0.0570	0.0005	0.001	0.001	-	0.0010	0.0010	-	-
-	-	-	-	-	-	-	0.0005	-	0.0003	-	0.0010	-	0.0070	-	-	-	0.0005	-	-	-	0.00005	-	0.0060	-	0.3250	0.0005	0.001	0.001	-	0.0010	0.0010	-	-
0.002	0.040	70.90	64.30	-	4,220	-	0.0005	-	0.0001	-	0.0020	-	0.0005	-	0.03	-	0.0005	-	0.248	-	0.00005	-	0.0005	-	0.0080	0.0005	0.001	0.001	-	0.0010	0.0010	0.0010	-	-
0.002	-	87.50	83.10	2.58	4,630	-	0.0020	-	0.0001	-	0.0005	-	0.0010	-	0.60	-	0.0005	-	0.368	-	0.00005	-	0.0040	-	0.0690	0.0005	0.001	0.001	0.0055	0.0010	0.0010	-	0.0055	0.0005
0.002	-	53.10	56.30	-	3,790	-	0.0005	-	0.0001	-	0.0005	-	0.0010	-	0.03	-	0.0005	-	0.221	-	0.00005	-	0.0005	-	0.0100	0.0005	0.001	0.001	-	0.0010	0.0010	0.0010	-	-
0.002	-	57.00	54.60	-	3,950	-	0.0005	-	0.0001	-	0.0005	-	0.0020	-	0.03	-	0.0100	-	0.176	-	0.00005	-	0.0010	-	0.0025	0.0005	0.001	0.001	-	0.0010	0.0010	0.0010	-	-
0.002	-	60.60	60.20	-	3,640	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0100	-	0.216	-	0.00005	-	0.0005	-	0.0025	0.0005	0.001	0.001	-	0.0010	0.0010	0.0010	-	-
0.002	-	55.80	55.70	-	3,340	-	0.0005	-	0.0001	-	0.0005	-	0.0020	-	0.03	-	0.0005	-	0.201	-	0.00005	-	0.0010	-	0.0140	0.0005	0.001	0.001	-	0.0010	0.0010	0.0010	-	-
0.002	-	51.30	52.30	-	3,090	-	0.0005	-	0.0001	-	0.0005	-	0.0020	-	0.03	-	0.0005	-	0.167	-	0.00005	-	0.0010	-	0.0025	0.0005	0.001	0.001	-	0.0010	0.0010	0.0010	-	-
0.002	-	42.70	45.30	-	2,620	-	0.0005	-	0.0001	-	0.0005	-	0.0010	-	0.03	-	0.0005	-	0.125	-	0.00005	-	0.0020	-	0.0025	0.0005	0.001	0.001	-	0.0010	0.0010	0.0010	-	-
0.002	-	46.30	49.80	-	2,960	-	0.0005	-	0.0001	-	0.0005	-	0.0020	-	0.06	-	0.1200	-	0.172	-	0.00005	-	0.0010	-	0.0710	0.0005	0.001	0.001	-	0.0010	0.0010	0.0010	-	-
0.002	-	55.40	47.00	-	3,100	-	0.0005	-	0.0001	-	0.0005	-	0.0020	-	0.03	-	0.0005	-	0.162	-	0.00005	-	0.0010	-	0.0025	0.0005	0.001	0.001	-	0.0010	0.0010	0.0010	-	-
-	0.005	47.70	51.40	-	3,970	0.0010	-	0.0001	-	0.0005	-	0.0020	-	-	-	0.0005	-	-	-	0.00025	-	0.0020	-	0.0025	-	0.0005	0.001	0.001	-	0.0010	0.0010	0.0010	-	-
-	0.050	-	-	-	3,230	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	-	3,101	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	-	3,093	0.0005	-	0.0010	-	0.0020	-	0.0005	-	-	-	0.0005	-	-	-	0.00030	-	0.0020	-	0.0025	-	0.0005	0.001	0.001	-	0.0010	0.0010	0.0010	-	-
-	0.050	-	-	-	3,172	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	-	3,071	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	-	2,912	0.0005	0.0005	0.0001	0.0001	0.0005	0.0005	0.0040	0.0030	-	-	0.0005	0.0005	-	-	0.00030	0.00030	0.0030	0.0030	0.0080	0.0080	0.0005	0.001	0.001	-	0.0010	0.0010	0.0010	-	-
0.002	0.050	87.50	83.10	2.58	4,630	0.0010	0.0020	0.0010	0.0006	0.0020	0.0020	0.0040	0.1220	0.00	0.60	0.0005	0.1200	0.000	0.368	0.00030	0.00030	0.0030	0.0130	0.0080	0.3250	0.0005	0.001	0.001	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005
0.002	0.005	42.70	45.30	2.58	2,620	0.0005	0.0005	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.00	0.03	0.0005	0.0005	0.000	0.125	0.00025	0.00005	0.0020	0.0005	0.0025	0.0025	0.0005	0.001	0.001	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005
0.002	0.038	57.12	56.36	2.58	3,405	0.0007	0.0006	0.0004	0.0001	0.0010	0.0006	0.0022	0.0100	#DIV/0!	0.09	0.0005	0.0092	#DIV/0!	0.206	0.00028	0.00007	0.0023	0.0023	0.0043	0.0490	0.0005	0.001	0.001	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005
0.002	0.050	55.40	54.60	2.58	3,172	0.0005	0.0005	0.0001	0.0001	0.0005	0.0005	0.0020	0.0020	#NUM!	0.03	0.0005	0.0005	#NUM!	0.189	0.00030	0.00005	0.0020	0.0010	0.0025	0.0140	0.0005	0.001	0.001	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005
0.002	0.050	53.35	51.85	ID	3,101	ID	0.0005	ID	0.0001	ID	0.0005	ID	0.0020	ID	0.03	ID	0.0005	ID	0.17	ID	0.00005	ID	0.0010	ID	0.0025	0.0005	0.001	0.001	ID	0.001	0.001	0.001	ID	ID
0.000	0.019	12.62	10.44	#DIV/0!	538	0.0003	0.0004	0.0005	0.0002	0.0009	0.0004	0.0018	0.0290	#DIV/0!	0.19	0.0000	0.0287	#DIV/0!	0.067	0.00003	0.00007	0.0006	0.0031	0.0032	0.0833	0.0000	0.000	0.000	#DIV/0!	0.0000	0.0000	0.0000	#DIV/0!	#DIV/0!

PAH																	Total Petroleum Hydrocarbons												Volatile Organic Compounds				
Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	PAH (Sum of Common 16 PAHs - Lab Reported)	TRH C10 - C36 (Sum, Lab Reported) SG Cleanup	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Calculated)	TRH C6 - C10 Fraction F1	TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4	Carbon tetrachloride	Chloroethane	Vinyl chloride	Chlorinated Hydrocarbons (Calculated)	Other Chlorinated Hydrocarbons (IWRG Calculated)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l
												0.016																	0.0065	0.0065	0.0065	0.0065	0.0065
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.100	0.025	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	-	0.010	0.050	0.210	0.025	0.260	-	0.20	-	-	-	-	0.0025	0.025	0.025	0.0275	0.0025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	-	-	-	-	-	-	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.130	0.025	-	0.14	-	0.01	0.05	0.14	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0005	-	-	-	-	0.010	0.090	0.180	0.060	-	0.20	-	0.01	0.05	0.20	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.005	-	-	-	-	0.010	0.070	0.160	0.025	-	0.23	-	0.01	0.05	0.15	0.05	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	0.025	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.005	0.0005	0.0005	0.00045	0.025	0.010	0.090	0.210	0.060	0.260	0.23	0.20	0.01	0.05	0.20	0.05	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00045	0.025	0.010	0.025	0.050	0.025	0.260	0.05	0.20	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.002545	0.0005	0.0005	0.00045	0.025	0.010	0.033	0.083	0.027	0.260	0.09	0.20	0.01	0.05	0.08	0.05	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	0.025	0.010	0.025	0.050	0.025	0.260	0.05	0.20	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	0.0275	0.0025
ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	0.0025	ID	ID	ID	ID	0.010	0.025	0.050	0.025	ID	0.05	ID	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	ID	ID
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.001011	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.000	0.020	0.055	0.009	#DIV/0!	0.07	#DIV/0!	0.00	0.00	0.05	0.00	0.0000	0.000	0.000	#DIV/0!	#DIV/0!

		Field Parameters						Sample Quality Parameters																							
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium	Magnesium (Filtered)	Sulphate (as SO4)	Sulphate (as SO4) (Filtered)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Hydroxide Alkalinity as OH	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ANZECC 95% Toxicants - Freshwater lowland																										0.7	0.900				
Contaminant Alert Trigger Values - Groundwater		7.5-7.8	463								180	180															0.020	0.064			0.50
Location	**Sampled Date**																														
MW3	3/12/2003	6.20	10,790	26.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.320	-	-	-	-	4.50
	15/06/2004	6.10	10,670	25.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.130	-	-	-	-	1.00
	23/02/2005	6.10	10,600	27.6	-	-	-	-	-	-	-	-	-	-	104.0	-	144.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2005	6.00	11,900	28.0	-	-	60.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.060	-	-	-	-	0.30
	13/12/2006	6.00	10,150	28.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/04/2008	5.99	8,800	29.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7/09/2010	6.00	10,400	-	-	-	-	0.50	502	3,380	1,910	-	1.0	-	91.0	-	123.0	-	80.0	-	102	0.5	-	102	0.5	0.020	0.040	0.060	0.30	0.20	0.30
	27/04/2011	7.03	4,200	-	-	-	-	-	-	1,180	-	798	-	0.5	-	22.0	-	35.0	-	39.0	175	0.5	0.5	175	-	-	-	-	-	-	-
	21/09/2011	5.80	10,200	-	-	-	-	-	-	3,520	1,900	-	1.0	-	89.0	-	120.0	-	85.0	-	99	0.5	-	99	0.5	-	-	-	-	-	-
	24/04/2012	6.12	10,720	-	-	-	-	-	-	3,780	1,960	-	0.5	-	94.0	-	124.0	-	88.0	-	106	0.5	-	106	0.5	-	-	-	-	-	-
	14/11/2012	6.73	11,400	-	-	-	-	-	-	4,040	2,180	-	1.0	-	113.0	-	153.0	-	97.0	-	153	0.5	-	153	0.5	-	-	-	-	-	-
	1/05/2013	6.51	10,800	-	-	-	-	-	-	3,870	2,020	-	1.0	-	112.0	-	150.0	-	97.0	-	162	0.5	-	162	0.5	-	-	-	-	-	-
	13/11/2013	7.04	11,000	-	-	-	-	-	-	4,490	2,400	-	2.0	-	149.0	-	198.0	-	212.0	-	233	0.5	-	233	0.5	-	-	-	-	-	-
	31/07/2014	8.02	13,200	-	-	-	-	-	-	4,750	2,610	-	2.0	-	159.0	-	208.0	-	125.0	-	321	0.5	-	321	0.5	-	-	-	-	-	-
	6/05/2015	7.06	12,100	-	-	-	-	-	-	4,140	2,280	-	1.0	-	147.0	-	177.0	-	90.0	-	460	0.5	-	460	0.5	-	-	-	-	-	-
	17/12/2015	6.79	10,700	-	-	-	-	-	-	3,660	1,970	-	1.0	-	125.0	-	132.0	-	105.0	-	-	-	-	-	0.5	-	-	-	-	-	-
	18/05/2016	-	8,000	-	-	-	-	1.00	25	3,200	1,910	-	0.5	-	86.0	-	111.0	-	95.0	-	482	0.5	-	482	0.5	0.005	0.040	0.045	-	-	-
	13/01/2017	6.70	8,860	-	-	-	-	0.50	68	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.020	0.025	-	-	-
	14/07/2017	6.07	7,793	26.1	25.1	-34.1	43.6	0.50	85	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.010	0.020	-	-	-
	31/08/2017	6.34	7,450	25.9	24.0	-49	101	1.00	20	2,020	1,360	-	1.0	-	56.4	-	72.6	-	82.6	-	437	2.5	-	717	-	0.005	0.040	0.045	-	-	-
	17/11/2017	6.00	7,183	26.3	26.0	13	62	0.50	94	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.140	0.145	-	-	-
	15/03/2018	6.23	7,800	26.2	34.4	22.1	95	3.00	61	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.010	0.015	-	-	-
	7/06/2018	5.99	7,315	25.8	28.6	100	96.2	2.00	51	1,890	1,260	1,240	0.7	0.4	47.2	46.8	61.1	57.3	96.2	-	323	2.5	-	529	-	0.005	0.020	0.025	-	-	-
Statistics:																															
	Maximum	8.02	13200	29	34.4	100	101	3.00	502	4,750	2,610	1,240	2.0	0.5	159.0	46.8	208.0	57.3	212.0	39.0	482	2.5	0.5	717	0.5	0.320	0.140	0.145	0.30	0.20	4.50
	Minimum	5.8	4200	25.7	24.0	-49	43.6	0.50	20	1,180	1,260	798	0.5	0.4	47.2	22.0	61.1	35.0	80.0	39.0	99	0.5	0.5	99	0.5	0.005	0.010	0.015	0.30	0.20	0.30
	Mean	6.400909	9653.522	26.91818	27.6	10.4	76.31667	1.13	113	3,378	1,980	1,019	1.1	0.5	105.6	34.4	136.4	46.2	104.4	39.0	254	0.8	0.5	295	0.5	0.052	0.040	0.048	0.30	0.20	1.53
	Median	6.16	10400	26.3	26.0	13	78.5	0.75	65	3,660	1,965	1,019	1.0	0.5	104.0	34.4	132.0	46.2	95.6	39.0	204	0.5	0.5	204	0.5	0.005	0.030	0.035	0.30	0.20	0.65
	Rolling Median	6.23	7,797	26.3	ID	ID	ID	1.00	65	3,765	1,995	ID	1.0	ID	118.5	ID	141.00	ID	96.6	ID	322	0.5	ID	391	0.5	0.005	0.030	0.035	ID	ID	ID
	Standard Deviation	0.534771	2061.558	1.204008	4.2	58.48166	24.04998	0.92	159	1,063	384	313	0.5	0.1	33.9	17.5	42.9	15.8	35.9	#DIV/0!	145	0.8	#DIV/0!	205	0.0	0.097	0.042	0.042	#DIV/0!	#DIV/0!	2.01

Notes:
Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.
"-" denotes the sample was not anaylsed for the specific analyte
"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

					Heavy Metals																			B-TEX									
Cyanide (total)	Total Phosphorus (as P)	Total Anions	Total Cations	Total Dissolved Solids @180°C (Filtered)	Arsenic (Total)	Arsenic (Filtered)	Cadmium (Total)	Cadmium (Filtered)	Chromium (Total)	Chromium (Filtered)	Copper (Total)	Copper (Filtered)	Iron (Total)	Iron (Filtered)	Lead (Total)	Lead (Filtered)	Manganese (Total)	Manganese (Filtered)	Mercury (Total)	Mercury (Filtered)	Nickel (Total)	Nickel (Filtered)	Zinc (Total)	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Total BTEX (Calculated)	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Total MAHs (Lab Reported)	Acenaphthene	Acenaphthylene
mg/L	mg/L	meq/L	meq/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
					0.0130	0.0130	0.0002	0.0002	0.001	0.001	0.0014	0.0014			0.0034	0.0034	1.900	1.900	0.00060	0.00060	0.0110	0.0110	0.0080	0.0080	0.9500					0.3500				
	0.500			2000-5000																														
-	1.220	-	-	-	-	0.0050	-	0.0003	-	0.0020	-	0.0010	-	-	-	0.0005	-	-	-	0.00005	-	0.0020	-	0.1080	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-
-	0.200	-	-	-	-	0.0040	-	0.0001	-	0.0020	-	0.0010	-	-	-	0.0005	-	-	-	0.00005	-	0.0010	-	0.0880	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	0.0003	-	0.0020	-	0.0080	-	-	-	0.0005	-	-	-	0.00005	-	0.0130	-	0.0500	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-
-	0.140	-	-	-	-	0.0010	-	0.0002	-	0.0020	-	0.0020	-	-	-	0.0020	-	-	-	0.00005	-	0.0030	-	0.0660	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-
-	-	-	-	-	-	0.0005	-	0.0001	-	0.0005	-	0.0020	-	-	-	0.0005	-	-	-	0.00005	-	0.0005	-	0.0025	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-
-	-	-	-	-	-	0.0005	-	0.0002	-	0.0010	-	0.0030	-	-	-	0.0005	-	-	-	0.00005	-	0.0010	-	0.0110	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-
0.002	0.270	99	97.6	6,650	-	0.0010	-	0.0001	-	0.0020	-	0.0005	-	1.47	-	0.0005	-	0.357	-	0.00005	-	0.001	-	0.0110	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	-	38	38.7	2,210	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	0.03	-	0.0005	-	0.124	-	0.00005	-	0.0005	-	0.0160	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	-	0.0055	0.0005	0.0005
0.002	-	103	97.0	6,530	-	0.0010	-	0.0001	-	0.0005	-	0.0020	-	1.25	-	0.0005	-	0.390	-	0.00005	-	0.002	-	0.0110	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	-	110	100.0	6,860	-	0.0005	-	0.0001	-	0.0005	-	0.0050	-	1.12	-	0.0120	-	0.335	-	0.00005	-	0.004	-	0.0260	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	-	119	113.0	7,110	-	0.0010	-	0.0006	-	0.0005	-	0.0030	-	1.77	-	0.0005	-	0.478	-	0.00005	-	0.003	-	0.0310	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	-	114	106.0	6,660	-	0.0005	-	0.0001	-	0.0005	-	0.0010	-	0.52	-	0.0005	-	0.364	-	0.00005	-	0.001	-	0.0050	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	-	136	128.0	7,900	-	0.0020	-	0.0001	-	0.0005	-	0.0030	-	0.38	-	0.0005	-	0.514	-	0.00005	-	0.002	-	0.0120	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	-	143	139.0	8,230	-	0.0010	-	0.0001	-	0.0005	-	0.0005	-	0.96	-	0.0005	-	0.522	-	0.00005	-	0.002	-	0.0050	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	-	128	121.0	6,960	-	0.0020	-	0.0001	-	0.0005	-	0.0020	-	0.38	-	0.0020	-	0.455	-	0.00005	-	0.002	-	0.0110	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	-	118	103.0	6,670	-	0.0020	-	0.0001	-	0.0005	-	0.0010	-	0.44	-	0.0005	-	0.365	-	0.00005	-	0.002	-	0.0070	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
-	0.080	102	96.5	5,120	-	0.0030	-	0.0001	-	0.0005	-	0.0010	-	-	-	0.0005	-	-	-	0.00005	-	0.003	-	0.0060	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
-	0.050	-	-	5,670	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	5,064	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.110	-	-	4,842	0.0010	-	0.0010	-	0.0060	-	0.0060	-	-	-	0.0050	-	-	-	0.00030	-	0.006	-	0.0110	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
-	0.130	-	-	4,668	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	4,655	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.150	-	-	4,395	0.0010	0.0010	0.0005	0.0001	0.0050	0.0005	0.0070	0.0040	-	-	0.0050	0.0005	-	-	0.00030	0.00030	0.004	0.0030	0.0220	0.0170	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	1.220	143	139.0	8,230	0.0010	0.0050	0.0010	0.0006	0.0060	0.0020	0.0070	0.0080	0.00	1.77	0.0050	0.0120	0.000	0.522	0.00030	0.00030	0.006	0.0130	0.0220	0.1080	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005	0.0005
0.002	0.050	38	38.7	2,210	0.0010	0.0005	0.0005	0.0001	0.0050	0.0005	0.0060	0.0005	0.00	0.03	0.0050	0.0005	0.000	0.124	0.00030	0.00005	0.004	0.0005	0.0110	0.0025	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005	0.0005
0.002	0.223	110	103.6	5,894	0.0010	0.0016	0.0008	0.0001	0.0055	0.0009	0.0065	0.0023	#DIV/0!	0.83	0.0050	0.0013	#DIV/0!	0.390	0.00030	0.00006	0.005	0.0026	0.0165	0.0269	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005	0.0005
0.002	0.130	114	103.0	6,530	0.0010	0.0010	0.0008	0.0001	0.0055	0.0005	0.0065	0.0020	#NUM!	0.74	0.0050	0.0005	#NUM!	0.378	0.00030	0.00005	0.005	0.0020	0.0165	0.0115	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005	0.0005
0.002	0.095	119	109.5	4,953	ID	0.0015	ID	0.0001	ID	0.0005	ID	0.0015	ID	0.48	ID	0.0005	ID	0.467	ID	0.00005	ID	0.0020	ID	0.0090	0.0005	0.0010	0.0010	ID	0.0010	0.0010	0.0010	ID	ID	ID
0.000	0.338	28	25.7	1,510	0.0000	0.0013	0.0004	0.0001	0.0007	0.0007	0.0007	0.0019	#DIV/0!	0.56	0.0000	0.0027	#DIV/0!	0.116	0.00000	0.00006	0.001	0.0028	0.0078	0.0309	0.0000	0.0000	0.0000	#DIV/0!	0.0000	0.0000	0.0000	#DIV/0!	#DIV/0!	#DIV/0!

PAH																Total Petroleum Hydrocarbons												Volatile Organic Compounds				
Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	PAH (Sum of Common 16 PAHs - Lab Reported)	TRH C10 - C36 (Sum, Lab Reported)	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Calculated)	TRH C6 - C10 Fraction F1	TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4	Carbon tetrachloride	Chloroethane	Vinyl chloride	Chlorinated Hydrocarbons (Calculated)	Other Chlorinated Hydrocarbons (IWRG Calculated)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l
											0.016																	0.0065	0.0065	0.0065	0.0065	0.0065
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.170	0.050	0.050	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.01	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.0005	-	0.01	0.025	0.050	0.025	0.025	-	0.05	-	-	-	-	0.0025	0.025	0.025	0.0275	0.0025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.01	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.01	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.01	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	-	-	-	-	-	-	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.01	0.025	0.170	0.025	-	0.19	-	0.01	0.05	0.19	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0005	-	-	-	-	0.01	0.190	0.310	0.090	-	0.48	-	0.01	0.14	0.34	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.01	0.025	0.120	0.025	-	0.11	-	0.01	0.05	0.11	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.01	0.025	0.050	0.025	-	0.03	-	0.01	0.05	0.05	0.05	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	0.180	0.01	0.050	0.130	0.025	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.0005	0.180	0.01	0.190	0.310	0.090	0.025	0.48	0.05	0.01	0.14	0.34	0.05	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.180	0.01	0.025	0.050	0.025	0.025	0.03	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.002318	0.0005	0.0005	0.0005	0.180	0.01	0.045	0.081	0.030	0.025	0.11	0.05	0.01	0.06	0.09	0.05	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.0005	0.180	0.01	0.025	0.050	0.025	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	0.0275	0.0025
ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	0.0025	ID	ID	ID	ID	0.01	0.025	0.085	0.025	ID	0.05	ID	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	ID	ID
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.000603	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.00	0.051	0.069	0.017	#DIV/0!	0.14	#DIV/0!	0.00	0.03	0.09	0.00	0.0000	0.000	0.000	#DIV/0!	#DIV/0!

		Field Parameters						Sample Quality Parameters																							
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium	Magnesium (Filtered)	Sulphate (as SO4)	Sulphate (as SO4) (Filtered)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Hydroxide Alkalinity as OH	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorganic Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ANZECC 95% Toxicants - Freshwater lowland																										0.7	0.900				
Contaminant Alert Trigger Values - Groundwater		7.5-7.8	463								180	180															0.020	0.064			
Location	**Sampled Date**																														
MW4	3/12/2003	6.70	8,110	25.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.030	-	-	-	-	0.30
	15/06/2004	6.40	9,080	25.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	-	-	-	-	0.50
	23/02/2005	6.80	8,200	26.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2005	6.30	9,400	27.4	-	-	12.69	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.059	-	-	-	-	0.05
	13/12/2006	6.60	7,900	26.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/04/2008	6.35	8,200	27.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7/09/2010	6.30	8,300	-	-	-	-	1.0	345	2,750	1,520	-	2.0	-	96.0	-	116.0	-	81.0	-	220	0.5	-	220	0.5	0.010	0.040	0.050	0.20	0.20	0.20
	27/04/2011	6.72	9,580	-	-	-	-	-	-	3,480	-	1,900	-	1.0	-	87.0	-	123.0	-	75	108	0.5	0.5	108	-	-	-	-	-	-	-
	21/09/2011	6.20	8,380	-	-	-	-	-	-	2,910	1,540	-	2.0	-	102.0	-	122.0	-	69.0	-	175	0.5	-	175	0.5	-	-	-	-	-	-
	24/04/2012	6.57	8,640	-	-	-	-	-	-	2,940	1,500	-	2.0	-	95.0	-	114.0	-	72.0	-	187	0.5	-	187	0.5	-	-	-	-	-	-
	14/11/2012	7.08	8,090	-	-	-	-	-	-	2,900	1,510	-	1.0	-	91.0	-	111.0	-	72.0	-	183	0.5	-	183	0.5	-	-	-	-	-	-
	2/05/2013	6.74	8,270	-	-	-	-	-	-	2,870	1,550	-	1.0	-	104.0	-	126.0	-	67.0	-	180	0.5	-	180	0.5	-	-	-	-	-	-
	13/11/2013	7.81	6,490	-	-	-	-	-	-	2,360	1,370	-	1.0	-	79.0	-	94.0	-	119.0	-	228	0.5	-	228	0.5	-	-	-	-	-	-
	31/07/2014	8.01	7,730	-	-	-	-	-	-	2,670	1,570	-	1.0	-	93.0	-	114.0	-	98.0	-	199	0.5	-	199	0.5	-	-	-	-	-	-
	6/05/2015	7.58	6,870	-	-	-	-	-	-	1,880	1,220	-	2.0	-	75.0	-	83.0	-	101.0	-	277	0.5	-	277	0.5	-	-	-	-	-	-
	17/12/2015	7.26	6,130	-	-	-	-	-	-	1,990	1,080	-	1.0	-	66.0	-	68.0	-	118.0	-	-	-	-	-	0.5	-	-	-	-	-	-
	18/05/2016	-	7,480	-	-	-	-	1.0	25	2,360	1,280	-	2.0	-	64.0	-	76.0	-	101.0	-	267	0.5	-	267	0.5	0.010	0.040	0.050	-	-	-
	13/01/2017	6.55	5,970	-	-	-	-	0.5	31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.670	0.020	0.690	-	-	-
	14/07/2017	6.55	5,875	24.1	50.6	39.6	38	0.5	45	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.080	0.020	0.100	-	-	-
	31/08/2017	6.76	5,390	22.8	67.0	-8	7.7	0.5	20	1,480	1,020	-	1.4	-	54.4	-	58.5	-	97.1	-	214	2.5	-	350	-	0.090	0.050	0.140	-	-	-
	17/11/2017	6.50	5,965	24.8	61.0	34	21	0.5	39	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.140	0.145	-	-	-
	15/03/2018	6.66	5,962	25.6	61.7	71.8	0	4.0	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.010	0.015	-	-	-
	7/06/2018	6.45	4,991	24.7	60.5	219	16.8	0.5	28	1,550	1,030	1,000	0.7	0.7	48.0	46.3	54.8	51.6	105.0	-	247	2.5	-	404	-	0.005	0.010	0.015	-	-	-
Statistics:																															
	Maximum	8.01	9580	27.6	67.0	219	38	4.0	345	3,480	1,570	1,900	2.0	1.0	104.0	87.0	126.0	123.0	119.0	75	277	2.5	0.5	404	0.5	0.670	0.140	0.690	0.20	0.20	0.50
	Minimum	6.2	4991	22.8	50.6	-8	0	0.5	3	1,480	1,020	1,000	0.7	0.7	48.0	46.3	54.8	51.6	67.0	75	108	0.5	0.5	108	0.5	0.005	0.010	0.015	0.20	0.20	0.05
	Mean	6.767727	7434.913	25.60909	60.2	71.28	16.03167	1.1	67	2,472	1,349	1,450	1.4	0.9	80.6	66.7	94.8	87.3	91.7	75	207	0.8	0.5	232	0.5	0.089	0.041	0.151	0.20	0.20	0.26
	Median	6.63	7900	25.6	61.0	39.6	14.745	0.5	30	2,670	1,435	1,450	1.2	0.9	85.0	66.7	102.5	87.3	97.6	75	207	0.5	0.5	210	0.5	0.010	0.030	0.075	0.20	0.20	0.25
	Rolling Median	6.61	5,964	25.2	ID	ID	ID	0.5	30	2,175	1,250	ID	1.0	ID	70.5	ID	79.50	ID	101.0	ID	221	0.5	ID	248	0.5	0.010	0.030	0.075	ID	ID	ID
	Standard Deviation	0.490568	1336.55	1.461133	5.9	87.32154	13.00369	1.2	113	600	215	636	0.5	0.2	19.0	28.8	25.7	50.5	18.8	#DIV/0!	46	0.8	#DIV/0!	82	0.0	0.195	0.043	0.224	#DIV/0!	#DIV/0!	0.19

Notes:

Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.

"-" denotes the sample was not anaylsed for the specific analyte

"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

						Heavy Metals																				B-TEX								
Cyanide (total)	Total Phosphorus (as P)	Total Anions	Total Cations	Ionic Balance (Lab)	Total Dissolved Solids @180°C (Filtered)	Arsenic (Total)	Arsenic (Filtered)	Cadmium (Total)	Cadmium (Filtered)	Chromium (Total)	Chromium (Filtered)	Copper (Total)	Copper (Filtered)	Iron (Total)	Iron (Filtered)	Lead (Total)	Lead (Filtered)	Manganese (Total)	Manganese (Filtered)	Mercury (Total)	Mercury (Filtered)	Nickel (Total)	Nickel (Filtered)	Zinc (Total)	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Total BTEX (Calculated)	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Total MAHs (Lab Reported)	Acenaphthene
mg/L	mg/L	meq/L	meq/L	%	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
						0.0130	0.0130	0.0002	0.0002	0.001	0.001	0.0014	0.0014			0.0034	0.0034	1.900	1.900	0.00060	0.00060	0.0110	0.0110	0.0080	0.0080	0.9500					0.3500			
	0.018				2000-5000																													
-	0.080	-	-	-	-	-	0.0005	-	0.0023	-	0.0020	-	0.0020	-	-	-	0.0005	-	-	-	0.00005	-	0.0005	-	0.0700	-	-	-	-	-	-	-	-	-
-	0.005	-	-	-	-	-	0.0005	-	0.0002	-	0.0020	-	0.0020	-	-	-	0.0005	-	-	-	0.00005	-	0.0005	-	0.0390	0.0005	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	0.0002	-	0.0020	-	0.0010	-	-	-	0.0005	-	-	-	0.00005	-	0.0010	-	0.0370	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-
-	0.005	-	-	-	-	-	0.0005	-	0.0001	-	0.0050	-	0.0110	-	-	-	0.0005	-	-	-	0.00005	-	0.0020	-	0.0520	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-
-	-	-	-	-	-	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00005	-	0.0005	-	0.0130	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-
-	-	-	-	-	-	-	0.0005	-	0.0001	-	0.0005	-	0.0030	-	-	-	0.0005	-	-	-	0.00005	-	0.0020	-	0.0220	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-
0.002	0.130	83.60	80.30	-	5,310	-	0.0005	-	0.0000	-	0.0020	-	0.0005	-	0.05	-	0.0005	-	0.273	-	0.00005	-	0.0005	-	0.0120	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-
0.002	-	102.00	97.10	2.45	5,650	-	0.0005	-	0.0001	-	0.0005	-	0.0010	-	1.55	-	0.0005	-	0.375	-	0.00005	-	0.0010	-	0.0120	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	-	0.0055	0.0005
0.002	-	87.00	82.20	-	5,360	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	0.66	-	0.0005	-	0.439	-	0.00005	-	0.0010	-	0.0100	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-
0.002	-	88.20	79.40	-	5,530	-	0.0010	-	0.0001	-	0.0005	-	0.0010	-	0.96	-	0.0005	-	0.482	-	0.00005	-	0.0010	-	0.0140	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-
0.002	-	87.00	79.40	-	4,970	-	0.0005	-	0.0001	-	0.0005	-	0.0030	-	0.34	-	0.0030	-	0.383	-	0.00005	-	0.0020	-	0.0340	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-
0.002	-	86.00	83.00	-	5,080	-	0.0010	-	0.0001	-	0.0005	-	0.0005	-	0.54	-	0.0005	-	0.599	-	0.00005	-	0.0010	-	0.0140	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-
0.002	-	73.60	71.30	-	4,290	-	0.0005	-	0.0001	-	0.0005	-	0.0010	-	0.03	-	0.0005	-	0.236	-	0.00005	-	0.0005	-	0.0070	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-
0.002	-	81.30	82.30	-	4,430	-	0.0005	-	0.0001	-	0.0005	-	0.0020	-	0.03	-	0.0005	-	0.380	-	0.00005	-	0.0010	-	0.0090	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-
0.002	-	60.70	63.70	-	3,900	-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	0.03	-	0.7110	-	0.344	-	0.00005	-	0.0010	-	0.0120	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-
0.002	-	65.00	55.90	-	3,570	-	0.0005	-	0.0001	-	0.0005	-	0.0060	-	0.03	-	0.0010	-	0.182	-	0.00005	-	0.0005	-	0.0110	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-
-	0.150	74.00	65.20	-	4,790	0.0005	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00005	-	0.0010	-	0.0120	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-
-	0.050	-	-	-	3,820	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	-	3,819	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	-	3,504	0.0005	-	0.0010	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00030	-	0.0020	-	0.0240	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-
-	0.050	-	-	-	3,875	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	-	3,596	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	-	3,669	0.0005	0.0005	0.0001	0.0001	0.0010	0.0005	0.0020	0.0005	-	-	0.0010	0.0005	-	-	0.00030	0.00030	0.0010	0.0005	0.0150	0.0120	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-
0.002	0.150	102.00	97.10	2.45	5,650	0.0005	0.0010	0.0010	0.0023	0.0010	0.0050	0.0020	0.0110	0.00	1.55	0.0010	0.7110	0.000	0.599	0.00030	0.00030	0.0020	0.0020	0.0240	0.0700	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005
0.002	0.005	60.70	55.90	2.45	3,504	0.0005	0.0005	0.0001	0.0000	0.0005	0.0005	0.0005	0.0005	0.00	0.03	0.0005	0.0005	0.000	0.182	0.00005	0.00005	0.0010	0.0005	0.0120	0.0070	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005
0.002	0.061	80.76	76.35	2.45	4,421	0.0005	0.0006	0.0004	0.0002	0.0007	0.0011	0.0010	0.0021	#DIV/0!	0.42	0.0007	0.0425	#DIV/0!	0.369	0.00022	0.00006	0.0013	0.0010	0.0170	0.0224	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005
0.002	0.050	83.60	79.40	2.45	4,290	0.0005	0.0005	0.0001	0.0001	0.0005	0.0005	0.0005	0.0010	#NUM!	0.20	0.0005	0.0005	#NUM!	0.378	0.00030	0.00005	0.0010	0.0010	0.0150	0.0130	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005
0.002	0.050	77.65	75.35	ID	3,744	ID	0.0005	ID	0.0001	ID	0.0005	ID	0.0010	ID	0.03	ID	0.0005	ID	0.380	ID	0.00005	ID	0.0010	ID	0.0120	0.0005	0.0010	0.0010	ID	0.0010	0.0010	0.0010	ID	ID
0.000	0.045	11.70	11.43	#DIV/0!	767	0.0000	0.0002	0.0005	0.0005	0.0003	0.0012	0.0009	0.0027	#DIV/0!	0.52	0.0003	0.1723	#DIV/0!	0.122	0.00014	0.00006	0.0006	0.0005	0.0062	0.0179	0.0000	0.0000	0.0000	#DIV/0!	0.0000	0.0000	0.0000	#DIV/0!	#DIV/0!

PAH																	Total Petroleum Hydrocarbons												Volatile Organic Compounds				
Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	PAH (Sum of Common 16 PAHs - Lab Reported)	TRH C10 - C36 (Sum, Lab Reported) SG Cleanup	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Calculated)	TRH C6 - C10 Fraction F1	TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4	Carbon tetrachloride	Chloroethane	Vinyl chloride	Chlorinated Hydrocarbons (Calculated)	Other Chlorinated Hydrocarbons (IWRG Calculated)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l
												0.016																	0.0065	0.0065	0.0065	0.0065	0.0065
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.050	0.100	0.025	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.060	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.375	0.750	0.500	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	-	0.010	0.025	0.050	0.025	0.025	-	0.05	-	-	-	-	0.0025	0.025	0.025	0.0275	0.0025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	-	-	-	-	-	-	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0005	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.080	0.050	0.025	-	0.08	-	0.01	0.05	0.05	0.05	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	0.025	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-
0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	0.025	0.010	0.375	0.750	0.500	0.025	0.08	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00045	0.025	0.010	0.025	0.050	0.025	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.002318	0.0005	0.0005	0.00045	0.025	0.010	0.052	0.094	0.053	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	0.025	0.010	0.025	0.050	0.025	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	0.0275	0.0025
ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	0.0025	ID	ID	ID	ID	0.010	0.025	0.050	0.025	ID	0.05	ID	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	ID	ID
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.000603	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.000	0.085	0.169	0.115	#DIV/0!	0.01	#DIV/0!	0.00	0.00	0.00	0.00	0.0000	0.000	0.000	#DIV/0!	#DIV/0!

		Field Parameters						Sample Quality Parameters																							
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium	Magnesium (Filtered)	Sulphate (as SO4)	Sulphate (as SO4) (Filtered)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Hydroxide Alkalinity as OH	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorganic Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ANZECC 95% Toxicants - Freshwater lowland																										0.7	0.900				
Contaminant Alert Trigger Values - Groundwater		7.5-7.8	463								180	180															0.020	0.064			0.50
Location	**Sampled Date**																														
MW5	3/12/2003	5.80	21,960	25.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.030	-	-	-	-	0.70
	15/06/2004	6.50	14,950	24.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.420	-	-	-	-	3.90
	23/02/2005	5.70	24,100	27.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2005	5.90	25,400	28.1	-	-	89.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.065	-	-	-	-	3.00
	13/12/2006	5.80	27,800	28.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.070	0.700	0.770	-	-	-
	23/04/2008	4.60	38,800	22.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.018	0.616	0.634	-	-	-
	7/09/2010	6.00	26,300	-	-	-	-	1.00	1,880	9,100	4,380	-	8	-	272	-	711	-	480	-	69	0.5	-	69.0	0.5	0.040	0.550	0.590	1.30	0.70	1.30
	27/04/2011	7.34	7,970	-	-	-	-	-	-	2,820	-	1,540	-	2	-	96	-	117	-	83	207	0.5	0.5	207.0	-	-	-	-	-	-	-
	21/09/2011	5.80	25,340	-	-	-	-	-	-	9,480	4,320	-	8	-	276	-	714	-	470	-	60	0.5	-	60.0	0.5	0.010	0.010	0.020	0.30	0.05	0.30
	24/04/2012	5.70	21,000	-	-	-	-	-	-	9,410	4,160	-	5	-	266	-	676	-	408	-	64	0.5	-	64.0	0.5	0.040	-	-	0.05	-	0.05
	14/11/2012	6.71	24,800	-	-	-	-	-	-	10,200	5,730	-	10	-	290	-	740	-	447	-	66	0.5	-	66.0	0.5	0.030	-	-	1.20	-	1.20
	1/05/2013	6.16	24,200	-	-	-	-	-	-	9,260	4,220	-	7	-	271	-	706	-	439	-	68	0.5	-	68.0	0.5	0.010	-	-	0.70	-	0.70
	14/11/2013	7.34	19,300	-	-	-	-	-	-	8,560	4,050	-	6	-	227	-	632	-	450	-	162	0.5	-	162.0	0.5	0.005	-	-	0.50	-	0.50
	31/07/2014	7.34	24,000	-	-	-	-	-	-	8,800	4,380	-	6	-	266	-	682	-	448	-	65	0.5	-	65.0	0.5	0.020	-	-	2.00	-	2.00
	6/05/2015	6.71	24,800	-	-	-	-	-	-	8,670	4,200	-	5	-	293	-	650	-	406	-	65	0.5	-	65.0	0.5	0.270	-	-	0.50	-	0.80
	17/12/2015	6.42	23,500	-	-	-	-	-	-	8,690	4,060	-	5	-	321	-	601	-	415	-	-	-	-	-	0.5	0.090	-	-	1.00	-	1.10
	18/05/2016	-	8,000	-	-	-	-	1.00	50	8,360	4,400	-	5	-	248	-	602	-	376	-	114	0.5	-	114.0	0.5	0.140	0.450	0.590	-	-	-
	13/01/2017	5.75	25,210	-	-	-	-	0.50	66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.040	0.500	0.540	-	-	-
	14/07/2017	5.71	23,813	26.1	54.0	-16.4	53	0.50	92	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.150	0.155	-	-	-
	31/08/2017	5.64	24,664	25.9	41.0	-19	13	0.50	92	8,780	4,500	-	5	-	303	-	646	-	402	-	47	2.5	-	77.8	-	0.010	0.760	0.770	-	-	-
	17/11/2017	5.50	24,500	26.3	43.0	86	13	0.50	66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.470	0.475	-	-	-
	15/03/2018	5.64	26,503	26.4	50.0	229	11	0.50	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.740	0.745	-	-	-
	7/06/2018	5.43	26,079	25.8	52.2	172	304	2.00	370	8,150	4,180	3,960	6	5	287	268	636	594	406	-	52	2.5	-	84.6	-	0.005	0.710	0.715	-	-	-
Statistics:																															
	Maximum	7.34	38800	28.1	54.0	229	304	2.00	1,880	10,200	5,730	3,960	10	5	321	268	740	594	480	83	207	2.5	0.5	207.0	0.5	0.420	0.760	0.770	2.00	0.70	3.90
	Minimum	4.6	7970	22.4	41.0	-19	11	0.50	3	2,820	4,050	1,540	5	2	227	96	601	117	376	83	47	0.5	0.5	60.0	0.5	0.005	0.010	0.020	0.05	0.05	0.05
	Mean	6.067727	23173.43	26.06364	48.0	90.32	80.55	0.81	327	8,483	4,382	2,750	6	3	277	182	666	356	429	83	87	0.8	0.5	91.9	0.5	0.063	0.514	0.546	0.84	0.38	1.30
	Median	5.8	24500	26.1	50.0	86	33	0.50	79	8,780	4,270	2,750	6	3	274	182	663	356	427	83	66	0.5	0.5	68.5	0.5	0.030	0.550	0.590	0.70	0.38	0.95
	Rolling Median	5.68	24,582	26.2	ID	ID	ID	0.50	79	8,680	4,210	ID	6	ID	279	ID	641	ID	411	ID	66	0.5	ID	72.9	0.5	0.010	0.485	0.565	0.60	0.38	0.75
	Standard Deviation	0.689955	6293.156	1.629278	5.7	110.9757	113.7793	0.53	637	1,785	447	1,711	2	2	25	122	46	337	31	#DIV/0!	49	0.8	#DIV/0!	46.6	0.0	0.102	0.243	0.248	0.60	0.46	1.14

Notes:

Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.

"-" denotes the sample was not anaylsed for the specific analyte

"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

					Heavy Metals																				B-TEX									
Cyanide (total)	Total Phosphorus (as P)	Total Anions	Total Cations	Total Dissolved Solids @180°C (Filtered)	Arsenic (Total)	Arsenic (Filtered)	Cadmium (Total)	Cadmium (Filtered)	Chromium (Total)	Chromium (Filtered)	Copper (Total)	Copper (Filtered)	Iron (Total)	Iron (Filtered)	Lead (Total)	Lead (Filtered)	Manganese (Total)	Manganese (Filtered)	Mercury (Total)	Mercury (Filtered)	Nickel (Total)	Nickel (Filtered)	Zinc (Total)	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Total BTEX (Calculated)	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Total MAHs (Lab Reported)	Acenaphthene	Acenaphthylene
mg/L	mg/L	meq/L	meq/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
					0.0130	0.0130	0.0002	0.0002	0.001	0.001	0.0014	0.0014			0.0034	0.0034	1.900	1.900	0.00060	0.00060	0.0110	0.0110	0.0080	0.0080	0.9500					0.3500				
	0.500			2000-5000																														
-	0.060	-	-	-	-	0.0020	-	0.0004	-	0.0030	-	0.003	-	-	-	0.0005	-	-	-	0.00005	-	0.031	-	0.023	-	-	-	-	-	-	-	-	-	-
-	1.020	-	-	-	-	0.0060	-	0.0006	-	0.0040	-	0.012	-	-	-	0.0030	-	-	-	0.00005	-	0.029	-	0.155	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	0.0010	-	0.0040	-	0.009	-	-	-	0.0005	-	-	-	0.00005	-	0.035	-	0.045	-	-	-	-	-	-	-	-	-	-
-	0.212	-	-	-	-	0.0005	-	0.0007	-	0.0090	-	0.007	-	-	-	0.0010	-	-	-	0.00005	-	0.039	-	0.044	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-
-	1.200	-	-	-	-	0.0020	-	0.0012	-	0.0010	-	0.001	-	-	-	0.0005	-	-	-	0.00005	-	0.030	-	0.019	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-
-	0.010	-	-	-	-	0.0005	-	0.0007	-	0.0040	-	0.004	-	-	-	0.0010	-	-	-	0.00005	-	0.034	-	0.028	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-
0.002	0.610	268	263	16,800	-	0.0025	-	0.0007	-	0.0060	-	0.003	-	0.33	-	0.0030	4.160	-	-	0.00005	-	0.034	-	0.031	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	-	85	81	4,730	-	0.0005	-	0.0001	-	0.0005	-	0.001	-	0.66	-	0.0005	-	0.802	-	0.00005	-	0.002	-	0.017	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	-	0.0055	0.0005	0.0005
0.002	0.005	278	261	16,200	-	0.0005	-	0.0004	-	0.0020	-	0.004	-	0.21	-	0.0005	-	4.280	-	0.00005	-	0.036	-	0.021	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.440	275	250	13,400	-	0.0005	-	0.0002	-	0.0005	-	0.007	-	0.40	-	0.0060	-	3.260	-	0.00005	-	0.034	-	0.044	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.350	298	325	16,400	-	0.0005	-	0.0006	-	0.0005	-	0.006	-	-	-	0.0400	-	3.800	-	0.00005	-	0.032	-	0.016	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.310	272	255	15,600	-	0.0005	-	0.0002	-	0.0010	-	0.002	-	1.25	-	0.0005	-	3.760	-	0.00005	-	0.034	-	0.014	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.370	254	240	13,200	-	0.0025	-	0.0001	-	0.0005	-	0.003	-	0.27	-	0.0005	-	3.410	-	0.00005	-	0.031	-	0.013	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.810	259	260	15,500	-	0.0010	-	0.0001	-	0.0005	-	0.001	-	0.97	-	0.0005	-	3.490	-	0.00005	-	0.031	-	0.015	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.250	254	251	15,400	-	0.0005	-	0.0001	-	0.0005	-	0.001	-	0.87	-	0.0010	-	3.300	-	0.00005	-	0.030	-	0.023	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.170	255	242	16,100	-	0.0005	-	0.0017	-	0.0005	-	0.004	-	0.03	-	0.0005	-	3.160	-	0.00005	-	0.028	-	0.018	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
-	0.200	246	253	5,120	0.0020	-	0.0006	-	0.0005	-	0.0030	-	-	-	0.0005	-	-	-	0.00005	-	0.026	-	0.016	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
-	0.050	-	-	16,100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	15,478	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	16,032	0.0100	-	0.0010	-	0.0100	-	0.0100	-	-	-	0.0100	-	-	-	0.00600	-	0.032	-	0.050	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
-	0.050	-	-	15,920	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	15,768	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.170	-	-	15,674	0.0020	0.0025	0.0015	0.0010	0.0210	0.0003	0.0510	0.002	-	-	0.0070	0.0003	-	-	0.00100	0.00100	0.046	0.030	0.069	0.031	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	1.200	298	325	16,800	0.0100	0.0060	0.0015	0.0017	0.0210	0.0090	0.0510	0.012	0.00	1.25	0.0100	0.0400	4.160	4.280	0.00600	0.00100	0.046	0.039	0.069	0.155	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005	0.0005
0.002	0.005	85	81	4,730	0.0020	0.0005	0.0006	0.0001	0.0005	0.0003	0.0030	0.001	0.00	0.03	0.0005	0.0003	4.160	0.802	0.00005	0.00005	0.026	0.002	0.016	0.013	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005	0.0005
0.002	0.307	249	244	14,319	0.0047	0.0014	0.0010	0.0006	0.0105	0.0022	0.0213	0.004	#DIV/0!	0.55	0.0058	0.0035	4.160	3.251	0.00235	0.00011	0.035	0.031	0.045	0.033	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005	0.0005
0.002	0.200	259	253	15,674	0.0020	0.0005	0.0010	0.0006	0.0100	0.0010	0.0100	0.003	#NUM!	0.40	0.0070	0.0005	4.160	3.410	0.00100	0.00005	0.032	0.031	0.050	0.023	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005	0.0005
0.002	0.050	257	252	15,844	ID	0.0005	ID	0.0002	ID	0.0005	ID	0.002	ID	0.64	ID	0.0005	ID	3.450	ID	0.00005	ID	0.031	ID	0.017	0.0005	0.0010	0.0010	ID	0.0010	0.0010	0.0010	ID	ID	ID
0.000	0.340	56	58	3,657	0.0046	0.0015	0.0005	0.0005	0.0103	0.0025	0.0259	0.003	#DIV/0!	0.41	0.0049	0.0095	#DIV/0!	0.982	0.00320	0.00023	0.010	0.008	0.027	0.033	0.0000	0.0000	0.0000	#DIV/0!	0.0000	0.0000	0.0000	#DIV/0!	#DIV/0!	#DIV/0!

PAH																Total Petroleum Hydrocarbons												Volatile Organic Compounds				
Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	PAH (Sum of Common 16 PAHs - Lab Reported)	TRH C10 - C36 (Sum, Lab Reported) SG Cleanup	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Calculated)	TRH C6 - C10 Fraction F1	TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4	Carbon tetrachloride	Chloroethane	Vinyl chloride	Chlorinated Hydrocarbons (Calculated)	Other Chlorinated Hydrocarbons (IWRG Calculated)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l
											0.016																0.0065	0.0065	0.0065	0.0065	0.0065
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.750	0.500	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.110	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	-	0.010	0.025	0.050	0.025	0.025	-	0.05	-	-	-	-	0.0025	0.025	0.025	0.0275	0.0025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.090	-	0.10	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	-	-	-	-	-	-	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.110	-	0.17	-	0.01	0.05	0.17	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0005	-	-	-	-	0.010	0.050	0.120	0.070	-	0.16	-	0.01	0.05	0.16	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.050	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.03	-	0.01	0.05	0.05	0.05	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	0.100	0.010	0.025	0.050	0.100	-	-	-	-	-	-	-	-	-	-	-	-
0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	0.100	0.010	0.050	0.750	0.500	0.025	0.17	0.05	0.01	0.05	0.17	0.05	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.00045	0.100	0.010	0.025	0.050	0.025	0.025	0.03	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.002318	0.0005	0.0005	0.00045	0.100	0.010	0.027	0.101	0.082	0.025	0.08	0.05	0.01	0.05	0.07	0.05	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	0.100	0.010	0.025	0.050	0.025	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	0.0275	0.0025
ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	0.0025	ID	ID	ID	ID	0.010	0.025	0.050	0.038	ID	0.05	ID	0.01	0.05	0.05	0.05	0.0025	0.025	0.025	ID	ID
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.000603	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.000	0.006	0.180	0.121	#DIV/0!	0.05	#DIV/0!	0.00	0.00	0.05	0.00	0.0000	0.000	0.000	#DIV/0!	#DIV/0!

		Field Parameters																				
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Turbidity (Field Observation)	Chloride	Sodium (Filtered)	Potassium (Filtered)	Calcium (Filtered)	Magnesium (Filtered)	Sulphate (as SO4) (Filtered)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)	Cyanide (total)
		pH Units	uS/cm	oC	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ANZECC 95% Toxicants - Freshwater lowland																0.7	0.900					
Contaminant Alert Trigger Values - Groundwater		7.5-7.8	463				180										0.020	0.064			0.5	
Location	**Sampled Date**																					
MW6	3/12/2003	6.00	12,110	24.4	-	-	-	-	-	-	-	-	-	-	-	0.030	-	-	-	-	0.10	-
	15/06/2004	6.20	12,250	24.0	-	-	-	-	-	-	-	-	-	-	-	0.020	-	-	-	-	6.90	-
	23/02/2005	5.00	12,500	26.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2005	5.90	13,000	28.3	42.8	-	-	-	-	-	-	-	-	-	-	0.059	-	-	-	-	1.00	-
	13/12/2006	6.10	14,400	27.8	-	-	-	-	-	-	-	-	-	-	-	0.048	0.642	0.690	-	-	-	-
	23/04/2008	5.34	31,200	26.1	-	-	-	-	-	-	-	-	-	-	-	0.270	0.213	0.483	-	-	-	-
	27/04/2011	6.80	23,700	-	-	9,120.00	4,620.0	8.0	258.0	746.0	458.0	72.0	0.5	0.5	72.0	0.090	0.260	0.350	0.60	0.30	0.70	0.002
Statistics:																						
	Maximum	6.8	31200	28.3	42.8	9,120.00	4,620.0	8.0	258.0	746.0	458.0	72.0	0.5	0.5	72.0	0.270	0.642	0.690	0.60	0.30	6.90	0.002
	Minimum	5	12110	24	42.8	9,120.00	4,620.0	8.0	258.0	746.0	458.0	72.0	0.5	0.5	72.0	0.020	0.213	0.350	0.60	0.30	0.10	0.002
	Mean	5.905714	17022.86	26.16667	42.8	9,120.00	4,620.0	8.0	258.0	746.0	458.0	72.0	0.5	0.5	72.0	0.086	0.372	0.508	0.60	0.30	2.18	0.002
	Median	6	13000	26.25	42.8	9,120.00	4,620.0	8.0	258.0	746.0	458.0	72.0	0.5	0.5	72.0	0.054	0.260	0.483	0.60	0.30	0.85	0.002
	Rolling Median	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
	Standard Deviation	0.587845	7483.437	1.737431	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.093	0.235	0.171	#DIV/0!	#DIV/0!	3.17	#DIV/0!

Notes:
Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical
"-" denotes the sample was not anaylsed for the specific analyte
"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

GOLDER

														B-TEX												
Total Phosphorus (as P)	Total Anions	Total Cations	Total Dissolved Solids @180°C (Filtered)	Arsenic (Filtered)	Cadmium (Filtered)	Chromium (Filtered)	Copper (Filtered)	Iron (Filtered)	Lead (Filtered)	Manganese (Filtered)	Mercury (Filtered)	Nickel (Filtered)	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Total BTEX (Calculated)	Xylenes (m & p)	Xylene (o)	Total MAHs (Lab Reported)	Acenaphthene	Acenaphthylene	Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene
mg/L	meq/L	meq/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
				0.0130	0.0002	0.001	0.0014		0.0034	1.9000	0.0006	0.011	0.008	0.95					0.35							
0.5			2000-5000																							
0.030	-	-	-	0.0005	0.0038	0.0020	0.0060	-	0.0010	-	0.00005	0.0040	0.0270	-	-	-	-	-	-	-	-	-	-	-	-	-
1.420	-	-	-	0.0040	0.0001	0.0020	0.0010	-	0.0005	-	0.00005	0.0040	0.0800	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	0.0020	0.0006	0.0020	0.0130	-	0.0010	-	0.00050	0.0140	0.3020	-	-	-	-	-	-	-	-	-	-	-	-	-
0.520	-	-	-	0.0005	0.0002	0.0040	0.0020	-	0.0050	-	0.00005	0.0040	0.0490	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-	-	-	-
0.350	-	-	-	0.0040	0.0002	0.0005	0.0005	-	0.0005	-	0.00005	0.0030	0.0025	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-	-	-	-
0.240	-	-	-	0.0005	0.0006	0.0030	0.0030	-	0.0005	-	0.00005	0.0300	0.0260	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-	-	-	-
0.520	268.00	275.00	15,100.0	0.0005	0.0002	0.0020	0.0020	0.44	0.0005	3.970	0.00005	0.0340	0.0180	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0055	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
1.420	268.00	275.00	15,100.0	0.0040	0.0038	0.0040	0.0130	0.44	0.0050	3.970	0.00050	0.0340	0.3020	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0055	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
0.030	268.00	275.00	15,100.0	0.0005	0.0001	0.0005	0.0005	0.44	0.0005	3.970	0.00005	0.0030	0.0025	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0055	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
0.513	268.00	275.00	15,100.0	0.0017	0.0008	0.0022	0.0039	0.44	0.0013	3.970	0.00011	0.0133	0.0721	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0055	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
0.435	268.00	275.00	15,100.0	0.0005	0.0002	0.0020	0.0020	0.44	0.0005	3.970	0.00005	0.0040	0.0270	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0055	0.0005	0.0005	0.0005	0.0005	0.00025	0.0005
ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
0.481	#DIV/0!	#DIV/0!	#DIV/0!	0.0017	0.0013	0.0011	0.0044	#DIV/0!	0.0017	#DIV/0!	0.00017	0.0134	0.1044	0.0000	0.0000	0.0000	#DIV/0!	0.0000	0.0000	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

GOLDER	PAH																	Volatile Organic Compounds				
Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	PAH (Sum of Common 16 PAHs - Lab Reported)	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Calculated)	Carbon tetrachloride	Chloroethane	Vinyl chloride	Chlorinated Hydrocarbons (Calculated)	Other Chlorinated Hydrocarbons (IWRG Calculated)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/l	mg/l
							0.016										0.0065	0.0065	0.0065	0.0065	0.0065
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.010	0.375	0.750	0.500	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.160	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.020	0.025	0.050	0.025	-	-	-	-	-	-	-
0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	0.010	0.025	0.050	0.025	0.025	0.19	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	0.020	0.375	0.750	0.500	0.025	0.19	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	0.010	0.025	0.050	0.025	0.025	0.19	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	0.013	0.113	0.225	0.178	0.025	0.19	0.0025	0.025	0.025	0.0275	0.0025
0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	0.010	0.025	0.050	0.093	0.025	0.19	0.0025	0.025	0.025	0.0275	0.0025
ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.005	0.175	0.350	0.224	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

		Field Parameters						Sample Quality Parameters																								
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium	Magnesium (Filtered)	Sulphate (as SO4)	Sulphate (as SO4) (Filtered)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Hydroxide Alkalinity as OH	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ANZECC 95% Toxicants - Freshwater lowland																										0.7	0.900					
Contaminant Alert Trigger Values - Groundwater		7.5-7.8	463								180	180															0.020	0.064				0.5
Location	**Sampled Date**																															
MW7	3/12/2003	5.80	17,220	25.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.030	-	-	-	-	2.20
	15/06/2004	5.60	18,760	24.9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	-	-	-	-	3.00
	23/02/2005	5.80	19,600	27.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2005	5.70	11,400	26.6	-	-	63.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2006	5.50	23,500	26.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.020	0.579	0.599	-	-	-
	23/04/2008	5.53	18,900	29.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.011	0.796	0.807	-	-	-
	7/09/2010	5.50	19,200	-	-	-	-	1.00	910.0	910	3,330	-	3.0	-	74.0	-	436.0	-	97.0	-	55.0	0.5	-	55.0	0.5	0.020	0.490	0.510	0.90	0.40	0.90
	27/04/2011	6.83	13,300	-	-	-	-	-	-	4,980	-	2,600	-	3.0	-	147.0	-	239.0	-	196.0	117.0	0.5	0.5	117.0	-	0.050	0.130	0.180	0.40	0.30	0.40
	21/09/2011	5.50	18,500	-	-	-	-	-	-	6,870	3,260	-	3.0	-	71.0	-	419.0	-	99.0	-	36.0	0.5	-	36.0	0.5	0.010	0.540	0.550	0.60	0.05	0.60
	24/04/2012	5.70	18,960	-	-	-	-	-	-	6,710	3,110	-	1.0	-	69.0	-	384.0	-	72.0	-	38.0	0.5	-	38.0	0.5	0.040	-	-	2.90	-	2.90
	14/11/2012	6.50	16,400	-	-	-	-	-	-	6,060	3,000	-	2.0	-	66.0	-	370.0	-	77.0	-	54.0	0.5	-	54.0	0.5	0.030	-	-	3.80	-	3.80
	2/05/2013	6.12	15,900	-	-	-	-	-	-	5,790	3,130	-	2.0	-	70.0	-	376.0	-	76.0	-	55.0	0.5	-	55.0	0.5	0.005	-	-	0.80	-	0.80
	13/11/2013	6.45	13,000	-	-	-	-	-	-	5,700	2,860	-	2.0	-	60.0	-	332.0	-	112.0	-	33.0	0.5	-	33.0	0.5	0.010	-	-	0.60	-	0.60
	31/07/2014	7.16	14,400	-	-	-	-	-	-	5,400	2,960	-	2.0	-	59.0	-	309.0	-	76.0	-	51.0	0.5	-	51.0	0.5	0.010	-	-	0.40	-	0.40
	6/05/2015	6.68	15,600	-	-	-	-	-	-	5,580	2,730	-	2.0	-	76.0	-	314.0	-	67.0	-	70.0	0.5	-	70.0	0.5	0.010	-	-	1.10	-	1.10
	18/12/2015	6.44	13,900	-	-	-	-	-	-	5,260	2,430	-	2.0	-	76.0	-	259.0	-	67.0	-	-	-	-	-	0.5	0.005	-	-	0.80	-	0.80
	18/05/2016	-	8,000	-	-	-	-	1.00	50.0	5,250	2,760	-	2.0	-	57.0	-	274.0	-	67.0	-	58.0	0.5	-	58.0	0.5	0.010	0.530	0.540	-	-	-
	13/01/2017	5.56	14,370	-	-	-	-	0.50	66.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.570	0.575	-	-	-
	14/07/2017	5.57	13,380	25.7	34.0	18.8	25.7	0.50	74.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.020	0.490	0.510	-	-	-
	31/08/2017	5.80	12,463	24.8	36.0	-47.6	16	0.50	92.0	4,140	2,160	-	1.0	-	57.6	-	216.0	-	56.5	-	34.9	2.5	-	57.2	-	0.040	0.660	0.700	-	-	-
	17/11/2017	5.80	12,274	25.5	44.6	94	3.6	0.50	66.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.005	0.340	0.345	-	-	-
	15/03/2018	5.67	13,963	26.2	43.1	119.3	13.4	3.00	2.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.560	0.570	-	-	-
	7/06/2018	5.63	12,750	25.7	44.6	397	10	3.00	36.0	3,790	2,140	1,970	0.6	0.7	47.4	48.5	210.0	195.0	59.0	-	39.1	2.5	-	64.2	-	0.040	0.450	0.490	-	-	-
Statistics:																																
	Maximum	7.16	23500	29.1	44.6	397	63.4	3.00	910.0	6,870	3,330	2,600	3.0	3.0	76.0	147.0	436.0	239.0	112.0	196.0	117.0	2.5	0.5	0.5	117.0	0.5	0.050	0.796	0.807	3.80	0.40	3.80
	Minimum	5.5	8000	24.8	34.0	-47.6	3.6	0.50	2.5	910	2,140	1,970	0.6	0.7	47.4	48.5	210.0	195.0	56.5	196.0	33.0	0.5	0.5	33.0	0.5	0.005	0.130	0.180	0.40	0.05	0.40
	Mean	5.947273	15466.96	26.11818	40.5	116.3	22.01667	1.25	162.1	5,111	2,823	2,285	1.9	1.9	65.3	97.8	324.9	217.0	77.1	196.0	53.4	0.8	0.5	57.4	0.5	0.018	0.511	0.531	1.23	0.25	1.46
	Median	5.75	14400	25.7	43.1	94	14.7	0.75	66.0	5,400	2,910	2,285	2.0	1.9	67.5	97.8	323.0	217.0	74.0	196.0	52.5	0.5	0.5	55.0	0.5	0.010	0.535	0.545	0.80	0.30	0.85
	Rolling Median	5.67	13065.00	25.95	ID	ID	ID	0.75	66.00	5,330	2,745	ID	2.00	ID	59.50	ID	291.50	ID	67.00	ID	52.50	0.50	ID	56.10	0.50	0.010	0.535	0.545	0.800	ID	0.80
	Standard Deviation	0.497203	3469.471	1.285938	5.1	170.0502	21.54144	1.10	303.4	1,529	399	445	0.7	1.6	9.0	69.7	74.9	31.1	17.0	#DIV/0!	23.1	0.8	#DIV/0!	21.8	0.0	0.014	0.164	0.158	1.16	0.18	1.19

Notes:
Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.
"-" denotes the sample was not anaylsed for the specific analyte
"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

					Heavy Metals																				B-TEX									
Cyanide (total)	Total Phosphorus (as P)	Total Anions	Total Cations	Total Dissolved Solids @180°C (Filtered)	Arsenic (Total)	Arsenic (Filtered)	Cadmium (Total)	Cadmium (Filtered)	Chromium (Total)	Chromium (Filtered)	Copper (Total)	Copper (Filtered)	Iron (Total)	Iron (Filtered)	Lead (Total)	Lead (Filtered)	Manganese (Total)	Manganese (Filtered)	Mercury (Total)	Mercury (Filtered)	Nickel (Total)	Nickel (Filtered)	Zinc (Total)	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Total BTEX (Calculated)	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Total MAHs (Lab Reported)	Acenaphthene	Acenaphthylene
mg/L	mg/L	meq/L	meq/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
					0.0130	0.0130	0.0002	0.0002	0.0010	0.0010	0.0014	0.0014		0.0034	0.0034	1.900	0.00060	0.00060	0.0110	0.0110	0.0080	0.0080	0.9500	0.0080	0.9500						0.3500				
	0.5			2000-5000																														
-	2.320	-	-	-	-	0.0020	-	0.0021	-	0.0030	-	0.0070	-	-	-	0.0005	-	-	-	0.00005	-	0.0190	-	0.0310	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-
-	0.160	-	-	-	0.0010	0.0005	0.0006	0.0002	0.0320	0.0030	0.0550	0.0030	-	-	0.0180	0.0005	-	-	0.00005	0.00005	0.0340	0.0200	0.1080	0.0330	0.0005	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	0.0020	-	0.0001	-	0.0020	-	0.0030	-	-	-	0.0005	-	-	-	0.00050	-	0.0180	-	0.0660	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	0.0005	-	0.0002	-	0.0070	-	0.0030	-	-	-	0.0040	-	-	-	0.00005	-	0.0220	-	0.0470	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-
-	0.270	-	-	-	-	0.0020	-	0.0003	-	0.0010	-	0.0040	-	-	-	0.0005	-	-	-	0.00005	-	0.0210	-	0.0100	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-
-	0.160	-	-	-	-	0.0020	-	0.0004	-	0.0040	-	0.0020	-	-	-	0.0010	-	-	-	0.00005	-	0.0190	-	0.0490	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-
0.002	0.180	199	184	12,300	-	0.0020	-	0.0001	-	0.0030	-	0.0010	-	8.26	-	0.0005	-	1.880	-	0.00005	-	0.0160	-	0.0120	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.050	147	140	8,760	-	0.0005	-	0.0001	-	0.0010	-	0.0030	-	4.17	-	0.0005	-	0.359	-	0.00005	-	0.0030	-	0.0110	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	-	0.0055	0.0005	0.0005
0.002	0.460	196	180	11,800	-	0.0005	-	0.0001	-	0.0020	-	0.0030	-	3.67	-	0.0005	-	1.900	-	0.00005	-	0.0190	-	0.0160	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.740	192	170	12,100	-	0.0040	-	0.0001	-	0.0005	-	0.0020	-	11.10	-	0.0005	-	1.490	-	0.00005	-	0.0130	-	0.0360	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.340	174	164	9,870	-	0.0030	-	0.0001	-	0.0005	-	0.0005	-	5.97	-	0.0005	-	1.710	-	0.00005	-	0.0130	-	0.0100	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.250	166	171	9,700	-	0.0030	-	0.0001	-	0.0010	-	0.0020	-	6.04	-	0.0005	-	1.690	-	0.00005	-	0.0160	-	0.0370	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.750	164	155	9,330	-	0.0030	-	0.0001	-	0.0005	-	0.0100	-	3.33	-	0.0020	-	1.490	-	0.00005	-	0.0130	-	0.0100	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.240	155	157	9,540	-	0.0020	-	0.0001	-	0.0005	-	0.0005	-	4.19	-	0.0005	-	1.240	-	0.00005	-	0.0110	-	0.0120	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.190	160	148	8,810	-	0.0020	-	0.0001	-	0.0005	-	0.0005	-	3.81	-	19.2000	-	1.310	-	0.00005	-	0.0110	-	0.0220	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	0.100	151	131	9,130	-	0.0020	-	0.0001	-	0.0005	-	0.0005	-	4.98	-	0.0005	-	1.250	-	0.00005	-	0.0100	-	0.0060	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
-	0.090	151	145	5,120	0.0030	-	0.0001	-	0.0005	-	0.0010	-	-	-	0.0005	-	-	-	0.00005	-	0.0100	-	0.0060	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
-	0.050	-	-	9,190	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	8,697	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	8,100	0.0050	-	0.0005	-	0.0050	-	0.0050	-	-	-	0.0050	-	-	-	0.00300	-	0.0050	-	0.0250	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
-	0.050	-	-	7,977	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.050	-	-	8,336	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.190	-	-	7,682	0.0010	0.0010	0.0005	0.0005	0.0010	0.0005	0.0020	0.0010	-	-	0.0020	0.0003	-	-	0.00030	0.00100	0.0070	0.0070	0.0230	0.0240	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-
0.002	2.320	199	184	12,300	0.0050	0.0040	0.0006	0.0021	0.0320	0.0070	0.0550	0.0100	0.00	11.10	0.0180	19.2000	0.000	1.900	0.00300	0.00100	0.0340	0.0220	0.1080	0.0660	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005	0.0005
0.002	0.050	147	131	5,120	0.0010	0.0005	0.0001	0.0001	0.0005	0.0005	0.0010	0.0005	0.00	3.33	0.0005	0.0003	0.000	0.359	0.00005	0.00005	0.0050	0.0030	0.0060	0.0060	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005	0.0005
0.002	0.321	169	159	9,202	0.0025	0.0019	0.0004	0.0003	0.0096	0.0018	0.0158	0.0027	#DIV/0!	5.55	0.0064	1.1302	#DIV/0!	1.432	0.00085	0.00013	0.0140	0.0148	0.0405	0.0254	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005	0.0005
0.002	0.180	164	157	9,130	0.0020	0.0020	0.0005	0.0001	0.0030	0.0010	0.0035	0.0020	#NUM!	4.59	0.0035	0.0005	#NUM!	1.490	0.00018	0.00005	0.0085	0.0160	0.0240	0.0220	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0005	0.0005
0.002	0.295	162	156	8,218	ID	0.0025	ID	0.0001	ID	0.0005	ID	0.0008	ID	4.59	ID	0.0005	ID	1.490	ID	0.00005	ID	0.012	ID	0.017	0.0005	0.0010	0.0010	ID	0.0010	0.0010	0.0010	ID	ID	ID
0.000	0.502	19	17	1,743	0.0019	0.0010	0.0002	0.0005	0.0151	0.0018	0.0262	0.0025	#DIV/0!	2.45	0.0080	4.6565	#DIV/0!	0.448	0.00144	0.00025	0.0135	0.0053	0.0458	0.0173	0.0000	0.0000	0.0000	#DIV/0!	0.0000	0.0000	0.0000	#DIV/0!	#DIV/0!	#DIV/0!

PAH																Total Petroleum Hydrocarbons													Volatile Organic Compounds		
Anthracene	Benz(a)anthracene	Benzo(a)pyrene	Benzo(b)fluoranthene	Benzo(g,h,i)perylene	Benzo(k)fluoranthene	Chrysene	Dibenz(a,h)anthracene	Fluoranthene	Fluorene	Indeno(1,2,3-c,d)pyrene	Naphthalene	Phenanthrene	Pyrene	PAH (Sum of Common 16 PAHs - Lab Reported)	TRH C10 - C36 (Sum, Lab Reported)	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Calculated)	TRH C6 - C10 Fraction F1	TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4	Carbon tetrachloride	Chloroethane	Vinyl chloride
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
											0.016																				
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.250	0.750	0.375	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	-	0.010	0.025	0.050	0.025	0.025	-	0.05	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	-	-	-	-	-	-	-	0.01	0.05	0.05	0.05	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.070	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.120	0.025	-	0.14	-	0.01	0.05	0.14	0.05	0.0025	0.025	0.025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	0.010	0.025	0.050	0.025	-	0.03	-	0.01	0.05	0.05	0.05	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	0.0025	-	-	-	0.025	0.010	0.025	0.050	0.025	-	-	-	-	-	-	-	-	-	-	-	-
0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	0.025	0.010	0.250	0.750	0.375	0.025	0.14	0.05	0.01	0.05	0.14	0.05	0.0025	0.025	0.025
0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	0.025	0.010	0.025	0.050	0.025	0.025	0.03	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	0.025	0.010	0.041	0.095	0.046	0.025	0.06	0.05	0.01	0.05	0.06	0.05	0.0025	0.025	0.025
0.0005	0.0005	0.00025	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0025	0.0005	0.0005	0.00045	0.025	0.010	0.025	0.050	0.025	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	0.0025	ID	ID	ID	ID	0.010	0.025	0.050	0.025	ID	0.05	ID	0.01	0.05	0.05	0.05	ID	ID	ID
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	4.5485E-19	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	0.000	0.055	0.170	0.085	#DIV/0!	0.03	#DIV/0!	0.00	0.00	0.03	0.00	0.0000	0.000	0.000

		Field Parameters						Sample Quality Parameters																
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium	Magnesium (Filtered)	Sulphate (as SO4)	Sulphate (as SO4) (Filtered)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Hydroxide Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
ANZECC 95% Toxicants - Freshwater lowland																								
Contaminant Alert Trigger Values - Groundwater⍰		7.5-7.8	463								180	180												
Location	**Sampled Date**																							
MW8	3/12/2003	6.00	7,450	24.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15/06/2004	5.80	7,510	23.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/02/2005	6.00	7,600	25.9	-	-	-	-	-	-	-	-	-	-	63.0	-	118.0	-	-	-	-	-	-	-
	13/12/2005	5.80	7,900	26.6	-	-	36.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	13/12/2006	5.50	23,500	26.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	23/04/2008	5.91	8,200	26.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7/09/2010	5.70	8,000	-	-	-	-	1.00	337.0	337.00	1,460.0	-	2.0	-	68.0	-	129.0	-	68.0	-	49.0	0.5	-	49.0
	27/04/2011	6.31	18,300	-	-	-	-	-	-	7,120.00	-	3,620.0	-	3.0	-	74.0	-	480.0	-	109.0	41.0	0.5	0.5	41.0
	21/09/2011	5.60	7,950	-	-	-	-	-	-	2,820.00	1,460.0	-	2.0	-	68.0	-	129.0	-	68.0	-	40.0	0.5	-	40.0
	24/04/2012	5.90	8,150	-	-	-	-	-	-	2,910.00	1,460.0	-	2.0	-	65.0	-	125.0	-	50.0	-	69.0	0.5	-	69.0
	14/11/2012	6.48	7,960	-	-	-	-	-	-	2,950.00	1,500.0	-	2.0	-	69.0	-	132.0	-	63.0	-	51.0	0.5	-	51.0
	2/05/2013	6.42	7,730	-	-	-	-	-	-	2,800.00	1,520.0	-	2.0	-	70.0	-	132.0	-	41.0	-	78.0	0.5	-	78.0
	13/11/2013	6.92	7,080	-	-	-	-	-	-	2,760.00	1,470.0	-	2.0	-	69.0	-	133.0	-	87.0	-	50.0	0.5	-	50.0
	31/07/2014	7.13	7,780	-	-	-	-	-	-	2,780.00	4,530.0	-	2.0	-	67.0	-	127.0	-	67.0	-	55.0	0.5	-	55.0
	6/05/2015	6.70	8,200	-	-	-	-	-	-	2,870.00	1,380.0	-	2.0	-	75.0	-	132.0	-	55.0	-	62.0	0.5	-	62.0
	18/12/2015	6.50	7,790	-	-	-	-	-	-	2,870.00	1,320.0	-	2.0	-	76.0	-	120.0	-	68.0	-	-	-	-	-
	18/05/2016	-	8,000	-	-	-	-	1.00	50.0	2,920.00	1,500.0	-	2.0	-	71.0	-	131.0	-	66.0	-	47.0	0.5	-	47.0
	13/01/2017	5.70	8,340	-	-	-	-	0.50	30.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	14/07/2017	5.63	8,257	25.1	32.0	9.9	23.5	4.00	42.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	31/08/2017	5.91	8,115	24.7	45.0	-30	4.3	0.50	16.0	2,590.00	1,450.0	-	1.1	-	74.5	-	134.0	-	66.6	-	31.1	2.5	-	51.0
	17/11/2017	5.98	8,066	25.7	62.0	48	4.5	0.50	12.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	15/03/2018	5.86	9,000	26.4	57.5	40.3	4.3	2.00	21.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	7/06/2018	5.62	8,511	25.3	62.5	392.2	4.7	1.00	8.0	2,620.00	1,320.0	1,230.0	0.9	0.9	70.1	63.1	127.0	108.0	84.0	-	33.3	2.5	-	54.6
Statistics:																								
	Maximum	7.13	23500	26.6	62.5	392.2	36.7	4.00	337.0	7,120.00	4,530.0	3,620.0	2.0	3.0	76.0	74.0	134.0	480.0	87.0	109.0	78.0	2.5	0.5	78.0
	Minimum	5.5	7080	23.7	32.0	-30	4.3	0.50	8.0	337.00	1,320.0	1,230.0	0.9	0.9	63.0	63.1	118.0	108.0	41.0	109.0	31.1	0.5	0.5	40.0
	Mean	6.062273	9103.87	25.51818	51.8	92.08	13	1.31	64.5	2,949.77	1,697.5	2,425.0	1.8	2.0	69.7	68.6	128.4	294.0	65.3	109.0	50.5	0.8	0.5	54.0
	Median	5.91	8000	25.7	57.5	40.3	4.6	1.00	25.5	2,820.00	1,460.0	2,425.0	2.0	2.0	69.0	68.6	129.0	294.0	66.8	109.0	49.5	0.5	0.5	51.0
	Rolling Median	5.89	8,186	26.0	57.5	40.30	4.60	1.00	25.50	2790.00	1460.00	2425.00	2.00	1.95	70.55	68.55	131.50	294.00	66.80	109.00	50.50	0.50	0.50	52.80
	Standard Deviation	0.451368	3823.404	0.889739	13.1	170.553	13.88856	1.19	111.1	1,431.05	894.5	1,690.0	0.4	1.5	3.8	7.7	4.9	263.0	12.7	#DIV/0!	13.9	0.8	#DIV/0!	11.0

Notes:
Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.
"-" denotes the sample was not anaylsed for the specific analyte
"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

												Heavy Metals														
Hydroxide Alkalinity as OH	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)	Cyanide (total)	Total Phosphorus (as P)	Total Anions	Total Cations	Total Dissolved Solids @180°C (Filtered)	Arsenic (Total)	Arsenic (Filtered)	Cadmium (Total)	Cadmium (Filtered)	Chromium (Total)	Chromium (Filtered)	Copper (Total)	Copper (Filtered)	Iron (Total)	Iron (Filtered)	Lead (Total)	Lead (Filtered)	Manganese (Total)	Manganese (Filtered)	Mercury (Total)	Mercury (Filtered)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
	0.7	0.900										0.013	0.0130	0.0002	0.0002	0.001	0.001	0.0014	0.0014			0.0034	0.0034	1.900	1.900	0.0006	0.0006
		0.020	0.064			0.5		0.5			2000-5000																
-	0.030	-	-	-	-	0.05	-	0.030	-	-	-	-	0.0005	-	0.0100	-	0.0020	-	0.0060	-	-	-	0.0005	-	-	-	0.00005
-	0.005	-	-	-	-	0.80	-	0.240	-	-	-	0.0020	0.0020	0.0002	0.0001	0.0430	0.0020	0.0720	0.0005	-	-	0.0250	0.0005	-	-	0.00005	0.00005
-	-	-	-	-	-	-	-	-	-	-	-	-	0.0030	-	0.0004	-	0.0030	-	0.0010	-	-	-	0.0005	-	-	-	0.00050
-	-	-	-	-	-	-	-	-	-	-	-	-	0.0005	-	0.0001	-	0.0030	-	0.0030	-	-	-	0.0005	-	-	-	0.00005
-	0.024	0.281	0.305	-	-	-	-	5.090	-	-	-	-	0.0030	-	0.0004	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00005
-	0.010	0.822	0.832	-	-	-	-	4.530	-	-	-	-	0.0060	-	0.0007	-	0.0020	-	0.0680	-	-	-	0.0080	-	-	-	0.00005
0.5	0.030	0.260	0.290	0.70	0.40	0.70	0.002	0.200	81.10	77.60	5,120.0	-	0.0005	-	0.0002	-	0.0020	-	0.0005	-	2.22	-	0.0005	-	1.340	-	0.00005
-	0.020	0.610	0.630	1.10	0.50	1.10	0.002	0.290	204.00	201.00	12,100.0	-	0.0020	-	0.0001	-	0.0020	-	0.0010	-	9.01	-	0.0005	-	1.710	-	0.00005
0.5	0.010	0.460	0.470	0.60	0.10	0.60	0.002	0.260	81.80	77.60	5,090.0	-	0.0005	-	0.0001	-	0.0010	-	0.0010	-	1.51	-	0.0005	-	1.410	-	0.00005
0.5	0.005	-	-	1.90	-	1.90	0.002	0.190	84.50	77.10	5,210.0	-	0.0040	-	0.0001	-	0.0005	-	0.0020	-	11.10	-	0.0030	-	1.280	-	0.00005
0.5	0.030	-	-	0.60	-	0.60	0.002	0.100	85.60	79.60	4,960.0	-	0.0030	-	0.0001	-	0.0005	-	0.0005	-	9.86	-	0.0020	-	1.470	-	0.00005
0.5	0.030	-	-	1.30	-	1.30	0.002	0.300	81.40	80.50	4,670.0	-	0.0080	-	0.0001	-	0.0005	-	0.0005	-	12.70	-	0.0005	-	1.450	-	0.00005
0.5	0.005	-	-	0.50	-	0.50	0.002	0.005	80.70	78.40	4,910.0	-	0.0030	-	0.0001	-	0.0005	-	0.0020	-	5.55	-	0.0060	-	1.330	-	0.00005
0.5	0.005	-	-	0.40	-	0.40	0.002	0.480	80.90	80.40	4,510.0	-	0.0070	-	0.0001	-	0.0005	-	0.0005	-	13.80	-	0.0005	-	1.290	-	0.00005
0.5	0.005	-	-	0.90	-	0.90	0.002	0.190	83.30	74.70	4,640.0	-	0.0040	-	0.0001	-	0.0005	-	0.0005	-	5.51	-	0.0005	-	1.210	-	0.00005
0.5	0.005	-	-	0.70	-	0.70	0.002	0.100	83.40	71.10	5,190.0	-	0.0020	-	0.0001	-	0.0005	-	0.0005	-	5.11	-	0.0005	-	1.200	-	0.00005
0.5	0.050	0.310	0.360	-	-	-	-	0.060	84.70	79.60	5,120.0	0.0020	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00005	-
-	0.010	0.370	0.380	-	-	-	-	0.050	-	-	5,430.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.030	0.450	0.480	-	-	-	-	0.050	-	-	5,367.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.020	0.580	0.600	-	-	-	-	0.050	-	-	5,275.0	0.0005	-	0.0010	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00030	-
-	0.005	0.320	0.325	-	-	-	-	0.050	-	-	5,242.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.010	0.470	0.480	-	-	-	-	0.050	-	-	5,360.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.030	0.380	0.410	-	-	-	-	0.050	-	-	5,160.0	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005	0.0020	0.0010	-	-	0.0005	0.0003	-	-	0.00030	0.00100
0.5	0.050	0.822	0.832	1.90	0.50	1.90	0.002	5.090	204.00	201.00	12,100.0	0.0020	0.0080	0.0010	0.0100	0.0430	0.0030	0.0720	0.0680	0.00	13.80	0.0250	0.0080	0.000	1.710	0.00030	0.00100
0.5	0.005	0.260	0.290	0.40	0.10	0.05	0.002	0.005	80.70	71.10	4,510.0	0.0005	0.0005	0.0001	0.0001	0.0005	0.0005	0.0005	0.0005	0.00	1.51	0.0005	0.0003	0.000	1.200	0.00005	0.00005
0.5	0.018	0.443	0.464	0.87	0.33	0.80	0.002	0.589	93.76	88.87	5,491.4	0.0013	0.0029	0.0004	0.0008	0.0111	0.0013	0.0188	0.0052	#DIV/0!	7.64	0.0066	0.0015	#DIV/0!	1.369	0.00018	0.00013
0.5	0.010	0.415	0.440	0.70	0.40	0.70	0.002	0.100	83.30	78.40	5,160.0	0.0013	0.0030	0.0004	0.0001	0.0005	0.0005	0.0013	0.0010	#NUM!	7.28	0.0005	0.0005	#NUM!	1.335	0.00018	0.00005
0.50	0.02	0.38	0.44	0.65	0.40	0.65	0.00	0.050	83.35	79.00	5258.50	ID	0.004	ID	0.0001	ID	0.0005	ID	0.0005	ID	7.71	ID	0.0005	ID	1.310	ID	0.00005
0.0	0.013	0.163	0.159	0.45	0.21	0.47	0.000	1.411	36.60	37.29	1,723.4	0.0009	0.0023	0.0004	0.0024	0.0213	0.0009	0.0355	0.0162	#DIV/0!	4.28	0.0123	0.0022	#DIV/0!	0.151	0.00014	0.00025

GOLDER

				B-TEX									Total Petroleum Hydrocarbons												Volatile Organic Compounds		
Nickel (Total)	Nickel (Filtered)	Zinc (Total)	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Total BTEX (Calculated)	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Total MAHs (Lab Reported)	Naphthalene	TRH C10 - C36 (Sum, Lab Reported) SG Cleanup	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Calculated)	TRH C6 - C10 Fraction F1	TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4	Carbon tetrachloride	Chloroethane	Vinyl chloride
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.011	0.011	0.008	0.008	0.95					0.35			0.016															
-	0.005	-	0.064	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0210	0.004	0.124	0.018	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.005	-	0.023	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.005	-	0.024	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-	0.010	0.250	0.750	0.250	-	-	-	-	-	-	-	-	-	-
-	0.004	-	0.003	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-	0.010	0.025	0.050	0.050	-	-	-	-	-	-	-	-	-	-
-	0.017	-	0.065	0.0005	0.0010	0.0010	-	0.0010	0.0010	-	-	-	-	0.020	0.025	0.050	0.080	-	-	-	-	-	-	-	-	-	-
-	0.004	-	0.011	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.021	-	0.014	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	-	0.0055	0.0025	-	0.010	0.025	0.050	0.025	0.025	-	0.05	-	-	-	-	-	-	-	-
-	0.005	-	0.016	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.003	-	0.009	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	0.002	-	0.008	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	0.002	-	0.008	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	0.004	-	0.015	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	0.002	-	0.007	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	-	-	-	-	-	-	-	0.01	0.05	0.05	0.05	-	-	-
-	0.005	-	0.008	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
-	0.004	-	0.008	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	-	-	-
0.0040	-	0.009	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.05	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0040	-	0.011	-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.03	-	0.01	0.05	0.05	0.05	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0050	0.004	0.020	0.018	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	0.050	0.010	0.050	0.050	0.025	-	-	-	-	-	-	-	-	-	-
0.0210	0.021	0.124	0.065	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	0.050	0.020	0.250	0.750	0.250	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0040	0.002	0.009	0.003	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	0.050	0.010	0.025	0.050	0.025	0.025	0.03	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0085	0.006	0.041	0.019	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	0.050	0.011	0.042	0.097	0.045	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0045	0.004	0.016	0.014	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	0.050	0.010	0.025	0.050	0.025	0.025	0.05	0.05	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
ID	0.004	ID	0.008	0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	0.050	0.010	0.025	0.050	0.025	0.025	0.05	0.05	0.01	0.05	0.05	0.05	ID	ID	ID
0.0083	0.005	0.056	0.018	0.0000	0.0000	0.0000	#DIV/0!	0.0000	0.0000	0.0000	#DIV/0!	4.55E-19	#DIV/0!	0.003	0.058	0.181	0.059	#DIV/0!	0.01	#DIV/0!	0.00	0.00	0.00	0.00	0.0000	0.000	0.000

		Field Parameters																
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium	Magnesium (Filtered)
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Contaminant Alert Trigger Values - Surface Water		6.8-8.0									180	180						
Lethe Brook fresh waters WQO*		7.5-7.8	463		40-120		1											
Location	**Sampled Date**																	
SED1	2010-09-07	8.30	1,010	-	-	-	-	1	68	185	131	-	31	-	66	-	27	-
	2011-04-27	6.56	7,790	-	-	-	-	-	-	2810	-	1440	-	2	-	69	-	129
	2011-09-21	8.45	2,106	-	-	-	-	10	-	407	270	-	92	-	93	-	39	-
	2012-04-24	7.94	797	-	-	-	-	12	7	71	62	-	19	-	59	-	17	-
	2012-11-14	8.59	1,540	-	-	-	-	6	-	300	208	-	37	-	68	-	31	-
	2013-05-01	8.13	758	-	-	-	-	18	-	81	79	-	22	-	52	-	17	-
	2013-11-14	8.62	1,390		-		-	4	-	237	174	-	39	-	66	-	32	-
	2014-07-31	8.53	935	-	-	-	-	5	-	148	121	-	27	-	36	-	22	-
	2015-05-06	8.54	1,680	-	-	-	-	12	-	-	-	-	-	-	-	-	-	-
	2015-12-17	8.86	2,630	-	-	-	-	23	-	625	427	-	70	-	25	-	37	-
	2016-05-17	-	1,310	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2017-01-13	9.05	660	-	-	-	-	5	93	-	-	-	-	-	-	-	-	-
	2017-05-11	8.00	1,130	-	92	-	9.4	8	77	-	-	-	-	-	-	-	-	-
	2017-08-30	8.91	1,396	-	225	-	37	23	153	214	180	-	47.5	-	61.2	-	31.6	-
	2017-11-16	8.80	2,400	-	298	-	50	19	424	-	-	-	-	-	-	-	-	-
	2018-03-14	8.17	2,683	-	48	-	30	16	34	-	-	-	-	-	-	-	-	-
	2018-06-07	8.21	1,010	-	-	-	-	2	68	185	131	-	32	-	67	-	28	-
Statistics:																		
	Maximum	9.05	7,790	ID	298	ID	50.0	23	424	2810	427	1440	92	2	93	69	39	129
	Minimum	6.56	660	ID	48	ID	9.4	1	7	71	62	1440	19	2	25	69	17	129
	Mean	8.35	1,837	ID	166	ID	31.6	11	116	478	178	1440	42	2	59	69	28	129
	Median	8.49	1,390	ID	159	ID	33.5	10	73	214	153	1440	35	2	64	69	30	129
	Rolling Median	8.19	1,847	ID	48	ID	ID	14	73	200	153	ID	35	ID	60	ID	30	ID
	Standard Deviation	0.58	1,663	ID	116	ID	17.0	7	132	789	107	ID	23	ID	19	#DIV/0!	8	ID

Notes:
Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.
"-" denotes the sample was not anaylsed for the specific analyte
* Lethe Brook fresh waters Water Quaity Objective for baseflow applies to surface water at Kelsey Creek
"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

GOLDER

Sample Quality Parameters

Sulphate (as SO4)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Hydroxide Alkalinity as OH	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)	Cyanide (total)	Total Phosphorus (as P)	Total Anions	Total Cations	Total Dissolved Solids @180°C (Filtered)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	mg/L
					0.7	0.900				0.50		0.05			2000-5000
						0.020	0.064								
-	344	11	355	-	0.04	0.05	0.09	1.7	1.6	1.7	0.002	0.2	12.50	12.00	646
-	55	0.5	55	0.5	0.23	-	-	0.6	0.2	0.8	0.002	0.005	81.80	76.80	4,510
-	446	34	480	-	-	-	-	-	-	-	0.002	-	21.80	22.00	1,350
-	290	-	290	-	-	-	-	-	-	-	0.002	-	7.90	7.53	510
-	324	45	369	-	-	-	-	-	-	-	0.002	-	16.20	15.90	876
-	267	0.5	267	-	-	-	-	-	-	-	0.002	-	7.70	7.99	462
-	351	42	393	-	-	-	-	-	-	-	0.002	-	14.60	14.50	803
-	228	27	256	-	-	-	-	-	-	-	0.002	-	9.48	9.56	557
-	-	-	-	-	-	-	-	-	-	-	0.002	-	1.49	1.53	926
-	-	-	-	-	-	-	-	-	-	-	0.002	-	27.40	24.60	1,560
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	838
-	-	-	-	-	0.005	0.01	0.015	-	-	-	-	0.65	-	-	422
-	-	-	-	-	0.27	9.200	9.47	-	-	-	-	0.32	-	-	-
-	210	36.5	4410	-	0.1	0.31	0.41	-	-	-	-	0.56	-	-	907
-	-	-	-	-	4.27	9.400	13.67	-	-	-	-	1.10	-	-	1560
-	-	-	-	-	0.01	29.000	29.01	-	-	-	-	1.70	-	-	1528
-	344	11	355	-	0.42	0.05	0.47	1.7	1.6	1.7	0.002	0.18	12.60	12.00	646
ID	446	45	4410	ID	4.270	29.00	ID	1.7	1.6	1.7	0.002	1.70	81.80	76.80	4,510
ID	55	1	55	ID	0.005	0.01	ID	0.6	0.2	0.8	0.002	0.005	1.49	1.53	422
ID	286	23	723	ID	0.668	6.86	ID	1.3	1.1	1.4	0.002	0.59	19.41	18.58	1,131
ID	307	27	355	ID	0.165	0.31	ID	1.7	1.6	1.7	0.002	0.44	12.60	12.00	857
ID	307	31	362	ID	0.165	ID	ID	ID	ID	ID	0.002	0.440	11.04	10.78	1,087
ID	106	18	1300	ID	1.463	10.68	ID	0.6	0.8	0.5	0.000	0.57	21.86	20.38	982

Appendix I Kelsey Creek Analytical Results

GOLDER

Heavy Metals

Arsenic	Arsenic (Filtered)	Cadmium	Cadmium (Filtered)	Chromium	Chromium (Filtered)	Copper	Copper (Filtered)	Iron	Iron (Filtered)	Lead	Lead (Filtered)	Manganese	Manganese (Filtered)	Mercury	Mercury (Filtered)	Nickel	Nickel (Filtered)	Zinc	Zinc (Filtered)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.013	0.0130	0.0002	0.0002	0.001	0.001	0.0014	0.0014			0.0034	0.0034	1.900	1.900	0.0006	0.00060	0.011	0.011	0.008	0.0080
0.004	-	0.0057	-	0.003	-	0.001	-	0.27	-	0.0005	-	0.354	-	0.00005	-	0.005	-	0.011	-
-	0.0005	-	0.0001	-	0.0005	-	0.0005	-	5.7	-	0.0005	-	1.36	-	0.00005	-	0.004	-	0.012
0.007	-	0.00005	-	0.002	-	0.005	-	0.025	-	0.0005	-	0.394	-	0.00005	-	0.015	-	0.009	-
0.005	-	0.00005	-	0.0005	-	0.001	-	0.06	-	0.003	-	0.801	-	0.00005	-	0.004	-	0.020	-
0.008	-	0.00005	-	0.0005	-	0.001	-	-	-	0.277	-	0.072	-	0.00005	-	0.007	-	0.010	-
0.003	-	0.0002	-	0.0005	-	0.004	-	0.025	-	0.0005	-	0.236	-	0.00005	-	0.005	-	0.033	-
0.009	-	0.00005	-	0.004	-	0.002	-	0.49	-	0.001	-	0.373	-	0.00005	-	0.006	-	0.007	-
0.002	-	0.00005	-	0.001	-	0.004	-	0.37	-	0.001	-	0.144	-	0.00005	-	0.006	-	0.0025	-
0.006	-	0.00005	-	0.002	-	0.0005	-	0.025	-	0.0005	-	0.003	-	0.00005	-	0.009	-	0.0025	-
0.008	-	0.00005	-	0.002	-	0.002	-	0.33	-	0.0005	-	0.230	-	0.00005	-	0.014	-	0.0025	-
0.004	-	0.00005	-	0.002	-	0.003	-	-	-	0.002	-	-	-	0.00005	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.004	-	0.0001	-	0.005	-	0.0005	-	-	-	0.0005	-	-	-	0.00030	-	0.009	-	0.011	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.005	-	0.0058	-	0.004	-	0.002	-	0.28	-	0.0010	-	0.355	-	0.00010	-	0.006	-	0.012	-
0.009	0.0005	0.0058	0.00	0.005	0.00	0.0050	0.00	0.49	5.70	0.2770	0.00	0.801	1.36	0.0003	0.00	0.015	0.004	0.033	0.012
0.002	0.0005	0.0001	0.00005	0.0005	0.0005	0.0005	0.0005	0.025	5.70	0.0005	0.0005	0.003	1.36	0.0001	0.00005	0.004	0.004	0.003	0.012
0.005	ID	0.0010	ID	0.002	ID	0.0022	ID	0.21	ID	0.0240	ID	0.296	ID	0.0001	ID	0.008	ID	0.011	ID
0.005	ID	0.0001	ID	0.002	ID	0.0020	ID	0.27	ID	0.0008	ID	0.295	ID	0.0001	ID	0.006	ID	0.010	ID
0.005	ID	0.0001	ID	0.002	ID	0.0020	ID	0.17	ID	0.0008	ID	0.233	ID	0.0001	ID	0.007	ID	0.009	ID
0.002	ID	0.0022	ID	0.002	ID	0.0015	ID	0.18	ID	0.0797	ID	0.222	ID	0.0001	ID	0.004	ID	0.009	ID

Appendix I Kelsey Creek Analytical Results

GOLDER

B-TEX									Total Petroleum Hydrocarbons													Volatile Organic Compounds		
Benzene	Toluene	Ethylbenzene	Total BTEX (Calculated)	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Total MAHs (Lab Reported)	Naphthalene	TRH C10 - C36 (Sum, Lab Reported)	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reporte	TRH+C10 - C40 (Sum of total) (Lab Reporte	TRH+C10 - C40 (Sum of total) (Calculated)	TRH C6 - C10 Fraction F1	TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4	Carbon tetrachloride	Chloroethane	Vinyl chloride
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.9500					0.3500			0.016													0.0065	0.0065	0.0065
0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.050	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	-	0.0055	0.0025	-	0.010	0.025	0.050	0.025	0.025	-	0.05	-	-	-	-	-	-	-
0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-	0.010	0.025	0.050	0.025	-	0.050	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	-	-	0.010	0.025	0.050	0.025	-	0.050	-	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.050	-	0.01	0.05	0.05	0.05	-	-	-
0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.050	-	0.01	0.05	0.05	0.05	-	-	-
0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.050	-	0.01	0.05	0.05	0.05	-	-	-
0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	-	-	-	-	-	-	-	0.01	0.05	0.05	0.05	-	-	-
0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.340	0.090	-	0.380	-	-	0.05	0.38	0.05	0.0025	0.025	0.025
0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.060	0.500	0.230	-	0.750	-	0.01	0.05	0.65	0.1	-	-	-
1.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.670	0.190	-	0.890	-	0.01	0.05	0.79	0.1	0.0025	0.025	0.025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.180	0.080	-	0.260	0.0005	0.0010	0.0010	-	0.0010	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.100	-	0.01	0.01	0.01	0.01	0.0025	0.025	0.025
1.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	0.00	0.01	0.060	0.670	0.230	0.025	0.890	0.05	0.01	0.05	0.79	0.10	0.00	0.03	0.03
0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	0	0.01	0.025	0.050	0.025	0.025	0.050	0.0005	0.001	0.001	0.01	0.001	0.0025	0.025	0.025
0.0774	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	#DIV/0!	0.01	0.028	0.174	0.066	0.025	0.244	0.03	0.01	0.04	0.20	0.05	0.00	0.03	0.03
0.0005	0.0010	0.0010	0.0055	0.0010	0.0010	0.0010	0.0055	0.0025	#NUM!	0.01	0.025	0.050	0.025	0.025	0.050	0.02525	0.01	0.05	0.05	0.05	0.0025	0.025	0.025
0.0005	0.0010	0.0010	#NUM!	0.0010	0.0010	0.0010	#NUM!	ND	#NUM!	0.01	0.025	0.115	0.053	ID	0.180	ID	0.01	0.05	0.05	0.05	ID	ID	ID
0.2774	0.0000	0.0000	#DIV/0!	0.0000	0.0000	0.0000	#DIV/0!	ID	#DIV/0!	0.00	0.010	0.214	0.072	ID	0.306	0.04	0.00	0.02	0.28	0.03	0.00	0.00	0.00

Appendix I Kelsey Creek Analytical Results

		Field Parameters													
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Contaminant Alert Trigger Values - Surface Water		6.8-8.0									180	180			
Lethe Brook fresh waters WQO*		7.5-7.8	463		40-120		1								
Location	**Sampled Date**														
SED2	2010-09-07	8.1	2,030	-	-	3.0	30.0	11	216	-	-	-	-	-	-
	2011-04-27	9.6	775	-	-	27.0	3.4	5	70	159	88.9	-	27.4	-	34.2
	2011-09-21	8.0	555	-	-	13.9	5.4	5	75	-	-	-	-	-	-
	2012-04-24	8.1	918	-	-	-53.1	6.5	8	107	-	-	-	-	-	-
	2012-11-14	7.6	935	-	-	22.2	40.3	9	120	110	85.5	75.4	39.3	35.7	62.9
Statistics:															
	Maximum	9.6	2,030	ID	ID	27.0	40.3	11	216	159	88.9	75.4	39.3	35.7	62.9
	Minimum	7.6	555	ID	ID	-53.1	3.4	5	70	110	85.5	75.4	27.4	35.7	34.2
	Mean	8.3	1,043	ID	ID	2.6	17.1	8	118	135	87.2	75.4	33.4	35.7	48.6
	Median	8.1	918	ID	ID	13.9	6.5	8	107	135	87.2	75.4	33.4	35.7	48.6
	Rolling Median	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
	Standard Deviation	0.8	573	ID	ID	32.4	16.9	3	59	35	2.4	ID	8.4	#DIV/0!	20.3

Notes:

Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.

"-" denotes the sample was not anaylsed for the specific analyte

* Lethe Brook fresh waters Water Quaity Objective for baseflow applies to surface water at Kelsey Creek

"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

Appendix I Kelsey Creek Analytical Results

GOLDER

Sample Quality Parameters

Calcium (Filtered)	Magnesium	Magnesium (Filtered)	Sulphate (as SO4)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Hydroxide Alkalinity as OH	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Kjeldahl Nitrogen (as N)	Nitrogen (Organic)	Nitrogen (Total)	Cyanide (total)	Total Phosphorus (as P)	Total Anions	Total Cations	Total Dissolved Solids @180°C (Filtered)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	meq/L	meq/L	mg/L
								0.700	0.900				0.50		0.05			2000-5000
									0.020	0.064								
-	-	-	-	-	-	-	-	0.12	5.10	-	-	-	0.12	<0.004	3.80	-	-	-
-	20.5	-	4.6	12.3	104	194	-	0.005	0.01	-	-	-	0.01	<0.004	0.39	-	-	504
-	-	-	-	-	-	-	-	0.005	0.58	-	-	-	0.01	<0.004	0.78	-	-	360
-	-	-	-	-	-	-	-	0.005	4.80	-	-	-	0.01	<0.004	0.63	-	-	529
55.3	22.8	20.4	10.7	205.0	<5	337	-	0.02	-	-	-	-	0.02	<0.004	0.77	-	-	604
55.3	22.8	20.4	10.7	205.0	104	337	0.00	0.12	5.10	ID	ID	ID	0.12	0.00	3.80	ID	0.00	604.00
55.3	20.5	20.4	4.6	12.3	104	194	0	0.005	0.01	ID	ID	ID	0.01	0	0.39	ID	0	360
55.3	21.7	20.4	7.7	108.7	104	266	#DIV/0!	0.03	2.62	ID	ID	ID	0.03	#DIV/0!	1.27	ID	#DIV/0!	499.25
55.3	21.7	20.4	7.7	108.7	104	266	#NUM!	0.005	2.69	ID	ID	ID	0.01	#NUM!	0.77	ID	#NUM!	516.5
ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
#DIV/0!	1.6	#DIV/0!	4.3	136.3	#DIV/0!	101	#DIV/0!	0.05	2.70	ID	ID	ID	0.05	#DIV/0!	1.42	ID	#DIV/0!	102.10

Heavy Metals																		
Arsenic	Arsenic (Filtered)	Cadmium	Cadmium (Filtered)	Chromium	Chromium (Filtered)	Copper	Copper (Filtered)	Iron	Iron (Filtered)	Lead	Lead (Filtered)	Manganese	Manganese (Filtered)	Mercury	Mercury (Filtered)	Nickel	Nickel (Filtered)	Zinc
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.013	0.0130	0.0002	0.0002	0.001	0.001	0.0014	0.0014			0.0034	0.0034	1.900	1.900	0.0006	0.00060	0.011	0.011	0.008
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.003	-	0.0001	-	0.0005	-	0.0005	-	-	-	0.0005	-	-	-	0.00030	-	0.001	-	0.0025
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.003	-	0.0001	0.0001	0.002	-	0.002	-	-	-	0.004	-	-	-	0.00030	-	0.002	-	0.025
0.00	ID	0.00	0.00	0.00	ID	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03
0.003	ID	0.00005	0.00005	0.0005	ID	0.0005	0	0	0	0.0005	0	0	0	0.0003	0	0.001	0	0.0025
0.00	ID	0.00	0.00	0.00	ID	0.00	#DIV/0!	#DIV/0!	#DIV/0!	0.00	#DIV/0!	#DIV/0!	#DIV/0!	0.00	#DIV/0!	0.00	#DIV/0!	0.01
0.003	ID	0.000075	0.00005	0.00125	ID	0.00125	#NUM!	#NUM!	#NUM!	0.00225	#NUM!	#NUM!	#NUM!	0.0003	#NUM!	0.0015	#NUM!	0.01375
ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
0.00	ID	0.00	#DIV/0!	0.00	ID	0.00	#DIV/0!	#DIV/0!	#DIV/0!	0.00	#DIV/0!	#DIV/0!	#DIV/0!	0.00	#DIV/0!	0.00	#DIV/0!	0.02

Appendix I Kelsey Creek Analytical Results

	B-TEX									Total Petroleum Hydrocarbons								
Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Total BTEX (Calculated)	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Total MAHs (Lab Reported)	Naphthalene	TRH C10 - C36 (Sum, Lab Reported)	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C36 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Lab Reported)	TRH+C10 - C40 (Sum of total) (Calculated)	TRH C6 - C10 Fraction F1
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
0.0080	0.95					0.35			0.016									
-	-	-	-	-	-	-	-	-	0.0025	-	-	-	-	-	-	-	-	-
-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	-	0.010	0.025	0.050	0.025	-	0.03	-	0.01
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	0.0005	0.0010	0.0010	-	0.0010	0.0010	0.0010	-	0.0025	0.41	0.010	0.06	0.24	0.11	-	-	-	-
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.01	0.06	0.24	0.11	0.00	0.03	0.00	0.01
0	0.0005	0.001	0.001	0	0.001	0.001	0.001	0	0.0025	0.41	0.01	0.025	0.05	0.025	0	0.025	0	0.01
#DIV/0!	0.00	0.00	0.00	#DIV/0!	0.00	0.00	0.00	#DIV/0!	0.00	0.41	0.01	0.04	0.15	0.07	#DIV/0!	0.03	#DIV/0!	0.01
#NUM!	0.0005	0.001	0.001	#NUM!	0.001	0.001	0.001	#NUM!	0.0025	0.41	0.01	0.0425	0.145	0.0675	#NUM!	0.025	#NUM!	0.01
ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
#DIV/0!	0.00	0.00	0.00	#DIV/0!	0.00	0.00	0.00	#DIV/0!	0.00	#DIV/0!	0.00	0.02	0.13	0.06	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

			Volatile Organic Compounds		
TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4	Carbon tetrachloride	Chloroethane	Vinyl chloride
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
			0.0065	0.0065	0.0065
-	-	-	-	-	-
0.05	0.05	0.05	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
0.05	0.05	0.05	0.00	0.00	0.00
0.05	0.05	0.05	0	0	0
0.05	0.05	0.05	#DIV/0!	#DIV/0!	#DIV/0!
0.05	0.05	0.05	#NUM!	#NUM!	#NUM!
ID	ID	ID	ID	ID	ID
#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Appendix I Kelsey Creek Analytical Results

		Field Parameters						Sample Quali									
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Location	**Sampled Date**																
L1	11-05-17	7.10	1,005	27.0	14.0	-49	0.7	3.00	19.0	-	-	-	-	-	-	-	-
	30-08-17	7.88	3,600	26.6	11.2	-41	1	13.00	132.0	587.00	373.0	-	63.0	-	77.6	-	31.8
	16-11-17	7.58	3,572	28.2	8.3	-81	0	5.00	136.0	-	-	-	-	-	-	-	-
	14-03-18	7.27	1,627	29.1	31.3	-50.4	0.5	4.00	34.0	-	-	-	-	-	-	-	-
	07-06-18	7.46	1,676	26.2	27.8	1.4	0	3.00	52.0	238.00	154.0	140.0	32.3	27.4	61.3	54.2	18.0
Statistics:																	
	Maximum	7.88	3600	29.1	31.3	1.4	1	13.00	136.0	587.00	373.0	140.0	63.0	27.4	77.6	54.2	31.8
	Minimum	7.1	1005	26.2	8.3	-81	0	3.00	19.0	238.00	154.0	140.0	32.3	27.4	61.3	54.2	18.0
	Mean	7.458	2296	27.42	18.5	-44	0.44	5.60	74.6	412.50	263.5	140.0	47.7	27.4	69.5	54.2	24.9
	Median	7.46	1676	27	14.0	-49	0.5	4.00	52.0	412.50	263.5	140.0	47.7	27.4	69.5	54.2	24.9
	Rolling Median	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
	Standard Deviation	0.29853	1206.983	1.200833	10.3	29.60203	0.439318	4.22	55.5	246.78	154.9	#DIV/0!	21.7	#DIV/0!	11.5	#DIV/0!	9.8

Notes:

Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.

"-" denotes the sample was not anaylsed for the specific analyte

* Lethe Brook fresh waters Water Quaity Objective for baseflow applies to surface water at Kelsey Creek

"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

Appendix I Kelsey Creek Analytical Results

GOLDER

ty Parameters										Heavy Metals											
Magnesium (Filtered)	Sulphate (as SO4)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Phosphorus (as P)	Total Dissolved Solids @180°C (Filtered)	Arsenic	Arsenic (Filtered)	Cadmium	Cadmium (Filtered)	Chromium	Chromium (Filtered)	Copper	Copper (Filtered)	Lead	Lead (Filtered)	Mercury	Mercury (Filtered)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
-	-	-	-	-	2.100	23.500	25.600	0.290	-	-	-	-	-	-	-	-	-	-	-	-	-
-	17.6	579.0	2.5	949.0	1.700	129.000	130.700	0.380	2,341.0	0.0050	-	0.0001	-	0.0060	-	0.0005	-	0.0005	-	0.00030	-
-	-	-	-	-	16.600	98.600	115.200	0.530	2,321.0	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	18.000	10.600	28.600	0.190	928.0	-	-	-	-	-	-	-	-	-	-	-	-
15.5	5.6	241.0	2.5	395.0	4.900	28.800	33.700	0.140	1,001.0	0.0040	0.0040	0.0001	0.0001	0.0020	0.0020	0.0010	0.0010	0.0005	0.0005	0.00030	0.00030
15.5	17.6	579.0	2.5	949.0	18.000	129.000	130.700	0.530	2,341.0	0.0050	0.0040	0.0001	0.0001	0.0060	0.0020	0.0010	0.0010	0.0005	0.0005	0.00030	0.00030
15.5	5.6	241.0	2.5	395.0	1.700	10.600	25.600	0.140	928.0	0.0040	0.0040	0.0001	0.0001	0.0020	0.0020	0.0005	0.0010	0.0005	0.0005	0.00030	0.00030
15.5	11.6	410.0	2.5	672.0	8.660	58.100	66.760	0.306	1,647.8	0.0045	0.0040	0.0001	0.0001	0.0040	0.0020	0.0008	0.0010	0.0005	0.0005	0.00030	0.00030
15.5	11.6	410.0	2.5	672.0	4.900	28.800	33.700	0.290	1,661.0	0.0045	0.0040	0.0001	0.0001	0.0040	0.0020	0.0008	0.0010	0.0005	0.0005	0.00030	0.00030
ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
#DIV/0!	8.5	239.0	0.0	391.7	7.998	52.390	51.667	0.156	789.6	0.0007	#DIV/0!	0.0000	#DIV/0!	0.0028	#DIV/0!	0.0004	#DIV/0!	0.0000	#DIV/0!	0.00000	#DIV/0!

Appendix I Kelsey Creek Analytical Results

				B-TEX							Total Petroleum Hydrocarbons									
Nickel	Nickel (Filtered)	Zinc	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Naphthalene	TRH C10 - C36 (Sum, Lab Reported)	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C40 (Sum of total) (Lab Reported)	TRH C6 - C10 Fraction F1	TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0140	-	0.3340	-	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	-	0.010	0.090	0.240	0.025	0.33	0.01	0.12	0.23	0.05
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0070	0.0060	0.3590	0.3180	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	0.190	0.010	0.060	0.130	0.025	-	-	-	-	-
0.0140	0.0060	0.3590	0.3180	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	0.190	0.010	0.090	0.240	0.025	0.33	0.01	0.12	0.23	0.05
0.0070	0.0060	0.3340	0.3180	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	0.190	0.010	0.060	0.130	0.025	0.33	0.01	0.12	0.23	0.05
0.0105	0.0060	0.3465	0.3180	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	0.190	0.010	0.075	0.185	0.025	0.33	0.01	0.12	0.23	0.05
0.0105	0.0060	0.3465	0.3180	0.0005	0.0010	0.0010	0.0010	0.0010	0.0010	0.0025	0.190	0.010	0.075	0.185	0.025	0.33	0.01	0.12	0.23	0.05
ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
0.0049	#DIV/0!	0.0177	#DIV/0!	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0	#DIV/0!	0.000	0.021	0.078	0.000	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

Appendix I Kelsey Creek Analytical Results

		Field Parameters						Sample Quali									
		pH (Lab)	Electrical Conductivity @ 25°C	Temp (Field)	Dissolved Oxygen (%)	Redox Potential	Turbidity (Field Observation)	Biological Oxygen Demand	Chemical Oxygen Demand	Chloride	Sodium	Sodium (Filtered)	Potassium	Potassium (Filtered)	Calcium	Calcium (Filtered)	Magnesium
		pH Units	uS/cm	oC	%	mV	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Location	**Sampled Date**																
L2	11-05-17	7.45	12,045	25.0	3.7	-311	22	78.00	1,580.0	-	-	-	-	-	-	-	-
	30-08-17	7.23	14,335	31.9	2.8	-291	36	99.00	2,100.0	1,650.00	1,450.0	-	378.0	-	128.0	-	134.0
	16-11-17	7.07	14,820	31.8	3.8	-255	39	67.00	2,360.0	-	-	-	-	-	-	-	-
	14-03-18	7.39	23,210	32.3	4.3	-256	65	181.00	4,140.0	-	-	-	-	-	-	-	-
	07-06-18	7.32	21,983	28.5	6.4	-147.8	46.2	250.00	8.0	2,390.00	1,820.0	1,800.0	566.0	501.0	111.0	104.0	164.0
Statistics:																	
	Maximum	7.45	23210	32.3	6.4	-147.8	65	250.00	4,140.0	2,390.00	1,820.0	1,800.0	566.0	501.0	128.0	104.0	164.0
	Minimum	7.07	12045	25	2.8	-311	22	67.00	8.0	1,650.00	1,450.0	1,800.0	378.0	501.0	111.0	104.0	134.0
	Mean	7.292	17278.6	29.9	4.2	-252.16	41.64	135.00	2,037.6	2,020.00	1,635.0	1,800.0	472.0	501.0	119.5	104.0	149.0
	Median	7.32	14820	31.8	3.8	-256	39	99.00	2,100.0	2,020.00	1,635.0	1,800.0	472.0	501.0	119.5	104.0	149.0
	Rolling Median	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
	Standard Deviation	0.148728	4985.302	3.13608	1.3	63.01689	15.74001	78.28	1,488.0	523.26	261.6	#DIV/0!	132.9	#DIV/0!	12.0	#DIV/0!	21.2

Notes:

Indicates result below laboratory limit of reporting (LOR). A value equal to half of the LOR was adopted for statistical calculations.

"-" denotes the sample was not anaylsed for the specific analyte

* Lethe Brook fresh waters Water Quaity Objective for baseflow applies to surface water at Kelsey Creek

"ID" denotes insufficient data for calculating rolling median, a minimum of 8 sample data required.

Appendix I Kelsey Creek Analytical Results

ty Parameters										Heavy Metals											
Magnesium (Filtered)	Sulphate (as SO4)	Bicarbonate Alkalinity (as CaCO3)	Carbonate Alkalinity (as CaCO3)	Total Alkalinity (as CaCO3)	Nitrogen (Total Oxidised)	Ammonia	Dissolved Inorgainc Nitrogen (calculated)	Total Phosphorus (as P)	Total Dissolved Solids @180°C (Filtered)	Arsenic	Arsenic (Filtered)	Cadmium	Cadmium (Filtered)	Chromium	Chromium (Filtered)	Copper	Copper (Filtered)	Lead	Lead (Filtered)	Mercury	Mercury (Filtered)
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
-	-	-	-	-	0.040	754.000	754.040	6.200	-	-	-	-	-	-	-	-	-	-	-	-	-
-	90.3	3,500.0	2.5	5,740.0	0.050	950.000	950.050	8.400	9,317.0	0.0510	-	0.0005	-	0.1250	-	0.0050	-	0.0050	-	0.00300	-
-	-	-	-	-	0.025	1,050.000	1,050.025	9.000	9,633.0	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	0.050	1,400.000	1,400.050	13.700	12,593.0	-	-	-	-	-	-	-	-	-	-	-	-
147.0	1.3	4,540.0	2.5	7,450.0	0.140	1,220.000	1,220.140	13.800	12,650.0	0.1040	0.1000	0.0005	0.0005	0.6610	0.4780	0.0060	0.0060	0.0050	0.0050	0.00100	0.00100
147.0	90.3	4,540.0	2.5	7,450.0	0.140	1,400.000	1,400.050	13.800	12,650.0	0.1040	0.1000	0.0005	0.0005	0.6610	0.4780	0.0060	0.0060	0.0050	0.0050	0.00300	0.00100
147.0	1.3	3,500.0	2.5	5,740.0	0.025	754.000	754.040	6.200	9,317.0	0.0510	0.1000	0.0005	0.0005	0.1250	0.4780	0.0050	0.0060	0.0050	0.0050	0.00100	0.00100
147.0	45.8	4,020.0	2.5	6,595.0	0.061	1,074.800	1,074.861	10.220	11,048.3	0.0775	0.1000	0.0005	0.0005	0.3930	0.4780	0.0055	0.0060	0.0050	0.0050	0.00200	0.00100
147.0	45.8	4,020.0	2.5	6,595.0	0.050	1,050.000	1,050.025	9.000	11,113.0	0.0775	0.1000	0.0005	0.0005	0.3930	0.4780	0.0055	0.0060	0.0050	0.0050	0.00200	0.00100
ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
#DIV/0!	63.0	735.4	0.0	1,209.2	0.045	247.962	247.979	3.387	1,821.4	0.0375	#DIV/0!	0.0000	#DIV/0!	0.3790	#DIV/0!	0.0007	#DIV/0!	0.0000	#DIV/0!	0.00141	#DIV/0!

Appendix I Kelsey Creek Analytical Results

GOLDER

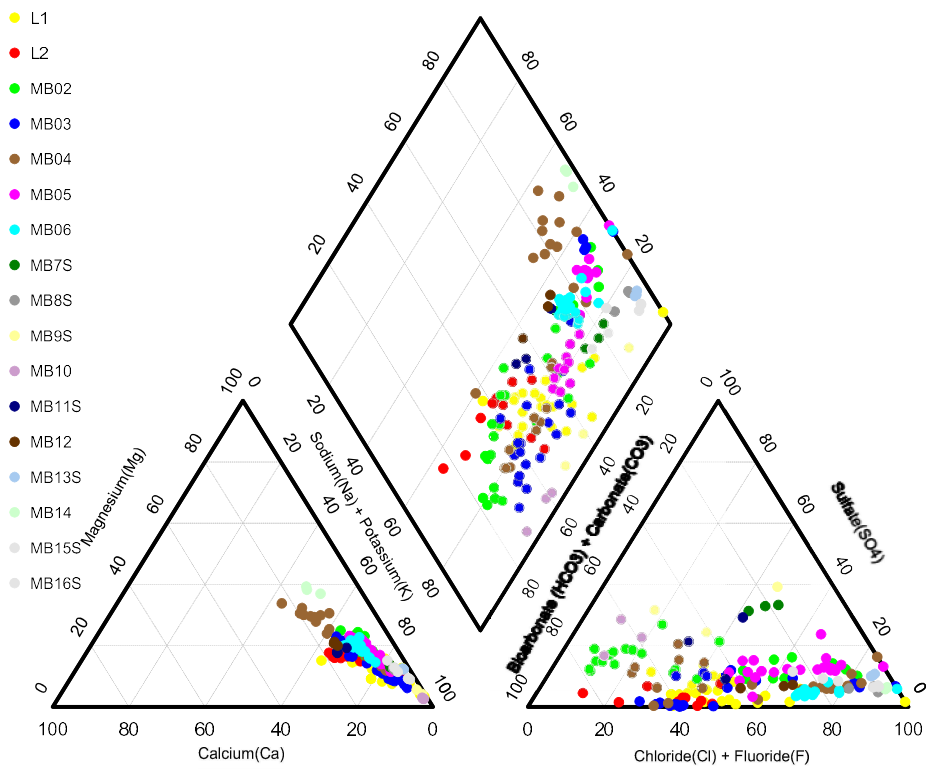
				B-TEX							Total Petroleum Hydrocarbons									
Nickel	Nickel (Filtered)	Zinc	Zinc (Filtered)	Benzene	Toluene	Ethylbenzene	Xylenes (m & p)	Xylene (o)	Xylenes (Sum of total) (Lab Reported)	Naphthalene	TRH C10 - C36 (Sum, Lab Reported)	TRH C6 - C9 Fraction	TRH C10 - C14 Fraction	TRH C15 - C28 Fraction	TRH C29 - C36 Fraction	TRH+C10 - C40 (Sum of total) (Lab Reported)	TRH C6 - C10 Fraction F1	TRH >C10 - C16 Fraction F2	TRH >C16 - C34 Fraction F3	TRH >C34 - C40 Fraction F4
mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.0670	-	0.0550	-	0.0040	0.0030	0.0090	0.0080	0.0070	0.0150	0.0025	-	0.080	1.130	2.540	0.330	4.00	0.06	1.40	2.46	0.20
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0.1380	0.1790	0.1740	0.1480	0.0020	0.0050	0.0080	0.0100	0.0080	0.0180	0.0025	10.600	0.140	2.620	7.090	0.910	-	-	-	-	-
0.1380	0.1790	0.1740	0.1480	0.0040	0.0050	0.0090	0.0100	0.0080	0.0180	0.0025	10.600	0.140	2.620	7.090	0.910	4.00	0.06	1.40	2.46	0.20
0.0670	0.1790	0.0550	0.1480	0.0020	0.0030	0.0080	0.0080	0.0070	0.0150	0.0025	10.600	0.080	1.130	2.540	0.330	4.00	0.06	1.40	2.46	0.20
0.1025	0.1790	0.1145	0.1480	0.0030	0.0040	0.0085	0.0090	0.0075	0.0165	0.0025	10.600	0.110	1.875	4.815	0.620	4.00	0.06	1.40	2.46	0.20
0.1025	0.1790	0.1145	0.1480	0.0030	0.0040	0.0085	0.0090	0.0075	0.0165	0.0025	10.600	0.110	1.875	4.815	0.620	4.00	0.06	1.40	2.46	0.20
ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID	ID
0.0502	#DIV/0!	0.0841	#DIV/0!	0.0014	0.0014	0.0007	0.0014	0.0007	0.0021	0	#DIV/0!	0.042	1.054	3.217	0.410	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

APPENDIX J

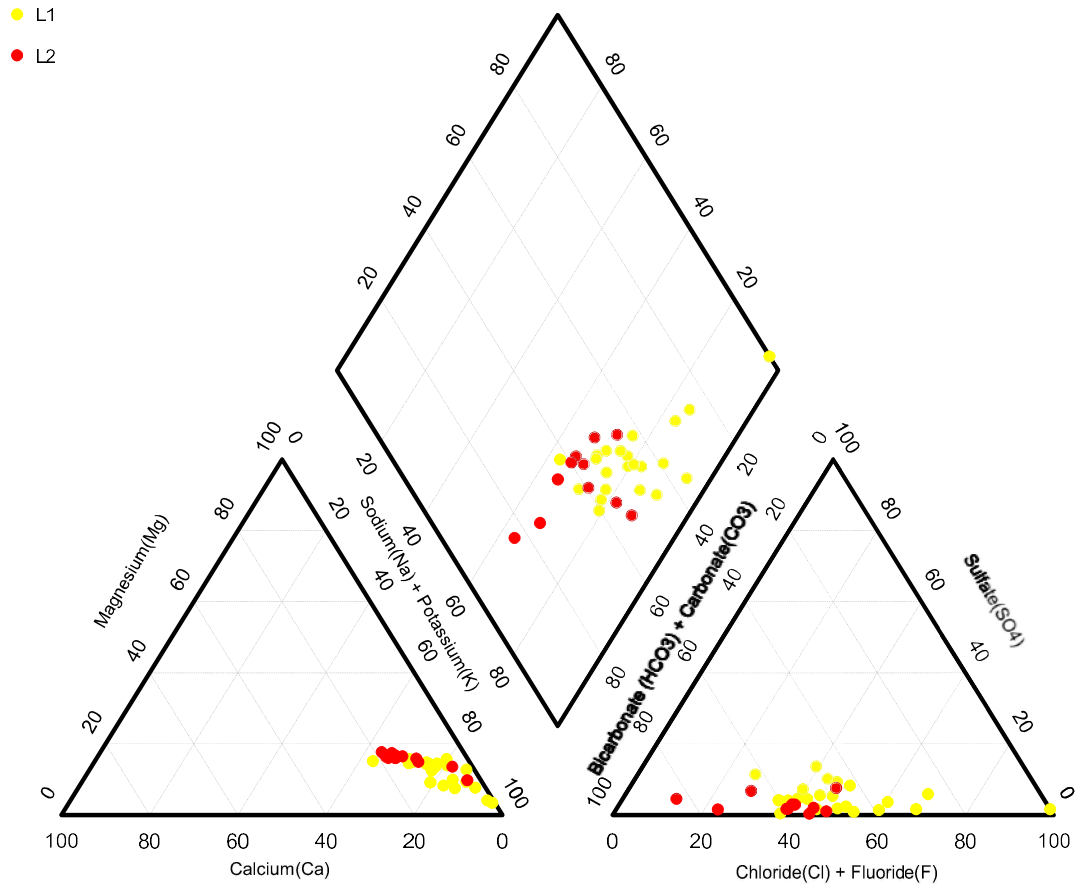
Piper Plots

Appendix L Bowen Landfill Piper Plots

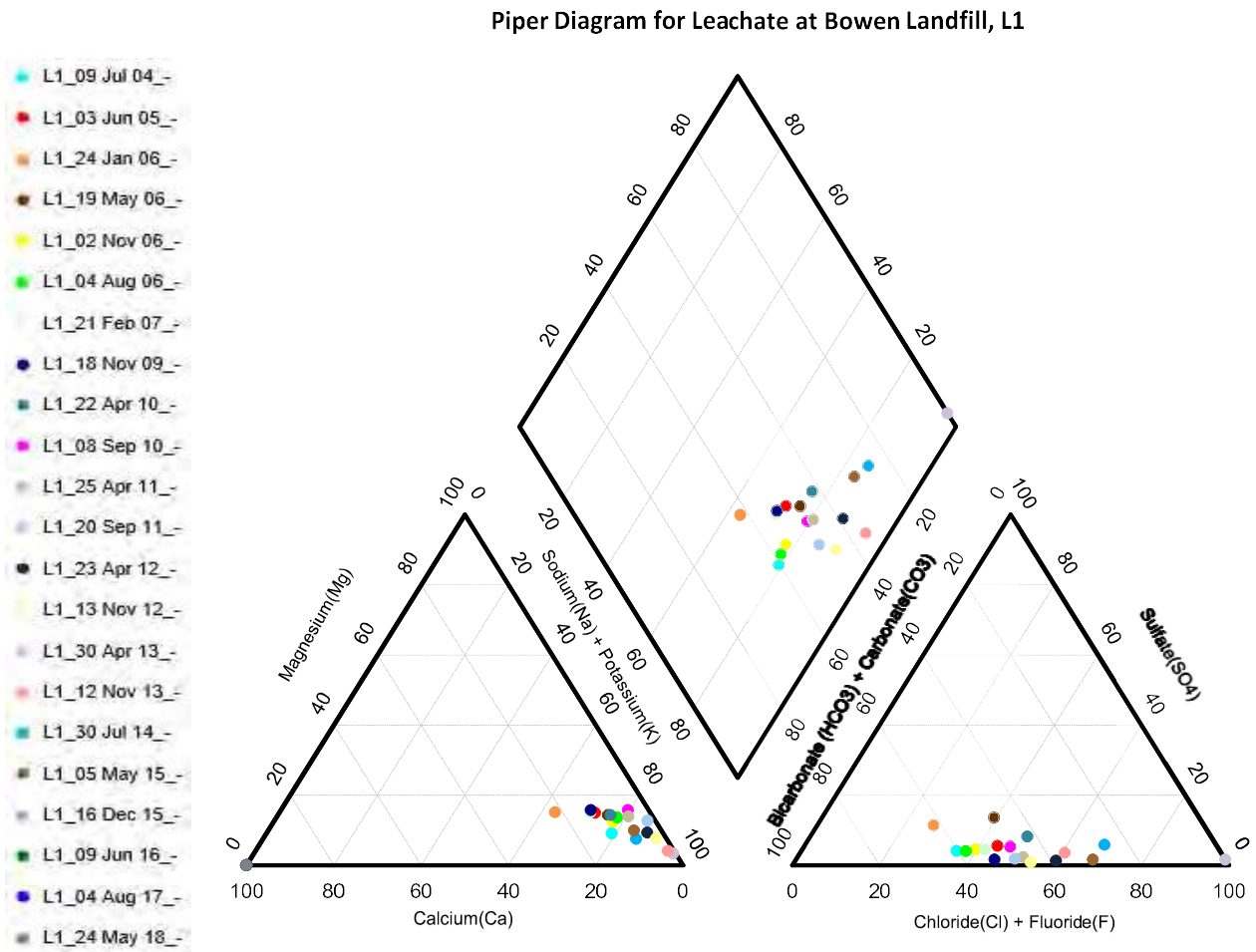
Piper Diagram for Leachate and Groundwater at Bowen Landfill



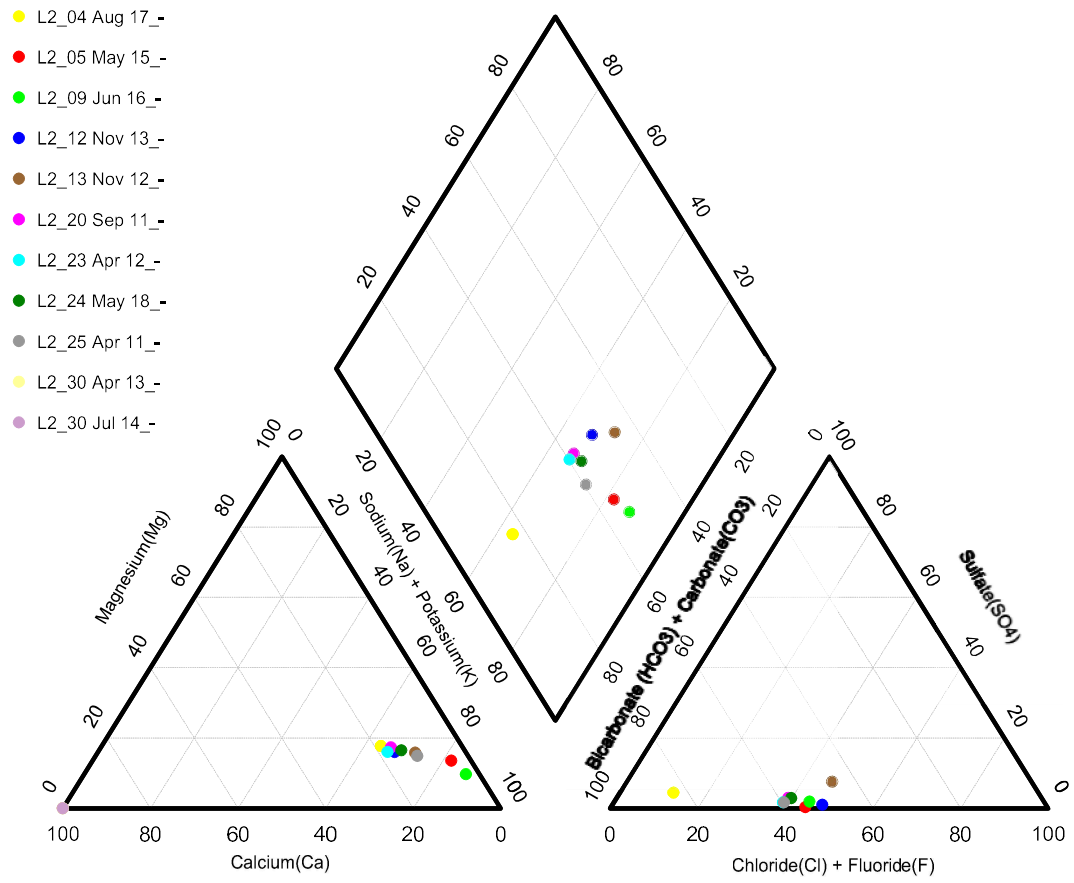
Piper Diagram for Leachate at Bowen Landfill, L1-L2



Appendix L Bowen Landfill Piper Plots

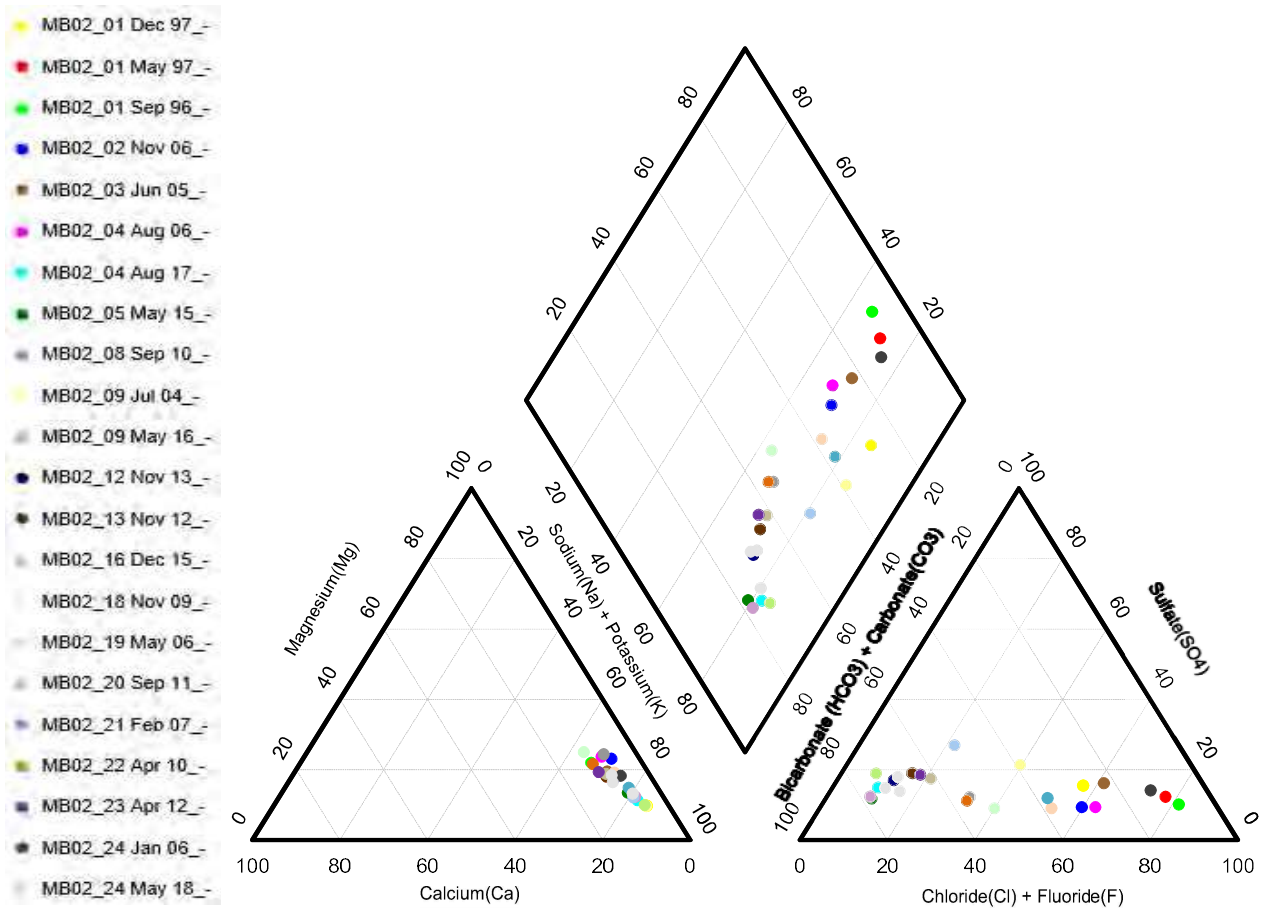


Piper Diagram for Leachate at Bowen Landfill, L2

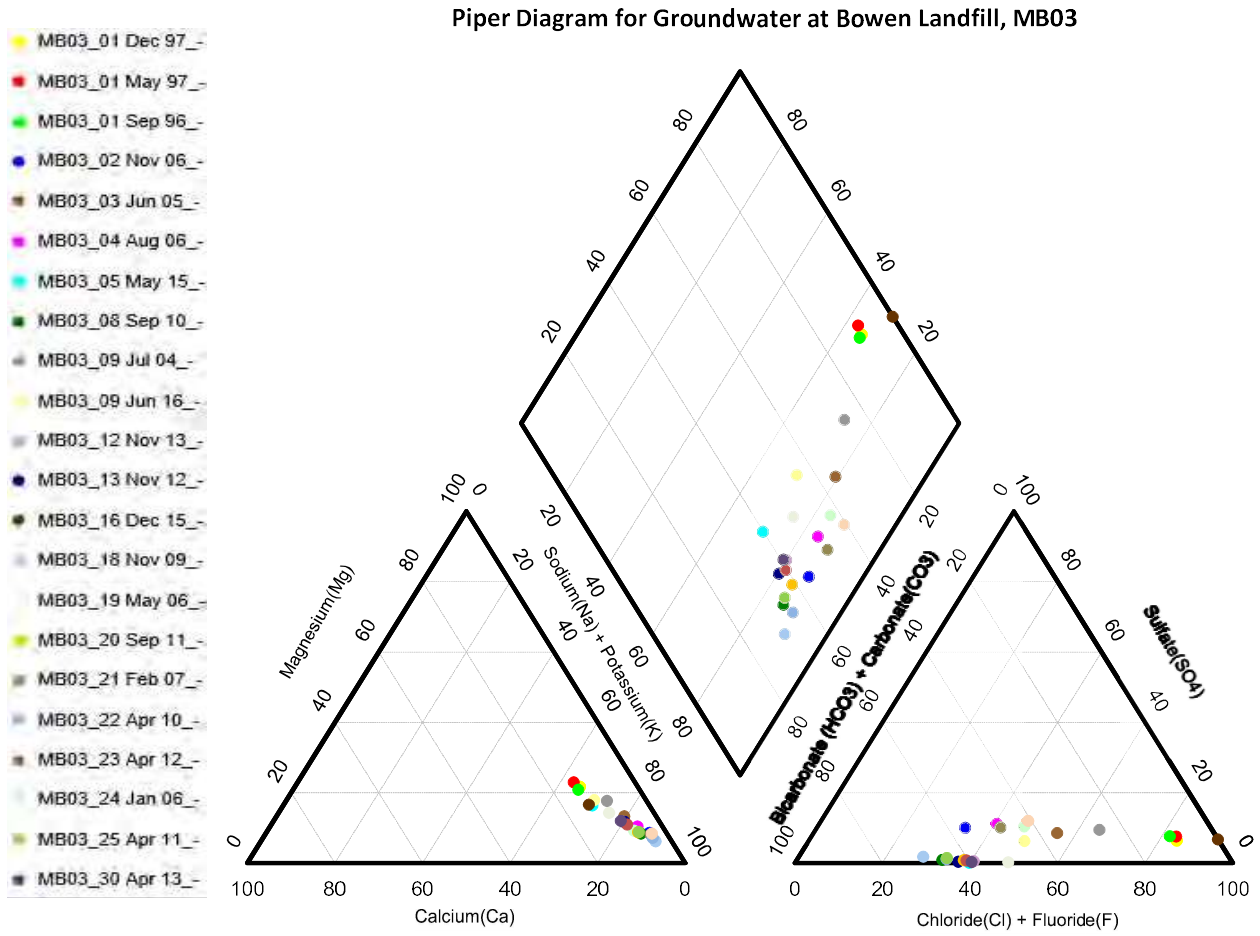


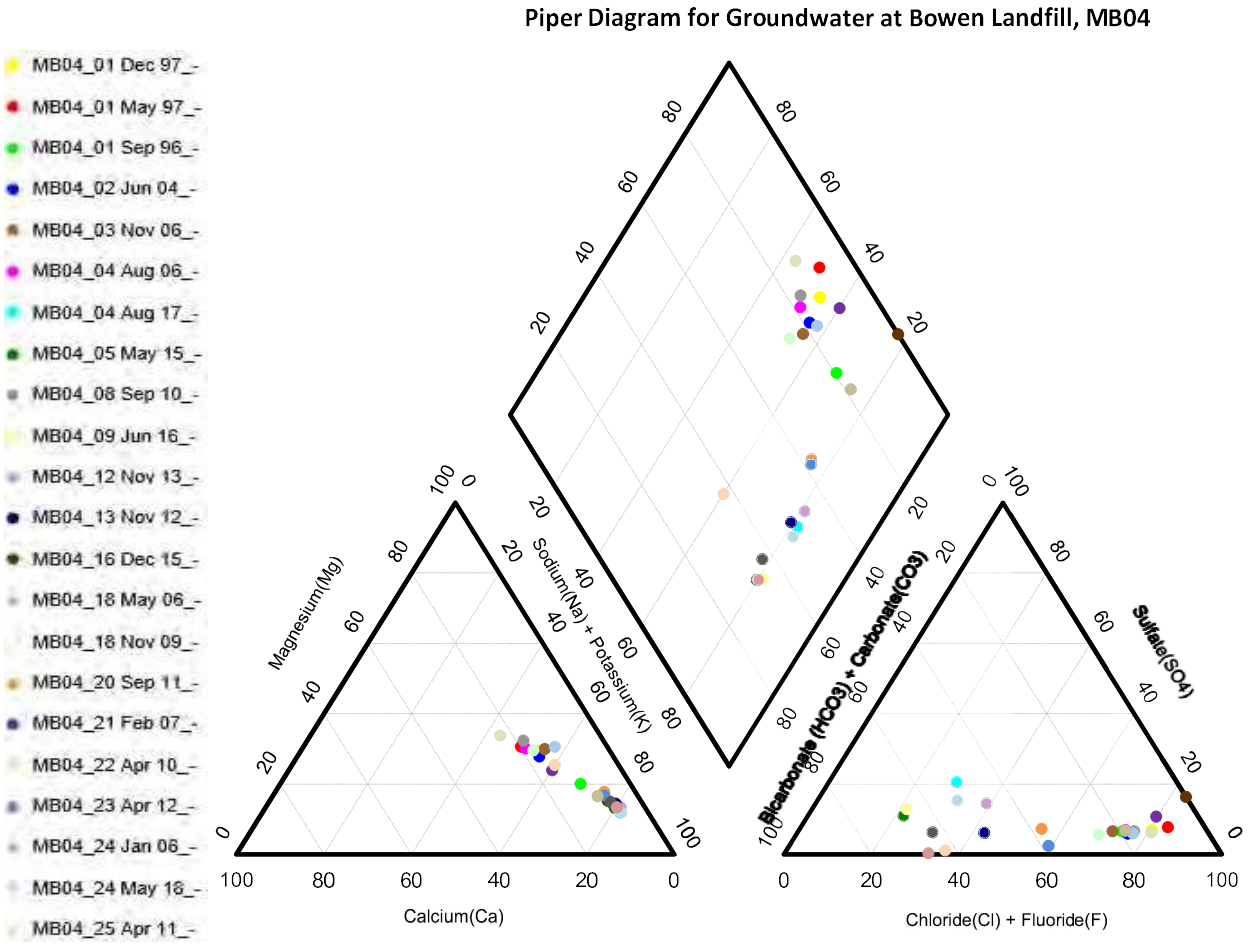
Appendix L Bowen Landfill Piper Plots

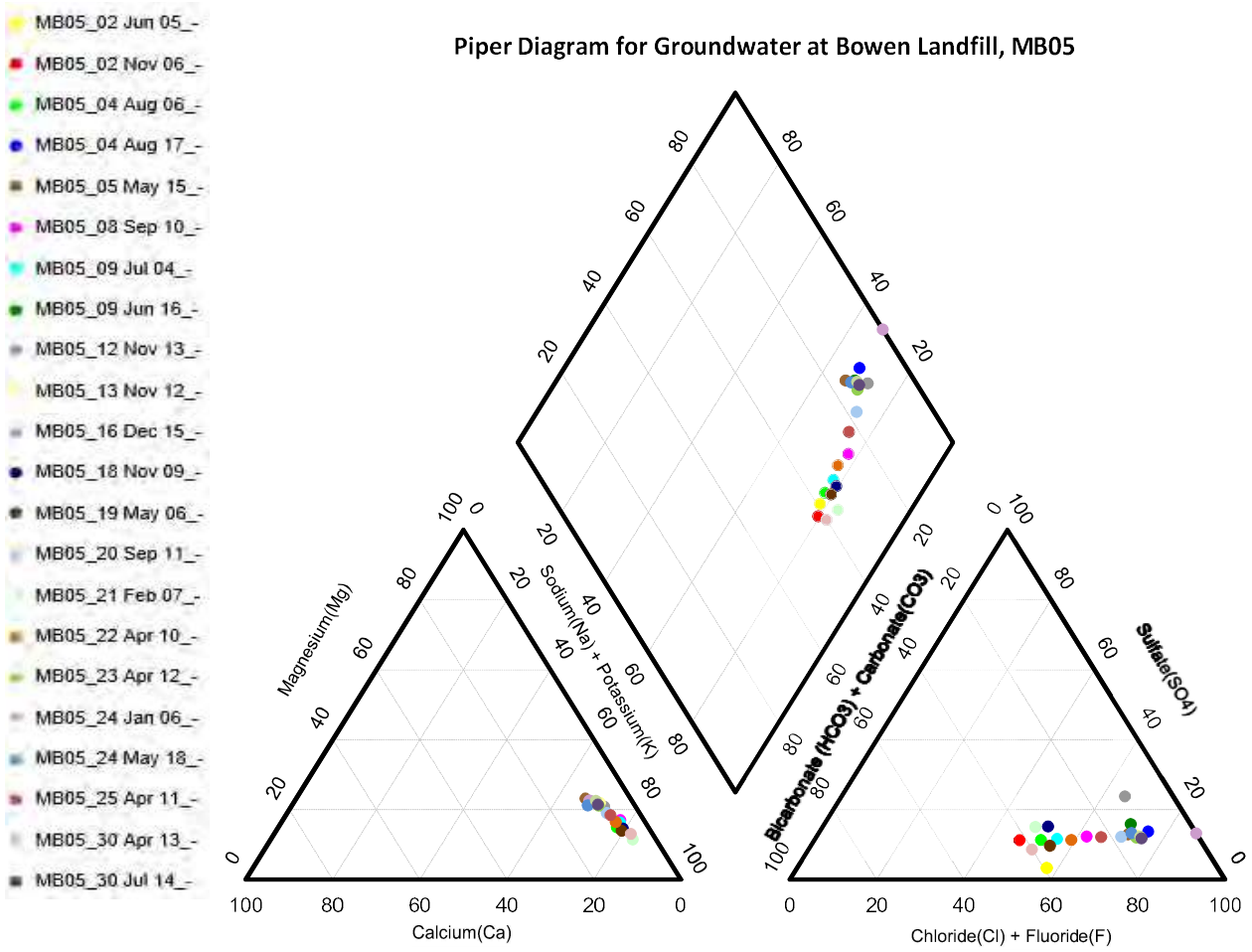
Piper Diagram for Groundwater at Bowen Landfill, MB02

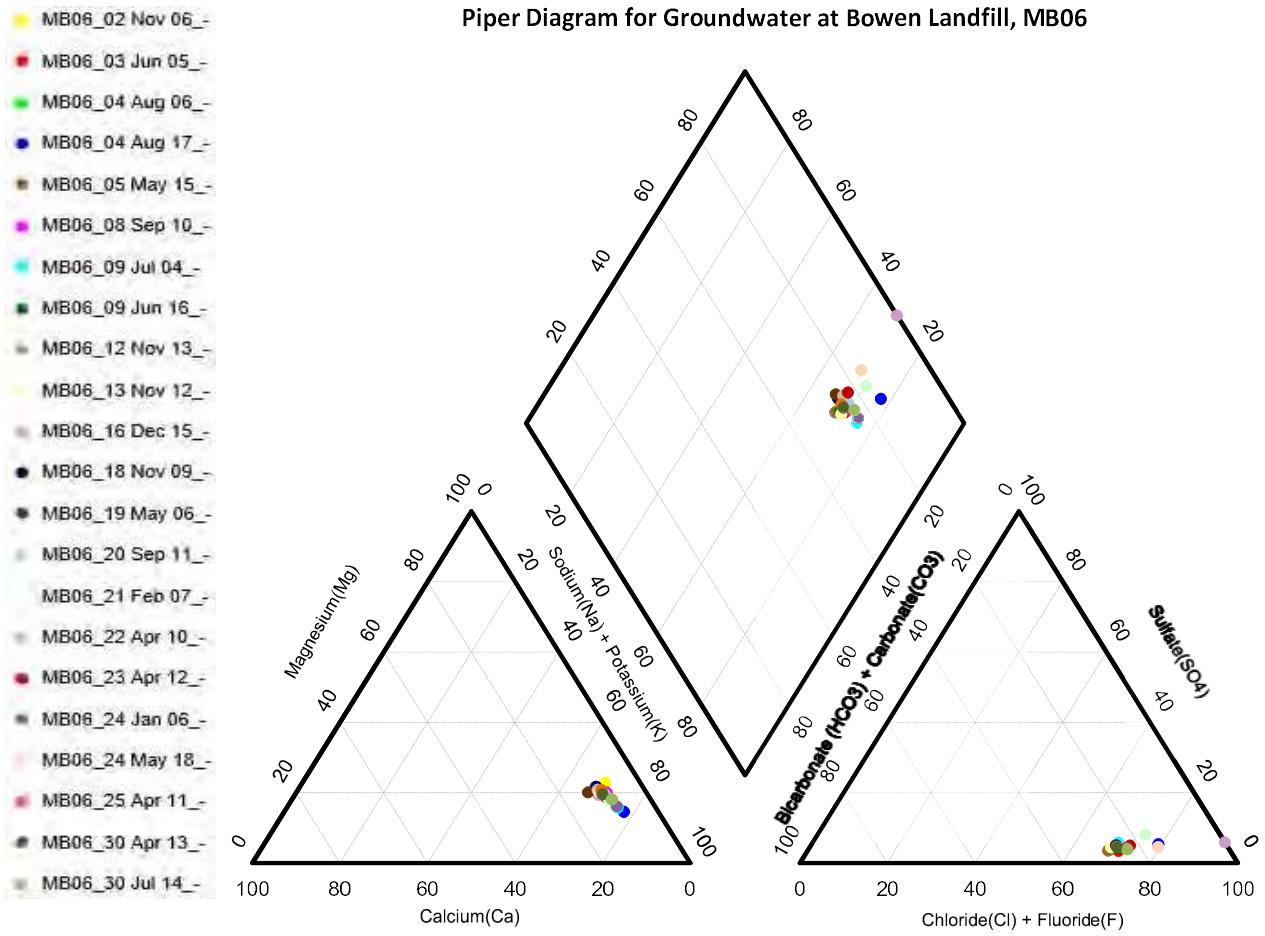


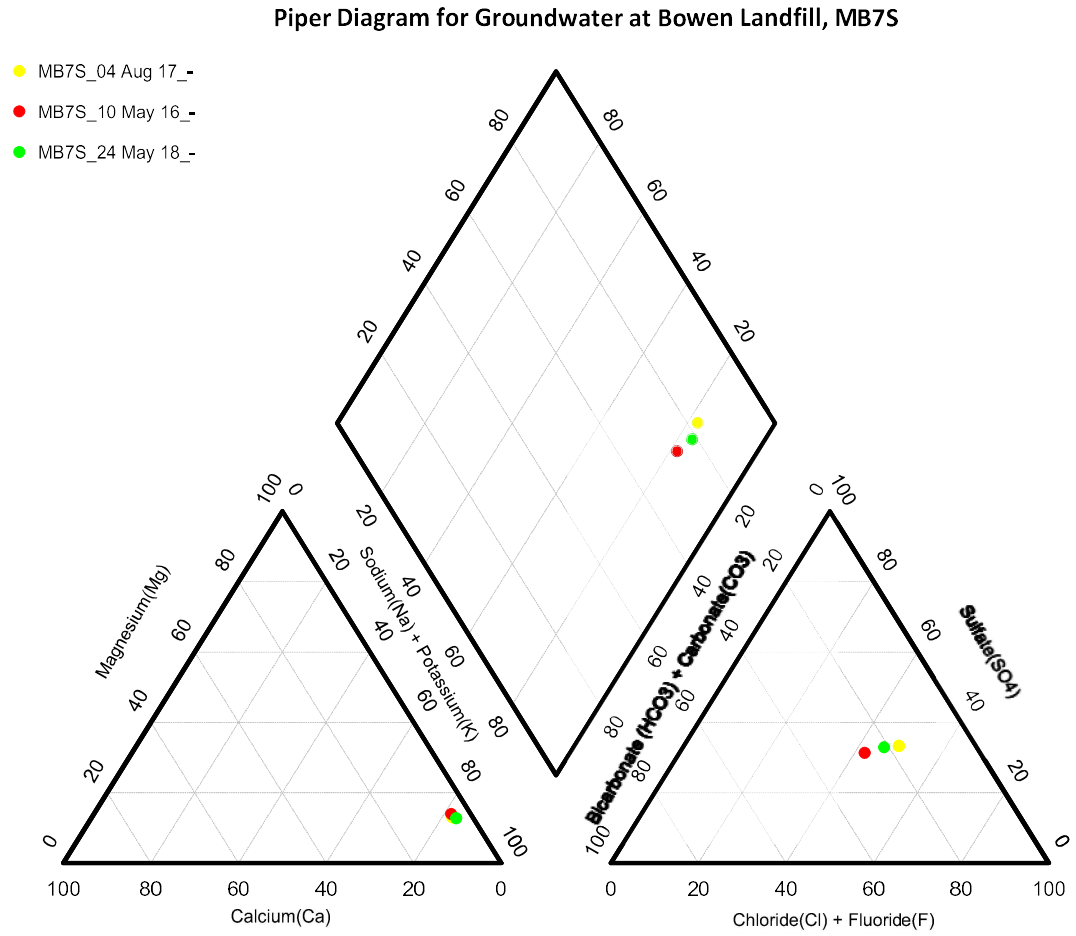
Appendix L Bowen Landfill Piper Plots

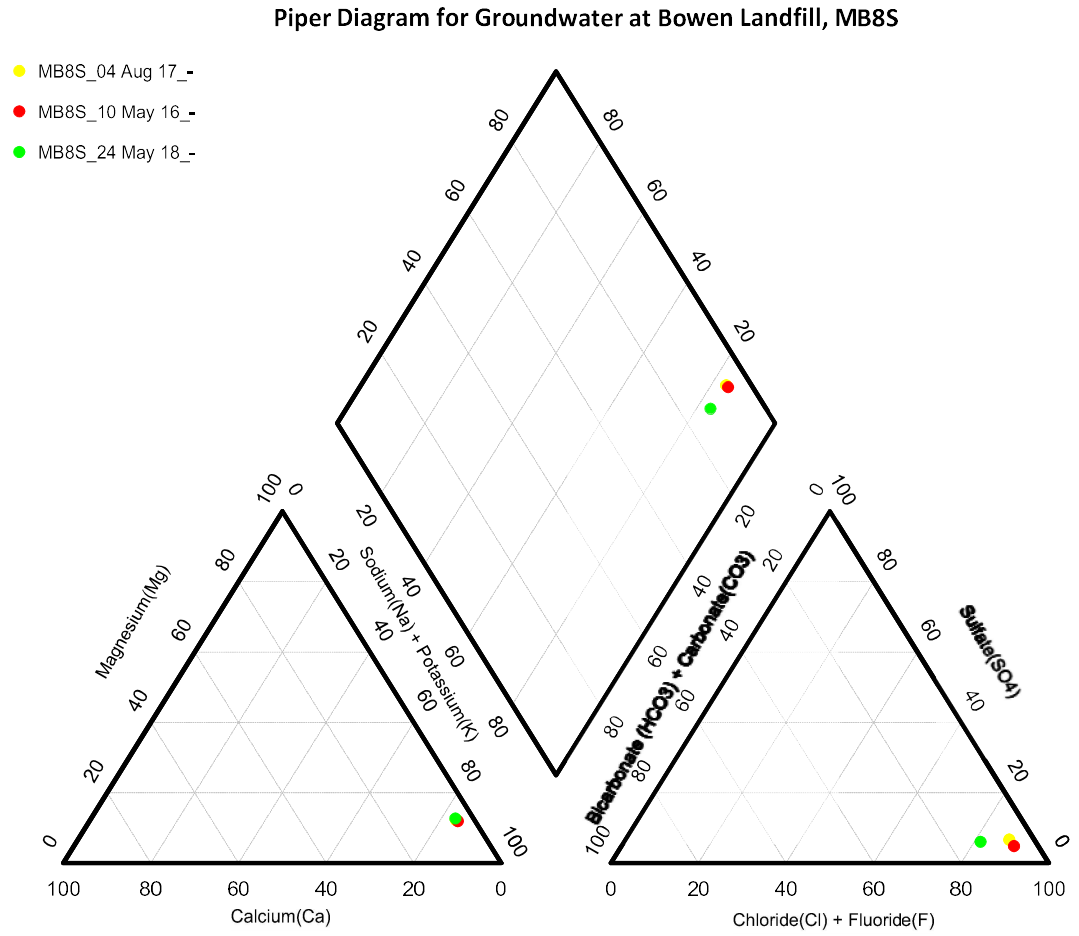


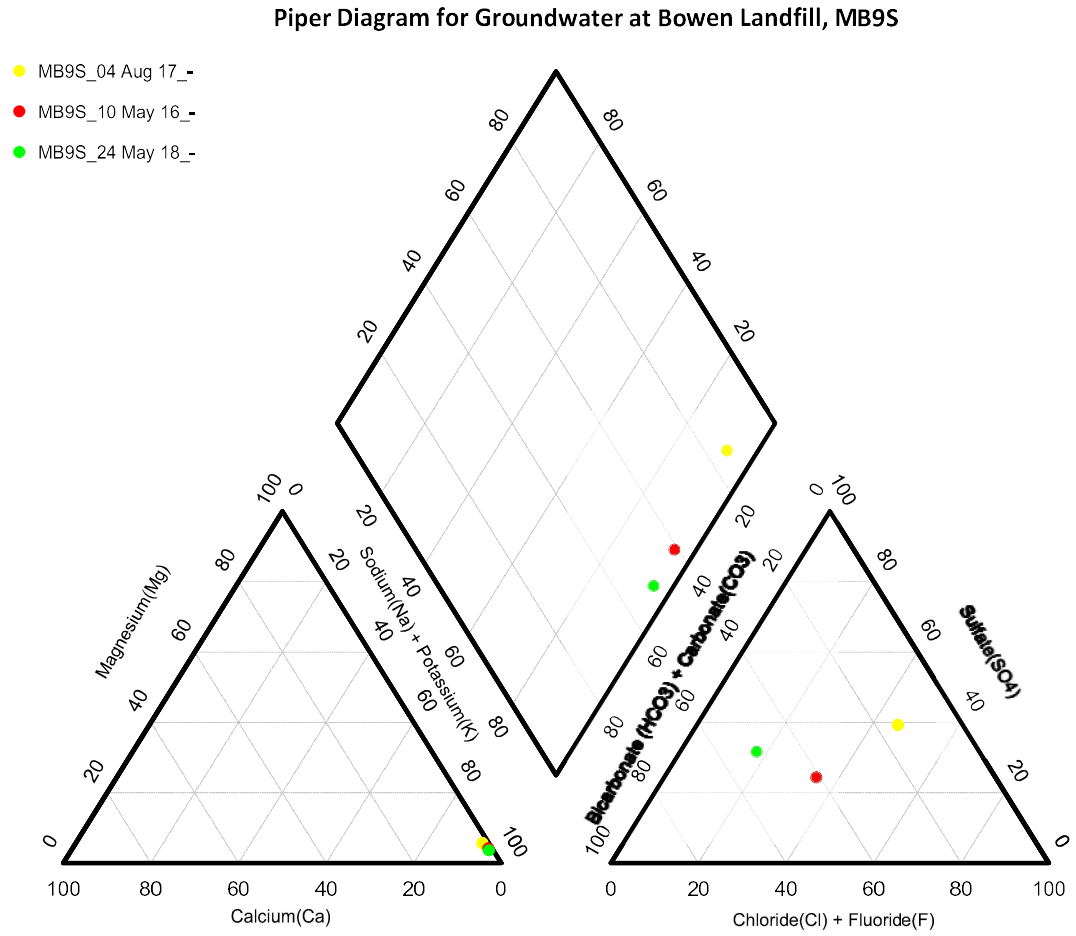

Piper Diagram for Groundwater at Bowen Landfill, MB04
MB04_01 Dec 97_-
MB04_01 May 97_-
MB04_01 Sep 96_-
MB04_02 Jun 04_-
MB04_03 Nov 06_-
MB04_04 Aug 06_-
MB04_04 Aug 17_-
MB04_05 May 15_-
MB04_08 Sep 10_-
MB04_09 Jun 16_-
MB04_12 Nov 13_-
MB04_13 Nov 12_-
MB04_16 Dec 15_-
MB04_18 May 06_-
MB04_18 Nov 09_-
MB04_20 Sep 11_-
MB04_21 Feb 07_-
MB04_22 Apr 10_-
MB04_23 Apr 12_-
MB04_24 Jan 06_-
MB04_24 May 18_-
MB04_25 Apr 11_-
Magnesium(Mg)
Sodium(Na) + Potassium(K)
Calcium(Ca)
Bicarbonate (HCO3) + Carbonate(CO3)
Sulfate(SO4)
Chloride(Cl) + Fluoride(F)


MB05_02 Jun 05_-
MB05_02 Nov 06_-
MB05_04 Aug 06_-
MB05_04 Aug 17_-
MB05_05 May 15_-
MB05_08 Sep 10_-
MB05_09 Jul 04_-
MB05_09 Jun 16_-
MB05_12 Nov 13_-
MB05_13 Nov 12_-
MB05_16 Dec 15_-
MB05_18 Nov 09_-
MB05_19 May 06_-
MB05_20 Sep 11_-
MB05_21 Feb 07_-
MB05_22 Apr 10_-
MB05_23 Apr 12_-
MB05_24 Jan 06_-
MB05_24 May 18_-
MB05_25 Apr 11_-
MB05_30 Apr 13_-
MB05_30 Jul 14_-
Piper Diagram for Groundwater at Bowen Landfill, MB05
Magnesium(Mg)
Calcium(Ca)
Sodium(Na) + Potassium(K)
Bicarbonate (HCO3) + Carbonate(CO3)
Chloride(Cl) + Fluoride(F)
Sulfate(SO4)

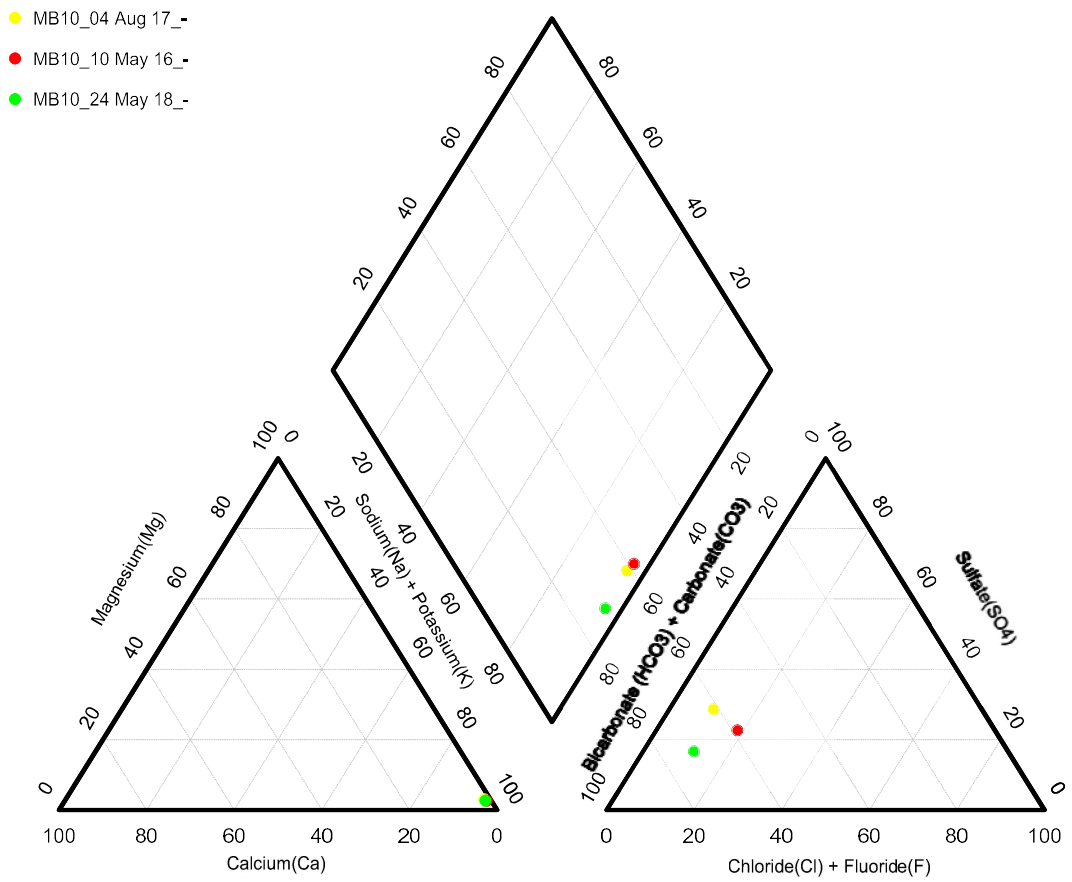

MB06_02 Nov 06_-
MB06_03 Jun 05_-
MB06_04 Aug 06_-
MB06_04 Aug 17_-
MB06_05 May 15_-
MB06_08 Sep 10_-
MB06_09 Jul 04_-
MB06_09 Jun 16_-
MB06_12 Nov 13_-
MB06_13 Nov 12_-
MB06_16 Dec 15_-
MB06_18 Nov 09_-
MB06_19 May 06_-
MB06_20 Sep 11_-
MB06_21 Feb 07_-
MB06_22 Apr 10_-
MB06_23 Apr 12_-
MB06_24 Jan 06_-
MB06_24 May 18_-
MB06_25 Apr 11_-
MB06_30 Apr 13_-
MB06_30 Jul 14_-
Piper Diagram for Groundwater at Bowen Landfill, MB06
Magnesium(Mg)
Calcium(Ca)
Sodium(Na) + Potassium(K)
Bicarbonate (HCO3) + Carbonate(CO3)
Sulfate(SO4)
Chloride(Cl) + Fluoride(F)


Piper Diagram for Groundwater at Bowen Landfill, MB7S
MB7S_04 Aug 17_-
MB7S_10 May 16_-
MB7S_24 May 18_-
Magnesium(Mg)
Sodium(Na) + Potassium(K)
Calcium(Ca)
Bicarbonate (HCO3) + Carbonate(CO3)
Sulfate(SO4)
Chloride(Cl) + Fluoride(F)

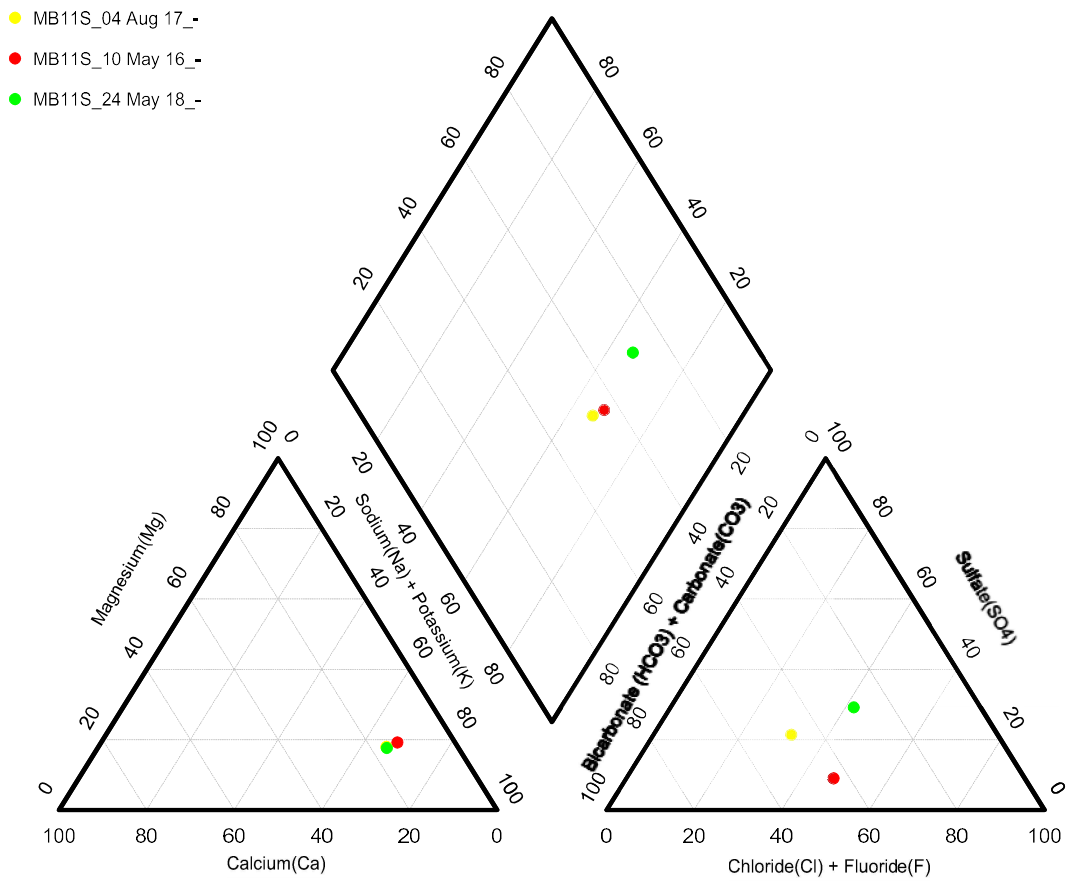

Piper Diagram for Groundwater at Bowen Landfill, MB8S
MB8S_04 Aug 17_-
MB8S_10 May 16_-
MB8S_24 May 18_-
Magnesium(Mg)
Sodium(Na) + Potassium(K)
Calcium(Ca)
Bicarbonate (HCO3) + Carbonate(CO3)
Sulfate(SO4)
Chloride(Cl) + Fluoride(F)


Piper Diagram for Groundwater at Bowen Landfill, MB9S
MB9S_04 Aug 17_-
MB9S_10 May 16_-
MB9S_24 May 18_-
Magnesium(Mg)
Calcium(Ca)
Sodium(Na) + Potassium(K)
Bicarbonate (HCO3) + Carbonate(CO3)
Sulfate(SO4)
Chloride(Cl) + Fluoride(F)

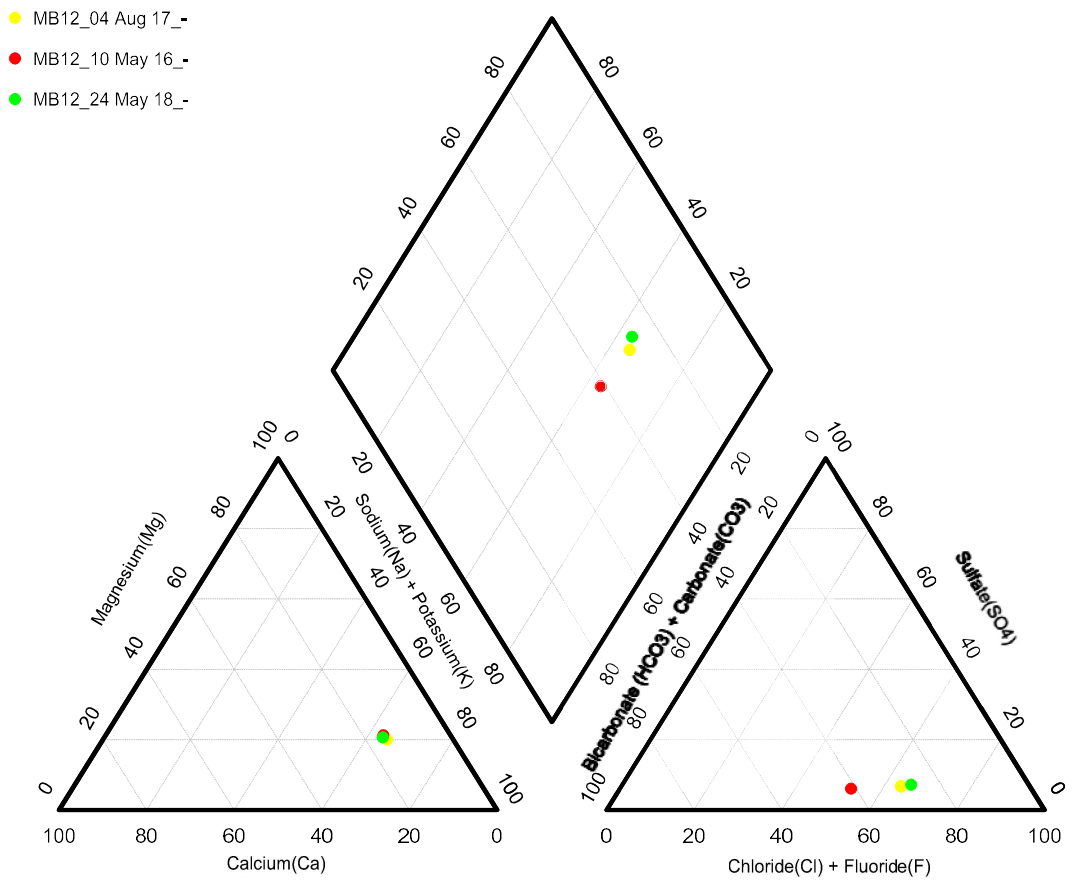
Piper Diagram for Groundwater at Bowen Landfill, MB10



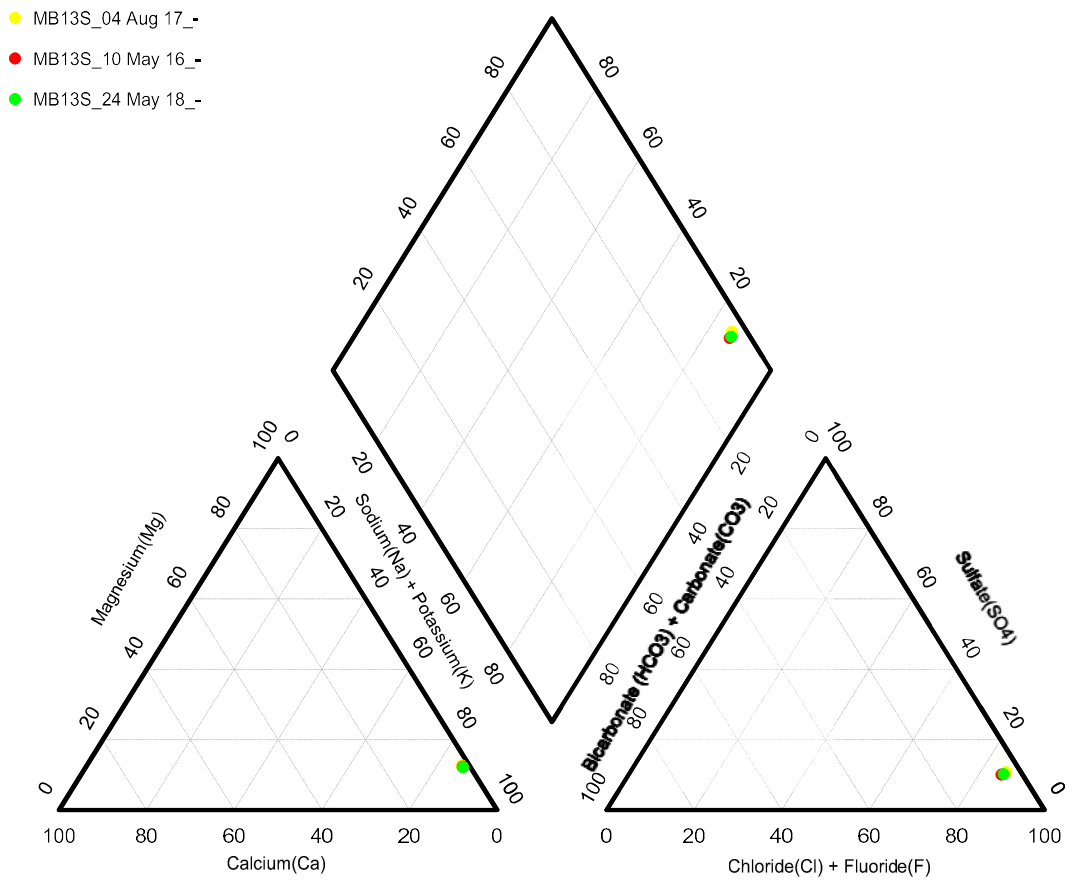
Piper Diagram for Groundwater at Bowen Landfill, MB11S

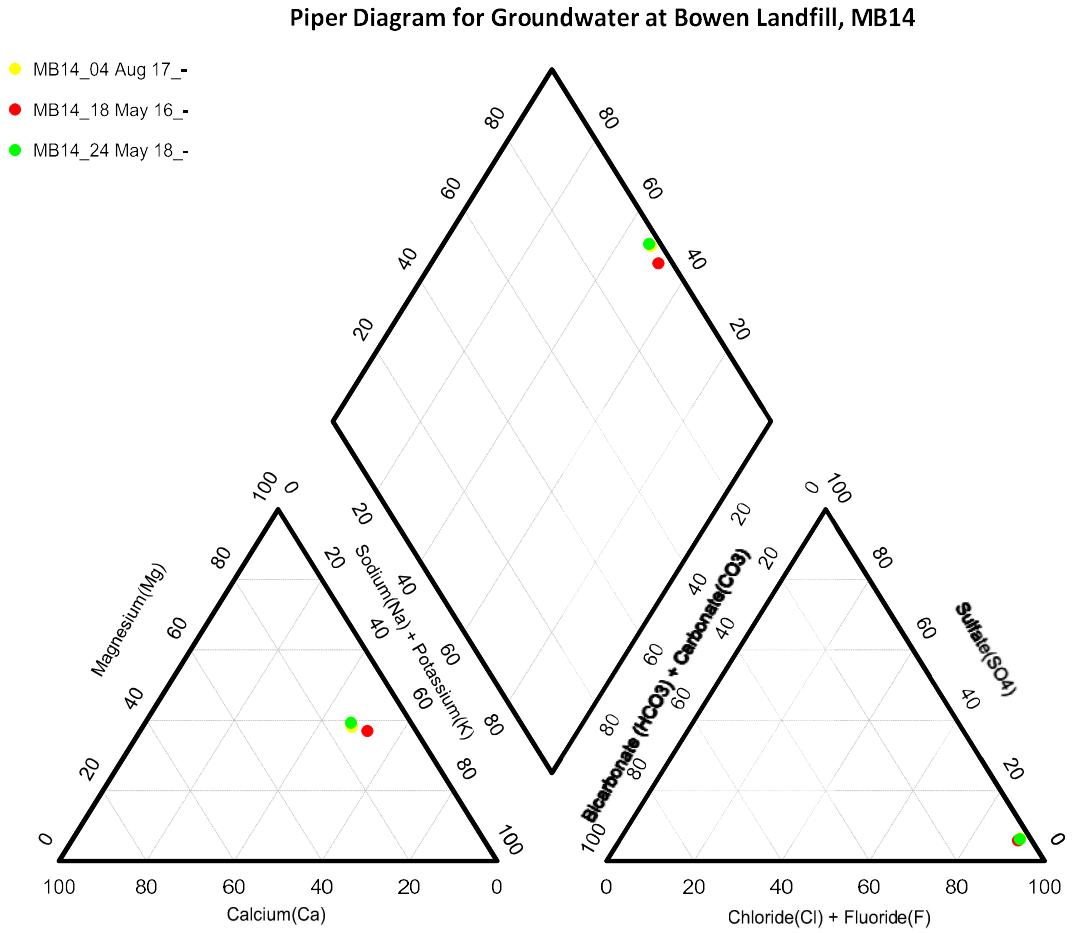


Piper Diagram for Groundwater at Bowen Landfill, MB12

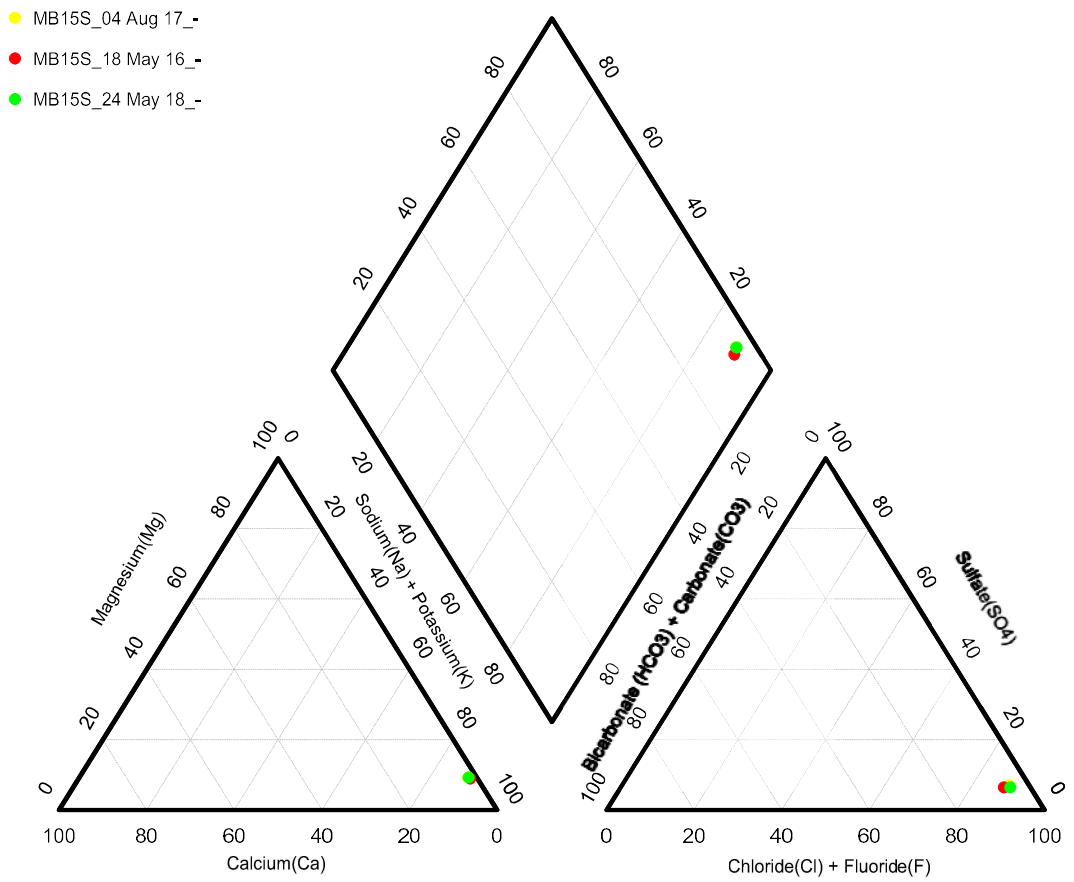


Piper Diagram for Groundwater at Bowen Landfill, MB13S

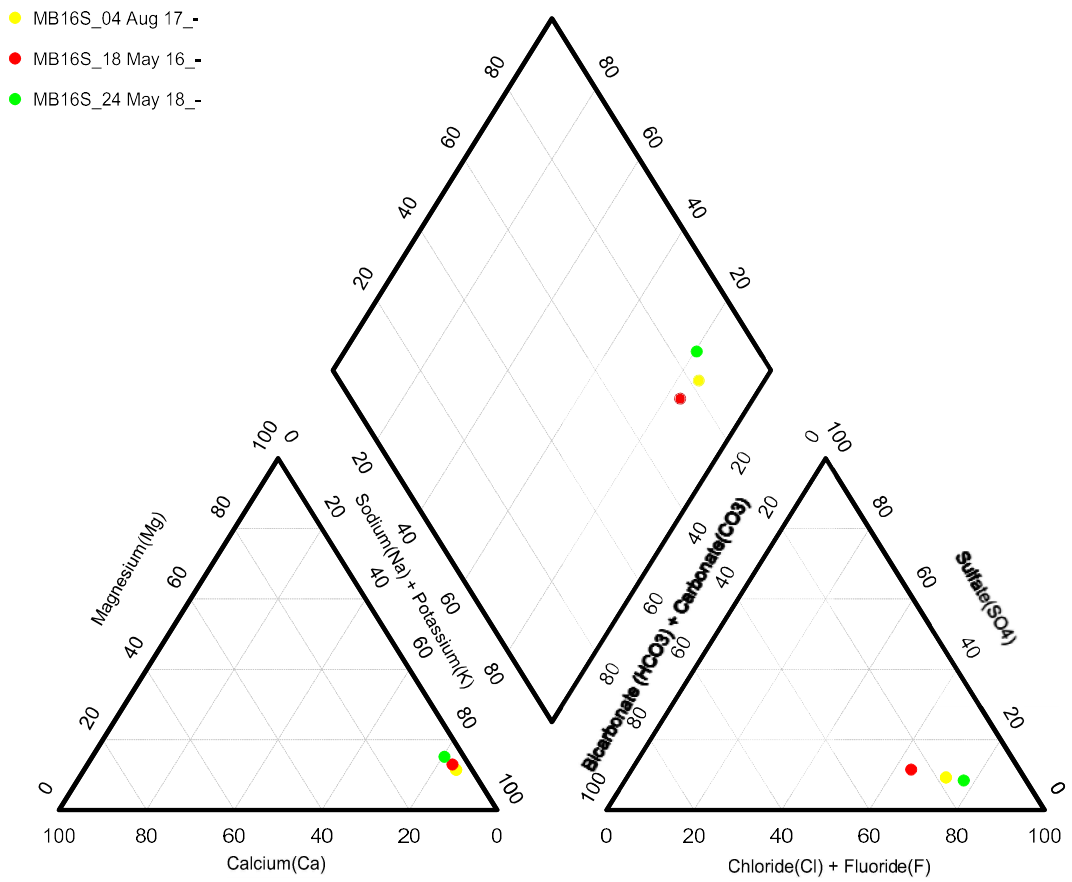



Piper Diagram for Groundwater at Bowen Landfill, MB14
MB14_04 Aug 17_-
MB14_18 May 16_-
MB14_24 May 18_-
Magnesium(Mg)
Calcium(Ca)
Sodium(Na) + Potassium(K)
Bicarbonate (HCO3) + Carbonate(CO3)
Sulfate(SO4)
Chloride(Cl) + Fluoride(F)

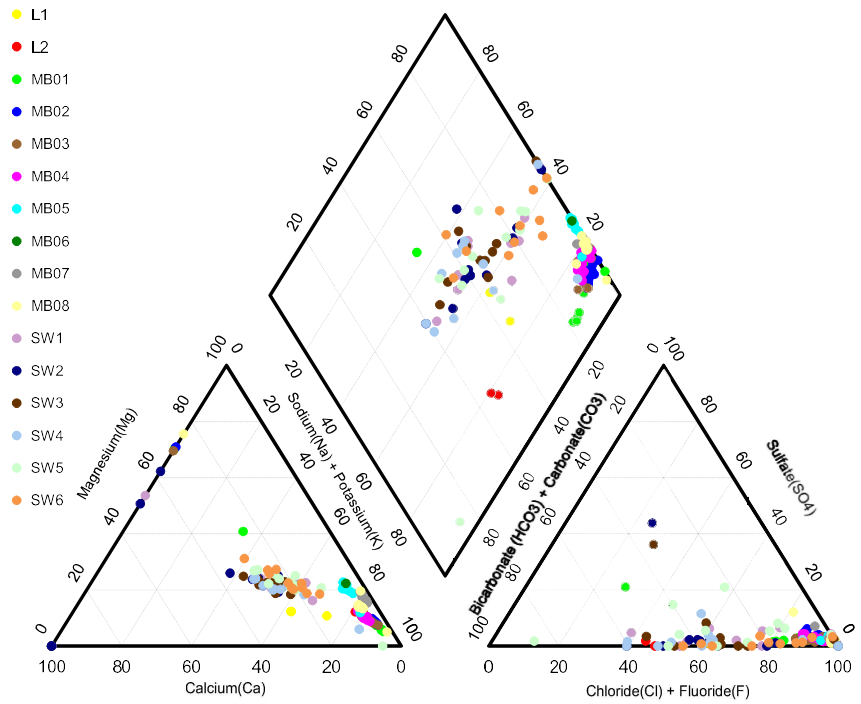
Piper Diagram for Groundwater at Bowen Landfill, MB15S

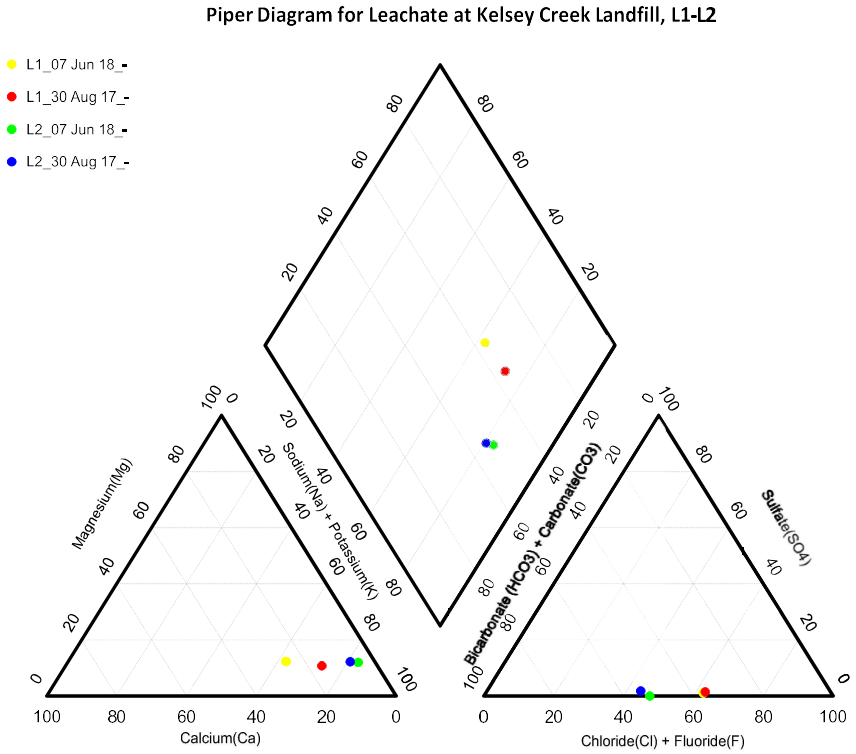


Piper Diagram for Groundwater at Bowen Landfill, MB16S

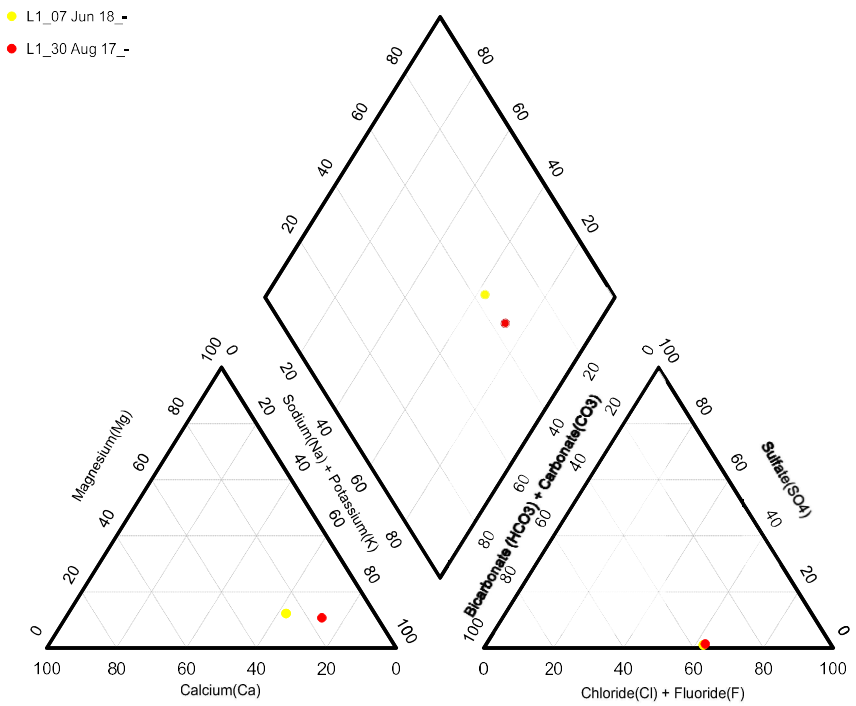


Piper Diagram for Leachate, Groundwater and Surface Water at Kelsey Creek Landfill

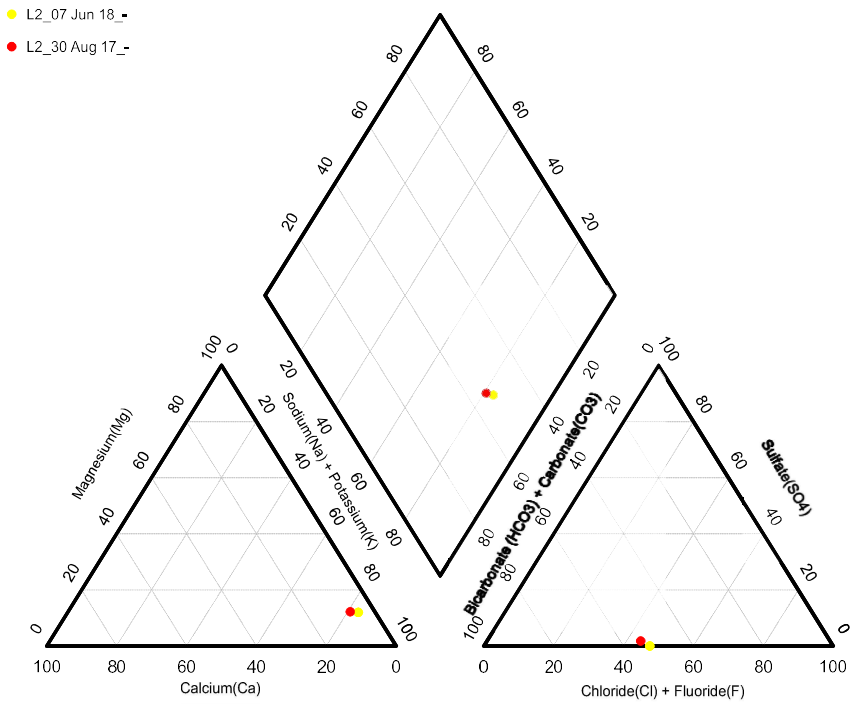



Piper Diagram for Leachate at Kelsey Creek Landfill, L1-L2
L1_07 Jun 18_-
L1_30 Aug 17_-
L2_07 Jun 18_-
L2_30 Aug 17_-
Magnesium(Mg)
Calcium(Ca)
Sodium(Na) + Potassium(K)
Bicarbonate (HCO3) + Carbonate(CO3)
Chloride(Cl) + Fluoride(F)
Sulfate(SO4)

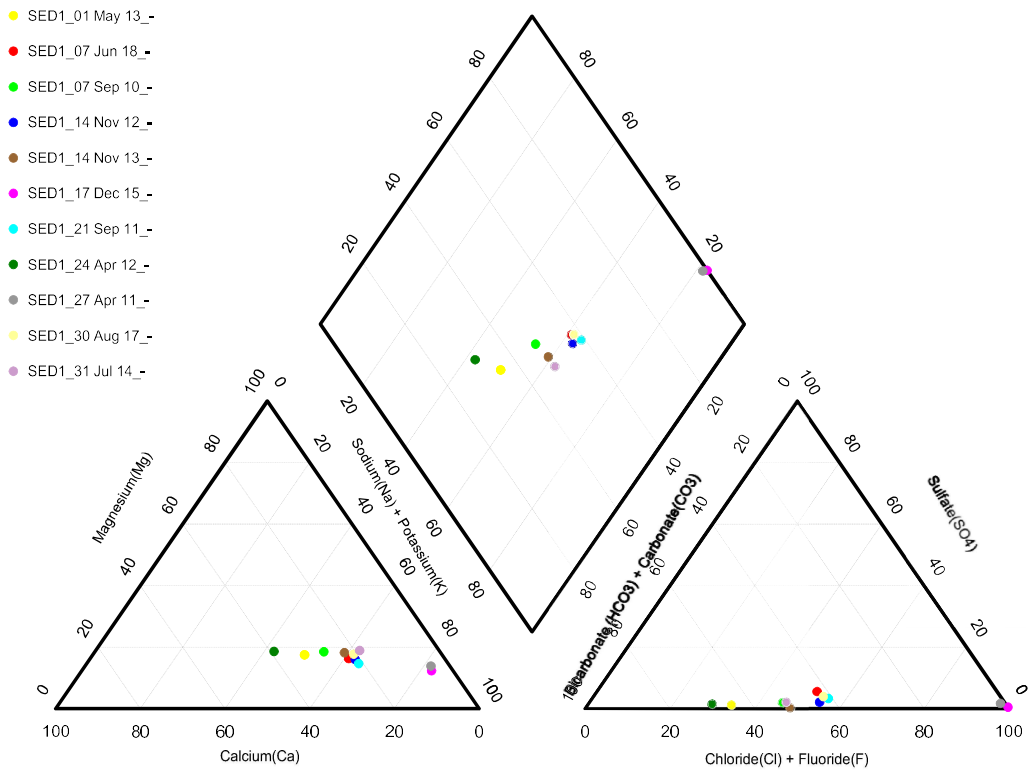
Piper Diagram for Leachate at Kelsey Creek Landfill, L1

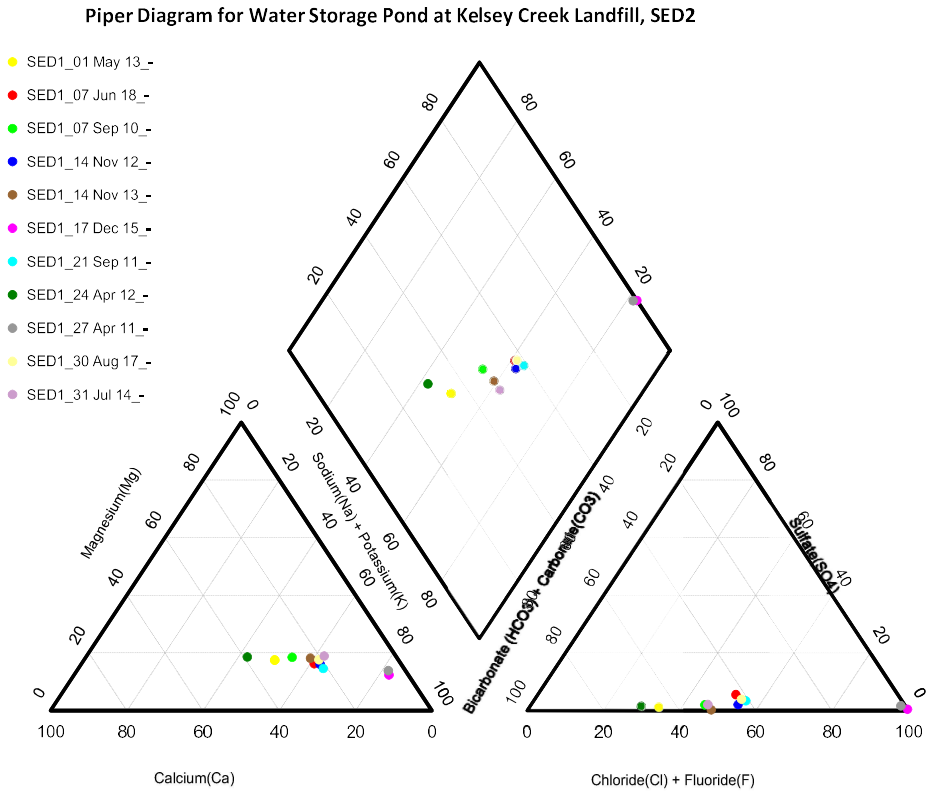


Piper Diagram for Leachate at Kelsey Creek Landfill, L2

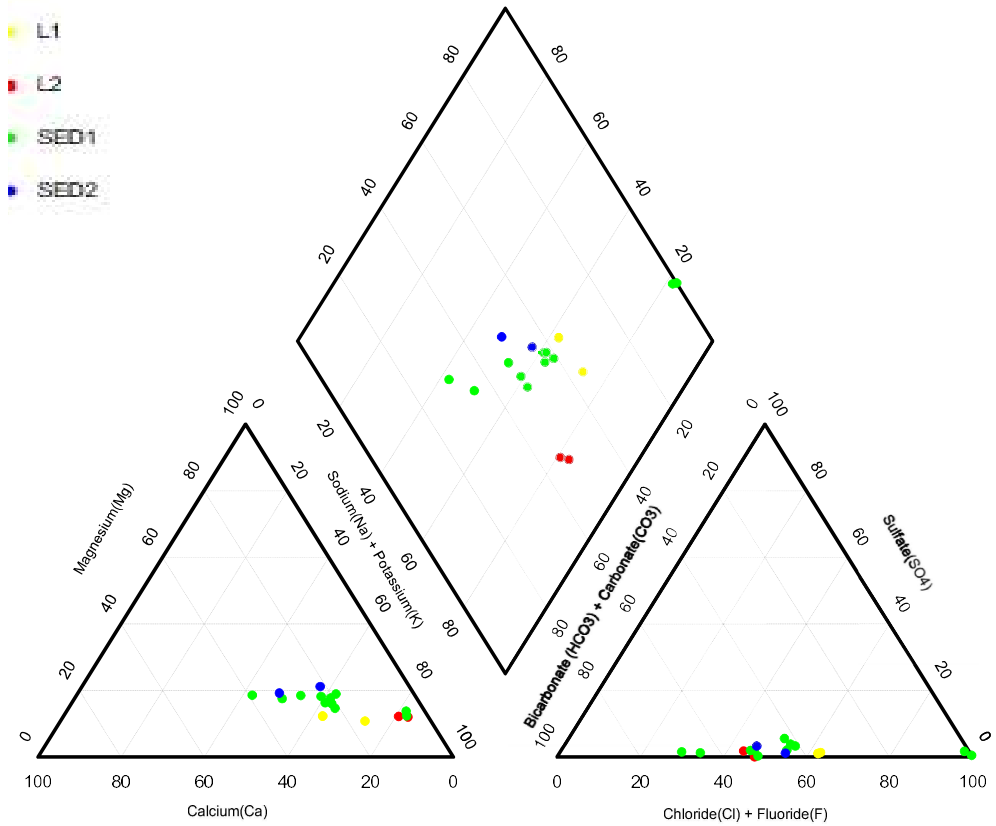


Piper Diagram for Water Storage Pond at Kelsey Creek Landfill, SED1

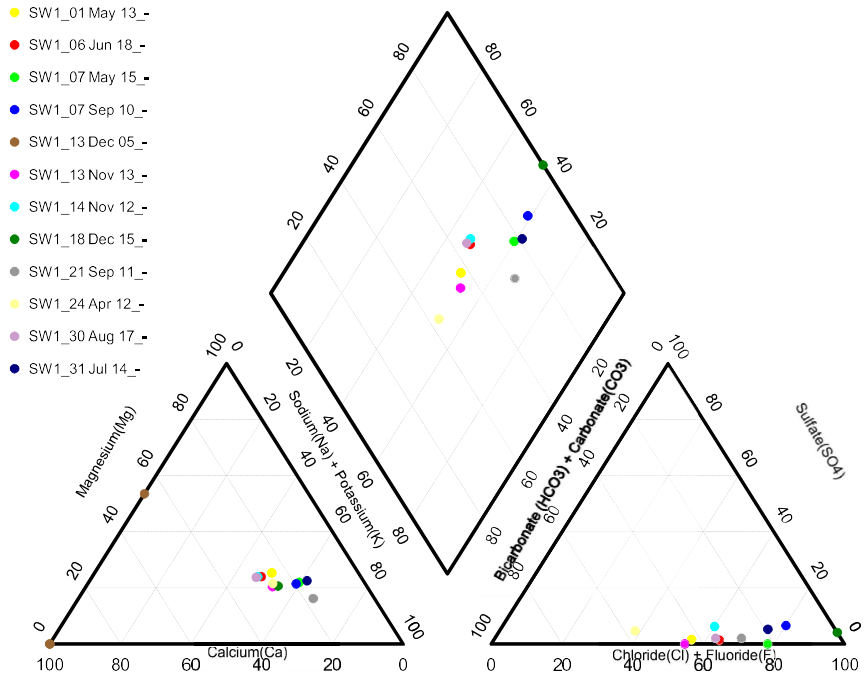



Piper Diagram for Water Storage Pond at Kelsey Creek Landfill, SED2
SED1_01 May 13_-
SED1_07 Jun 18_-
SED1_07 Sep 10_-
SED1_14 Nov 12_-
SED1_14 Nov 13_-
SED1_17 Dec 15_-
SED1_21 Sep 11_-
SED1_24 Apr 12_-
SED1_27 Apr 11_-
SED1_30 Aug 17_-
SED1_31 Jul 14_-
Magnesium(Mg)
Sodium(Na) + Potassium(K)
Calcium(Ca)
Bicarbonate (HCO3) + Carbonate(CO3)
Sulfate(SO4)
Chloride(Cl) + Fluoride(F)

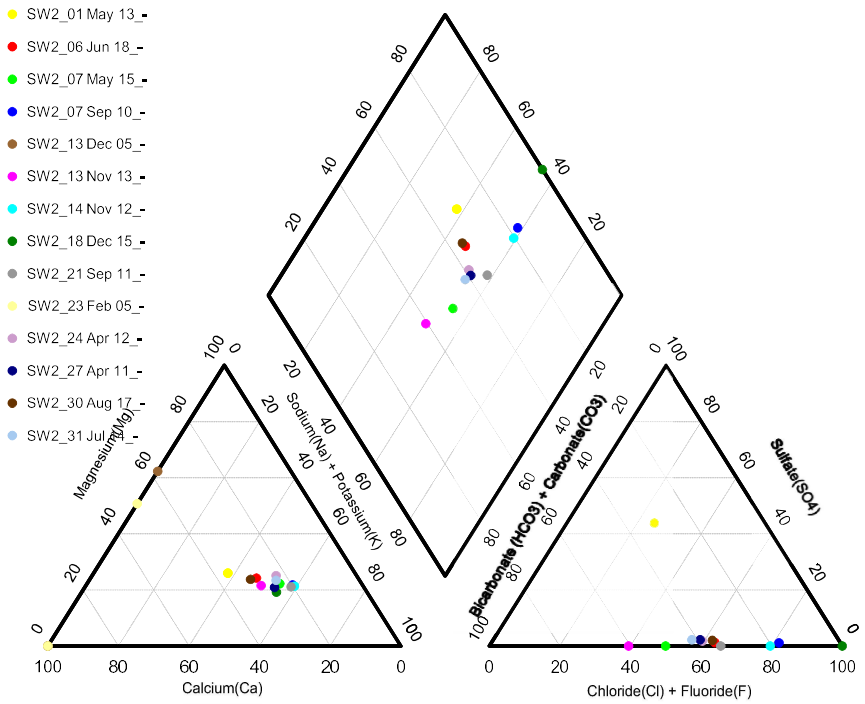
Piper Diagram for Water Storage Ponds & Leachate at Kelsey Creek Landfill



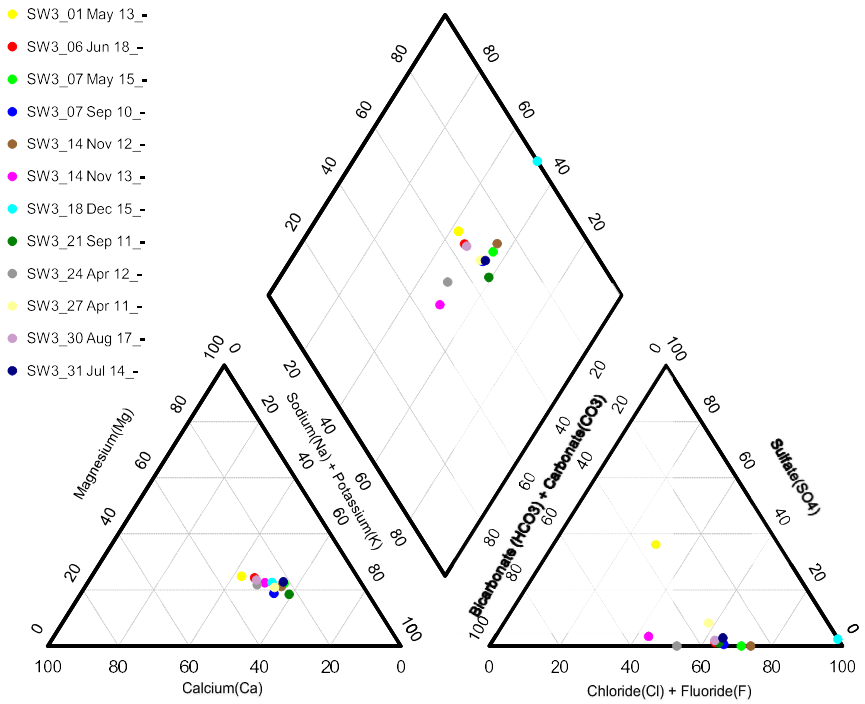
Piper Diagram for Surface Water at Kelsey Creek Landfill, SW1

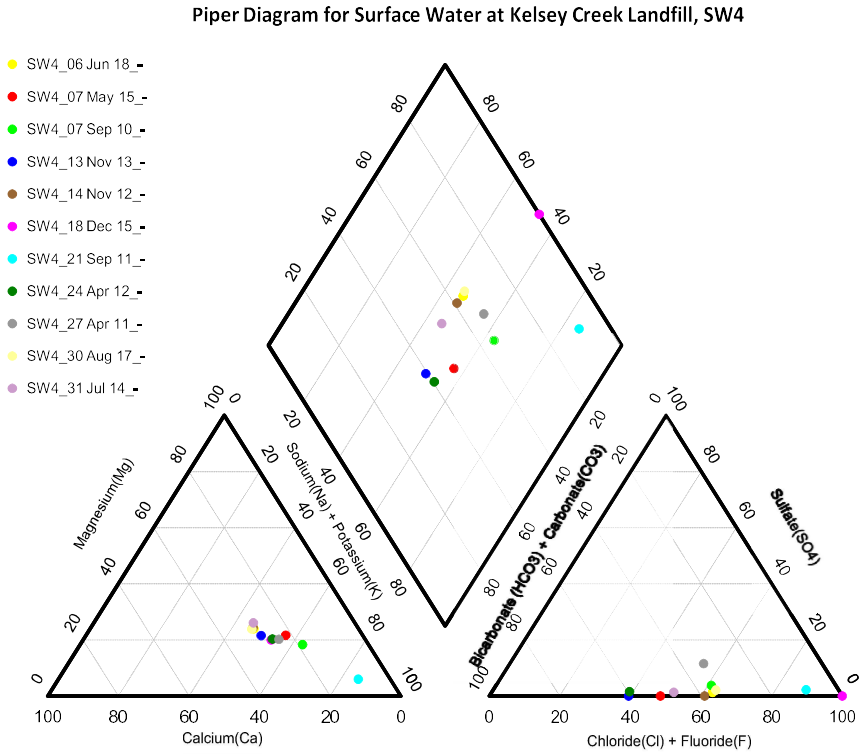


Piper Diagram for Surface Water at Kelsey Creek Landfill, SW2

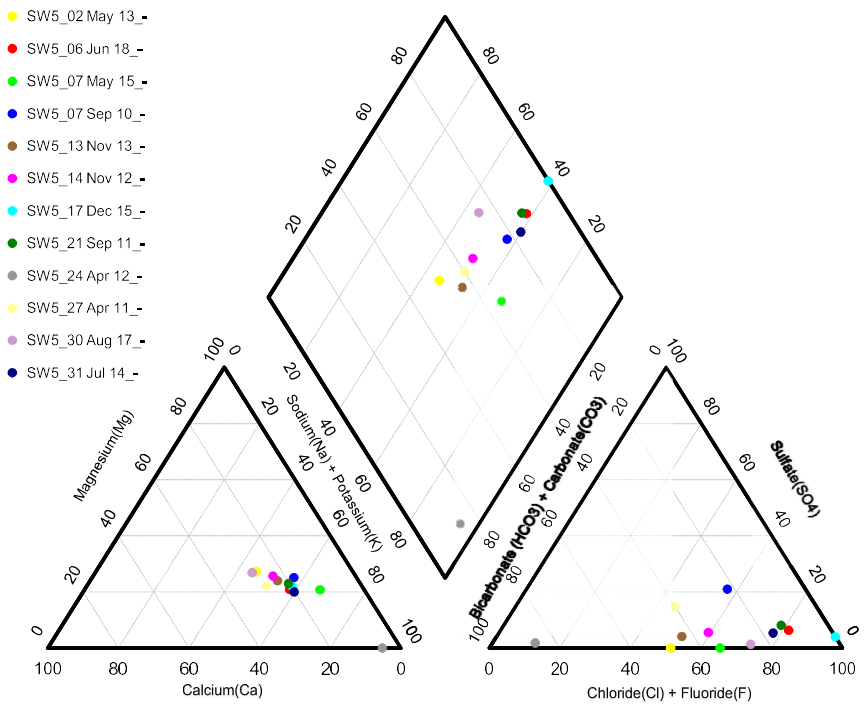


Piper Diagram for Surface Water at Kelsey Creek Landfill, SW3

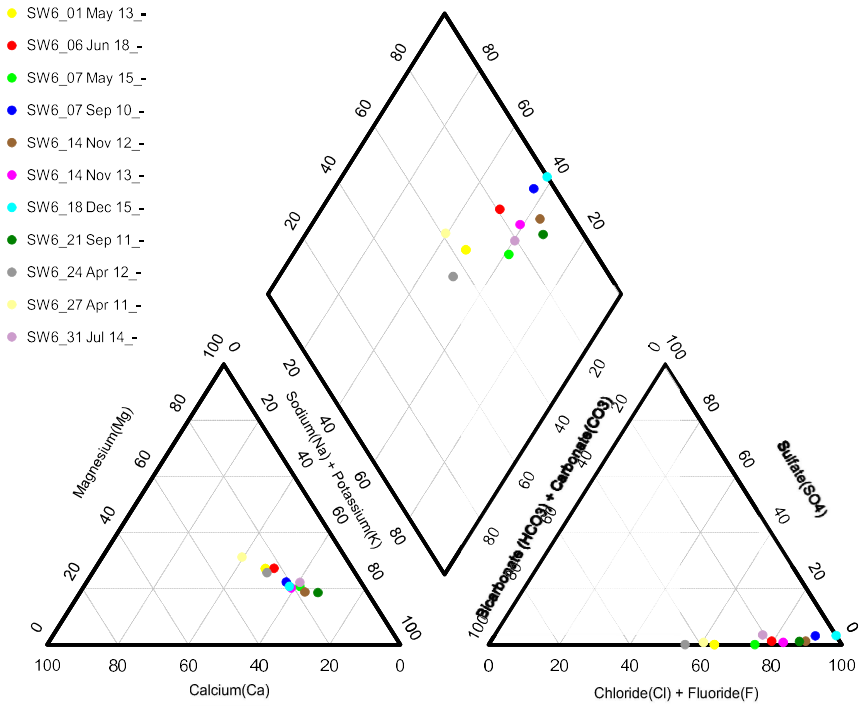



Piper Diagram for Surface Water at Kelsey Creek Landfill, SW4
SW4_06 Jun 18_-
SW4_07 May 15_-
SW4_07 Sep 10_-
SW4_13 Nov 13_-
SW4_14 Nov 12_-
SW4_18 Dec 15_-
SW4_21 Sep 11_-
SW4_24 Apr 12_-
SW4_27 Apr 11_-
SW4_30 Aug 17_-
SW4_31 Jul 14_-
Magnesium(Mg)
Calcium(Ca)
Sodium(Na) + Potassium(K)
Bicarbonate (HCO3) + Carbonate(CO3)
Sulfate(SO4)
Chloride(Cl) + Fluoride(F)

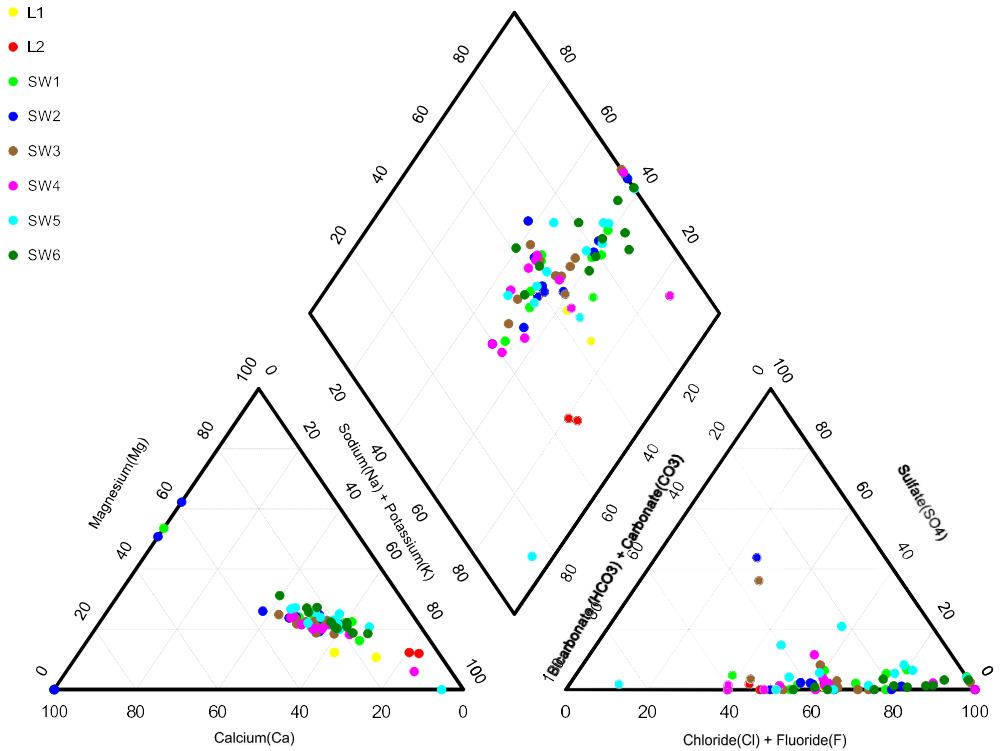
Piper Diagram for Surface Water at Kelsey Creek Landfill, SW5



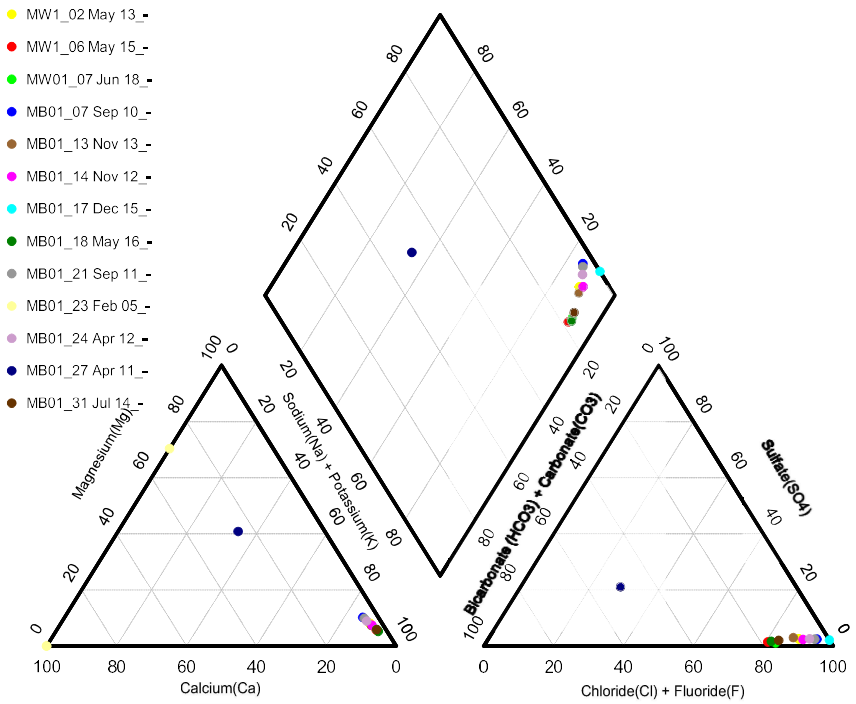
Piper Diagram for Surface Water at Kelsey Creek Landfill, SW6

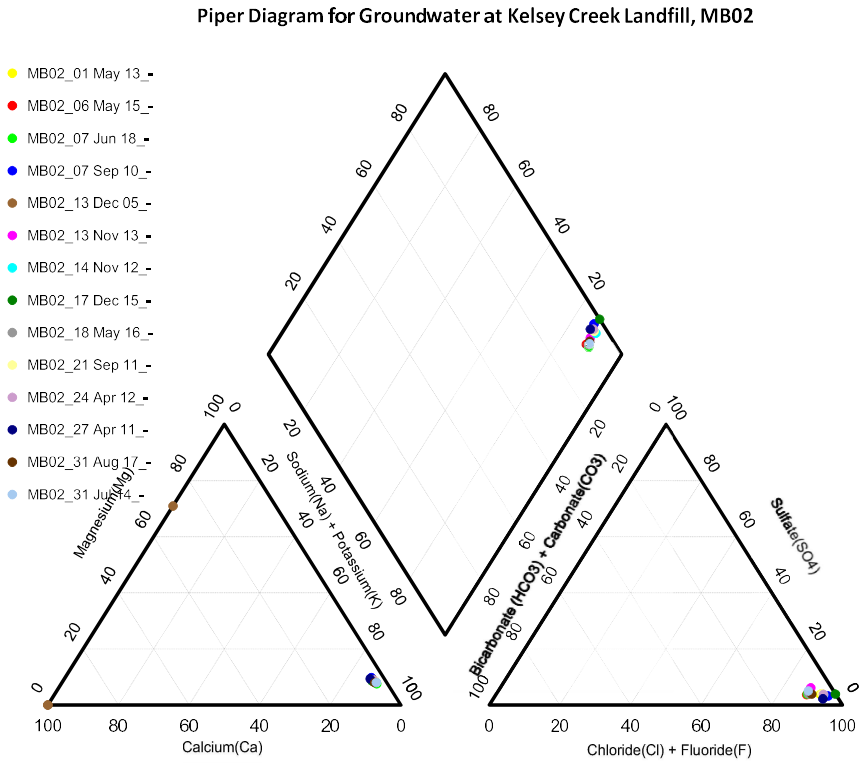


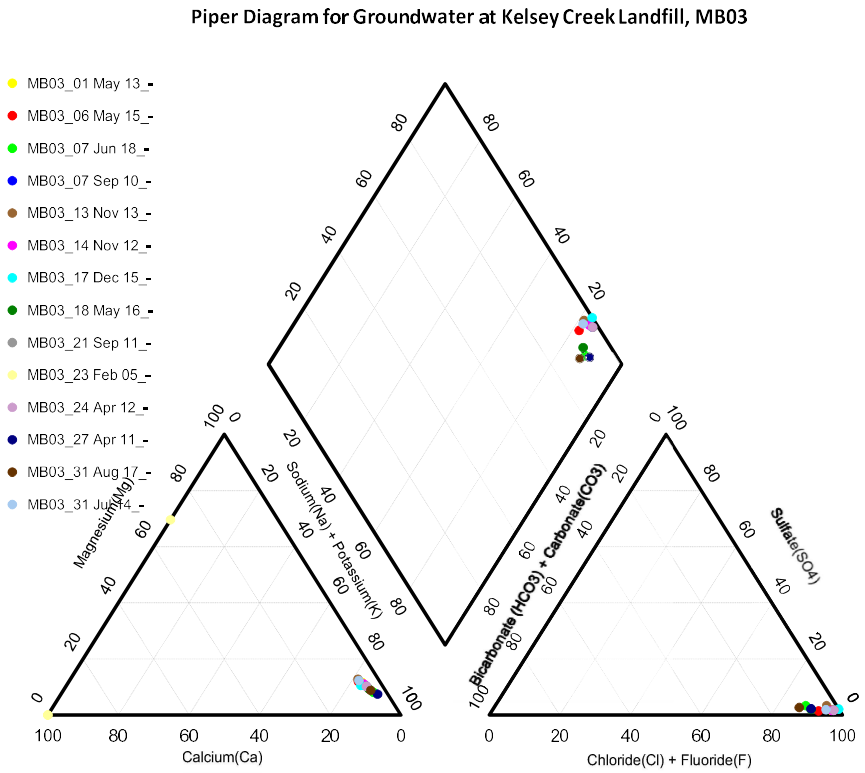
Piper Diagram for Surface Water & Leachate at Kelsey Creek Landfill

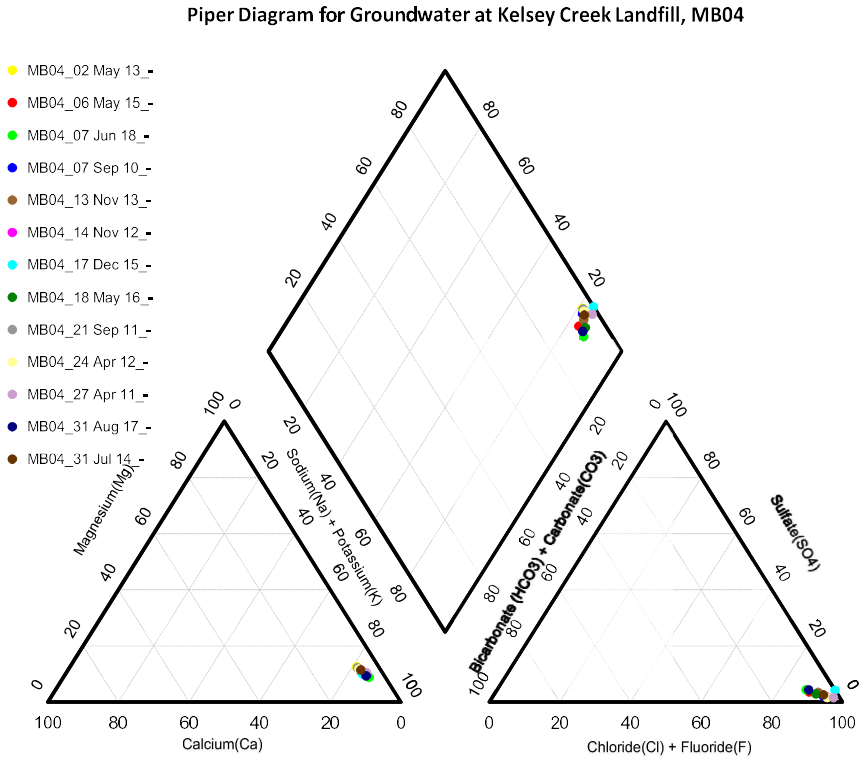


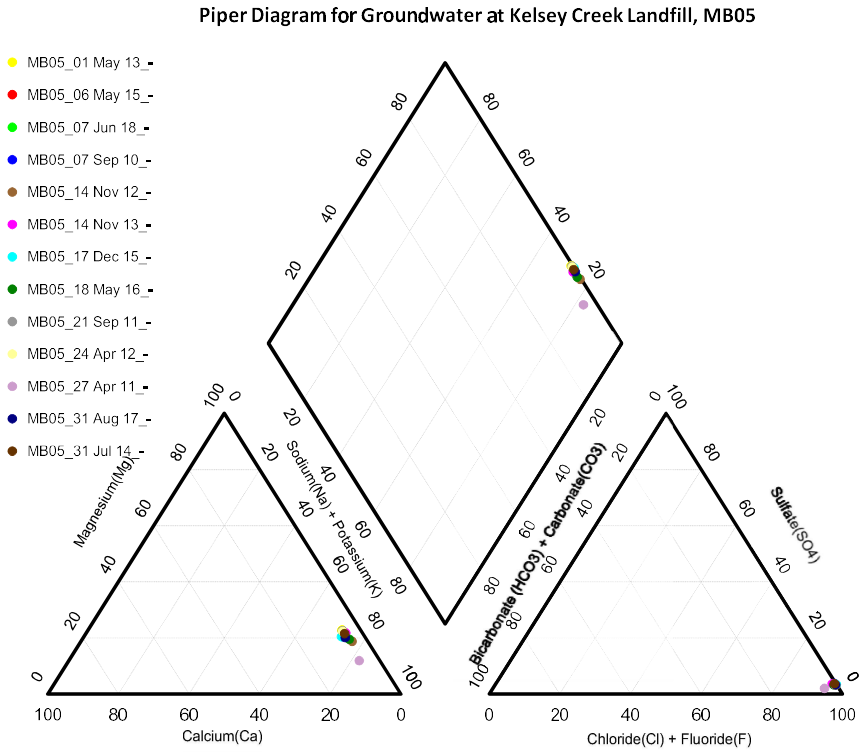
Piper Diagram for Groundwater at Kelsey Creek Landfill, MW1



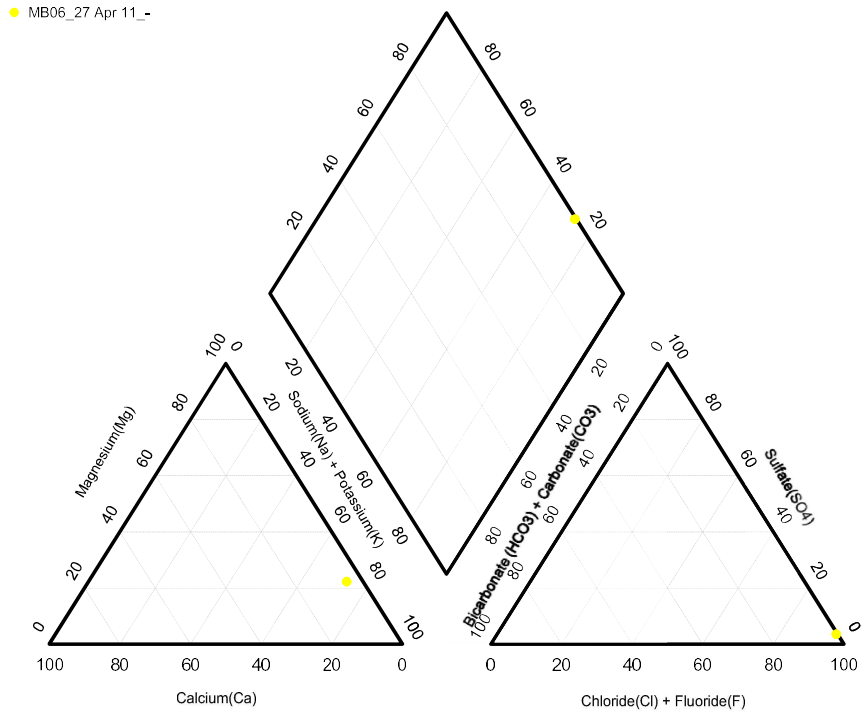

Piper Diagram for Groundwater at Kelsey Creek Landfill, MB02
MB02_01 May 13_-
MB02_06 May 15_-
MB02_07 Jun 18_-
MB02_07 Sep 10_-
MB02_13 Dec 05_-
MB02_13 Nov 13_-
MB02_14 Nov 12_-
MB02_17 Dec 15_-
MB02_18 May 16_-
MB02_21 Sep 11_-
MB02_24 Apr 12_-
MB02_27 Apr 11_-
MB02_31 Aug 17_-
MB02_31 Jul 14_-
Magnesium(Mg)
Sodium(Na) + Potassium(K)
Calcium(Ca)
Bicarbonate (HCO3) + Carbonate(CO3)
Sulfate(SO4)
Chloride(Cl) + Fluoride(F)


Piper Diagram for Groundwater at Kelsey Creek Landfill, MB03
MB03_01 May 13_-
MB03_06 May 15_-
MB03_07 Jun 18_-
MB03_07 Sep 10_-
MB03_13 Nov 13_-
MB03_14 Nov 12_-
MB03_17 Dec 15_-
MB03_18 May 16_-
MB03_21 Sep 11_-
MB03_23 Feb 05_-
MB03_24 Apr 12_-
MB03_27 Apr 11_-
MB03_31 Aug 17_-
MB03_31 Jul 14_-
Magnesium(Mg)
Sodium(Na) + Potassium(K)
Calcium(Ca)
Bicarbonate (HCO3) + Carbonate(CO3)
Sulfate(SO4)
Chloride(Cl) + Fluoride(F)

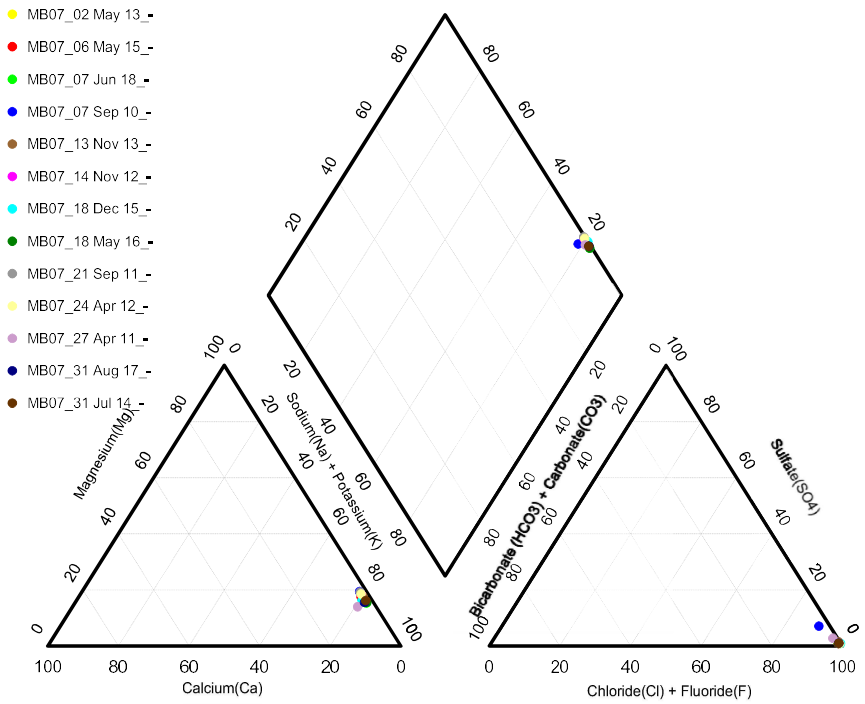

Piper Diagram for Groundwater at Kelsey Creek Landfill, MB04
MB04_02 May 13_-
MB04_06 May 15_-
MB04_07 Jun 18_-
MB04_07 Sep 10_-
MB04_13 Nov 13_-
MB04_14 Nov 12_-
MB04_17 Dec 15_-
MB04_18 May 16_-
MB04_21 Sep 11_-
MB04_24 Apr 12_-
MB04_27 Apr 11_-
MB04_31 Aug 17_-
MB04_31 Jul 14_-
Magnesium(Mg)
Calcium(Ca)
Sodium(Na) + Potassium(K)
Bicarbonate (HCO3) + Carbonate(CO3)
Sulfate(SO4)
Chloride(Cl) + Fluoride(F)

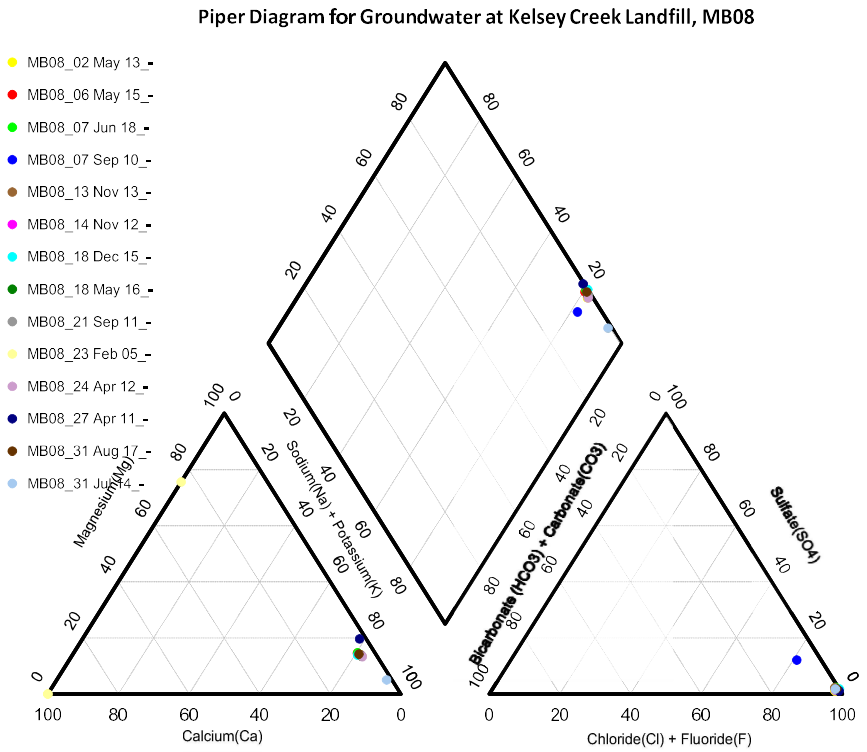

Piper Diagram for Groundwater at Kelsey Creek Landfill, MB05
MB05_01 May 13_-
MB05_06 May 15_-
MB05_07 Jun 18_-
MB05_07 Sep 10_-
MB05_14 Nov 12_-
MB05_14 Nov 13_-
MB05_17 Dec 15_-
MB05_18 May 16_-
MB05_21 Sep 11_-
MB05_24 Apr 12_-
MB05_27 Apr 11_-
MB05_31 Aug 17_-
MB05_31 Jul 14_-
Magnesium(Mg)
Calcium(Ca)
Sodium(Na) + Potassium(K)
Bicarbonate (HCO3) + Carbonate(CO3)
Sulfate(SO4)
Chloride(Cl) + Fluoride(F)

Piper Diagram for Groundwater at Kelsey Creek Landfill, MB06

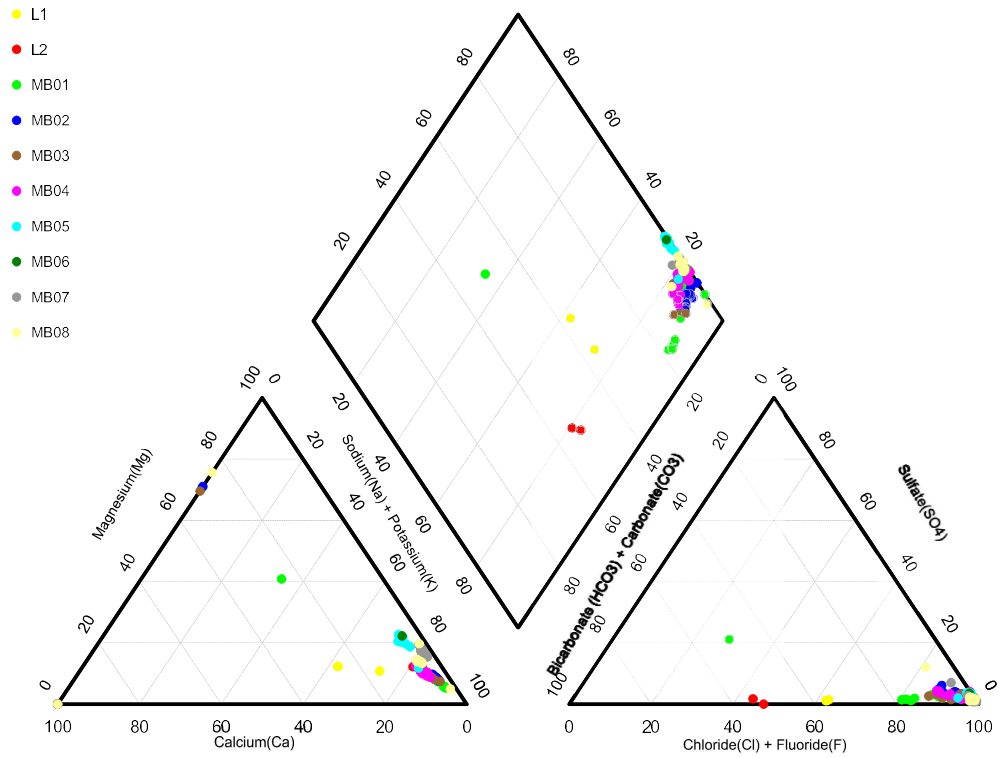


Piper Diagram for Groundwater at Kelsey Creek Landfill, MB07




Piper Diagram for Groundwater at Kelsey Creek Landfill, MB08
MB08_02 May 13_-
MB08_06 May 15_-
MB08_07 Jun 18_-
MB08_07 Sep 10_-
MB08_13 Nov 13_-
MB08_14 Nov 12_-
MB08_18 Dec 15_-
MB08_18 May 16_-
MB08_21 Sep 11_-
MB08_23 Feb 05_-
MB08_24 Apr 12_-
MB08_27 Apr 11_-
MB08_31 Aug 17_-
MB08_31 Jul 14_-
Magnesium(Mg)
Sodium(Na) + Potassium(K)
Calcium(Ca)
Bicarbonate (HCO3) + Carbonate(CO3)
Sulfate(SO4)
Chloride(Cl) + Fluoride(F)

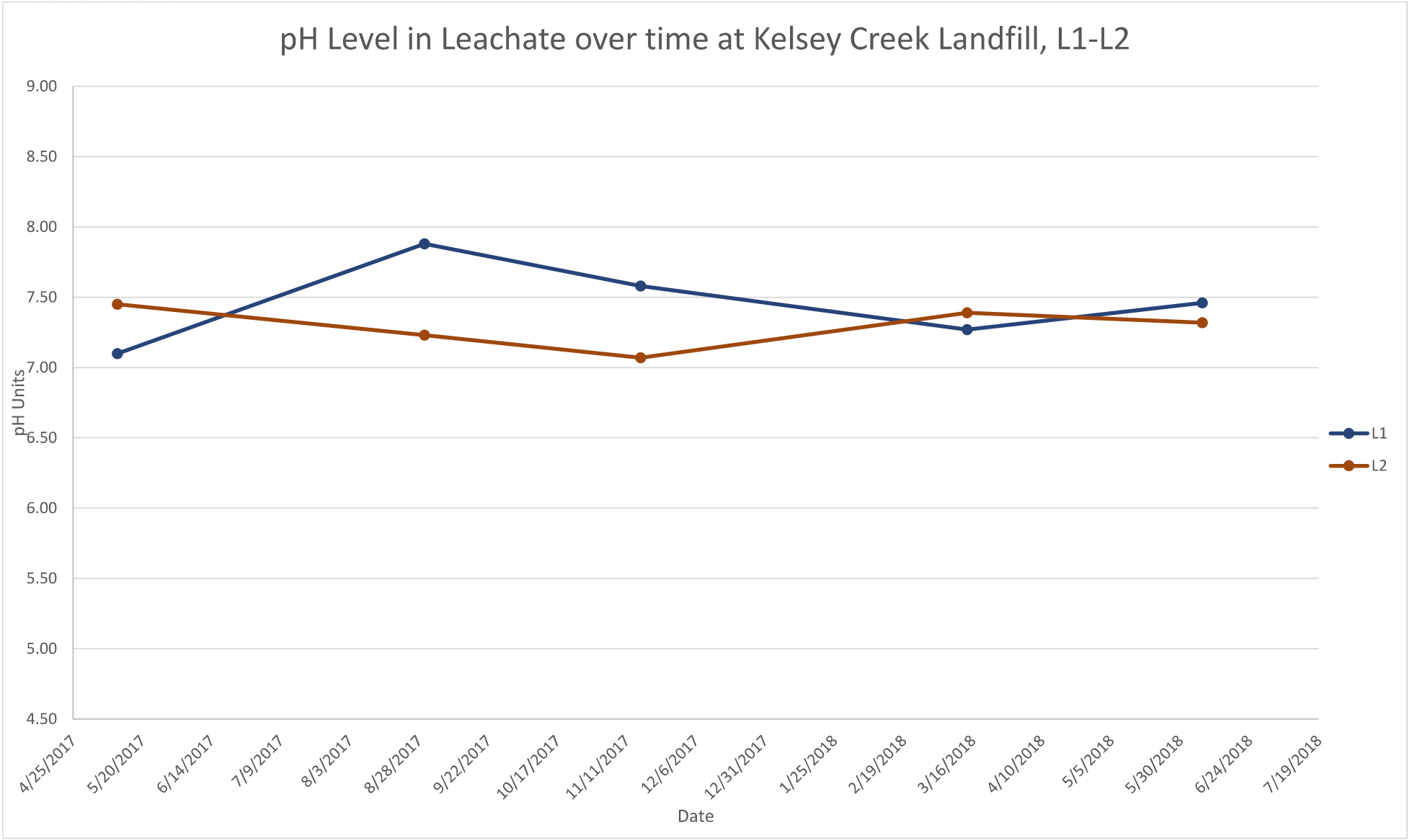
Piper Diagram for Groundwater & Leachate at Kelsey Creek Landfill



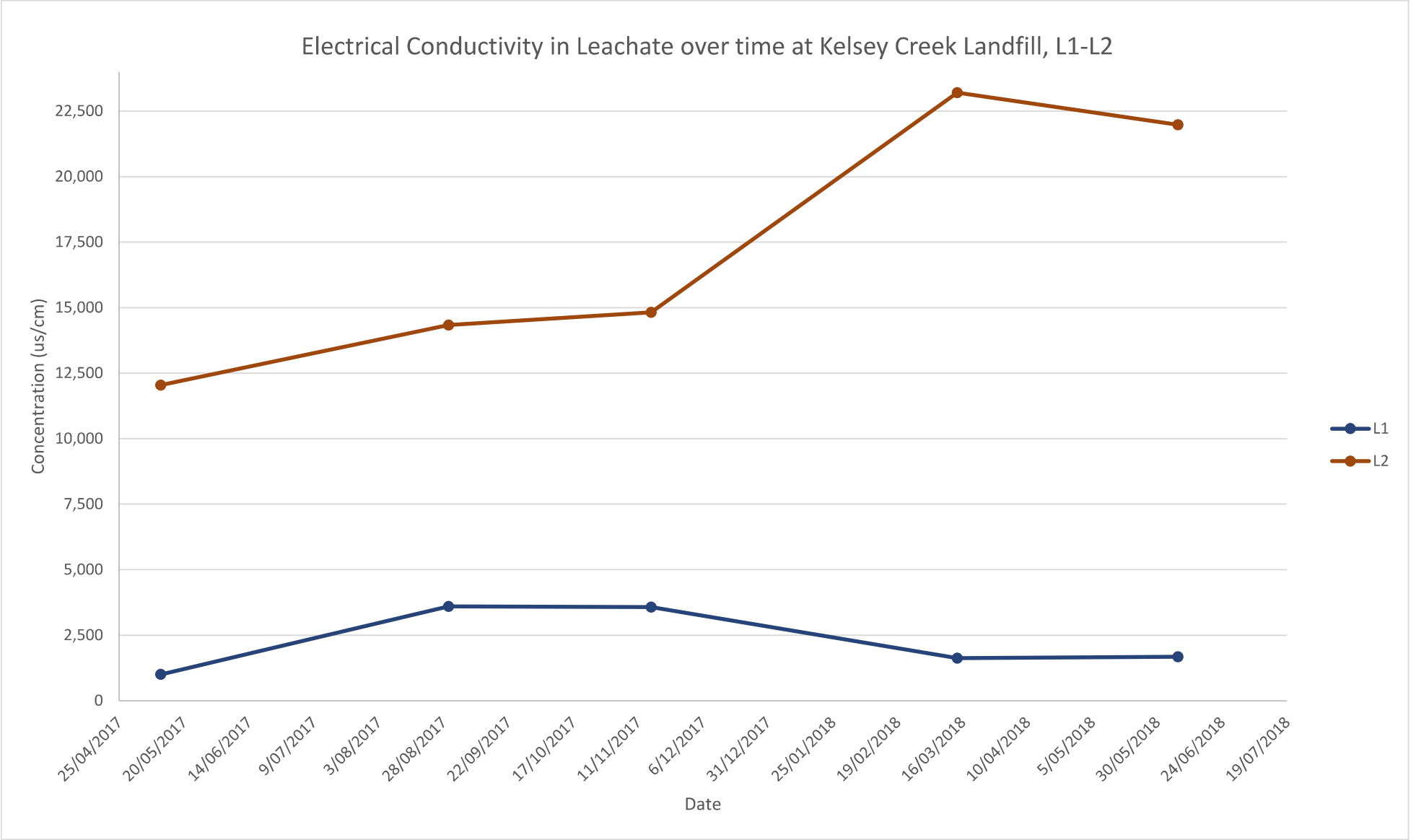
APPENDIX K

Graphs

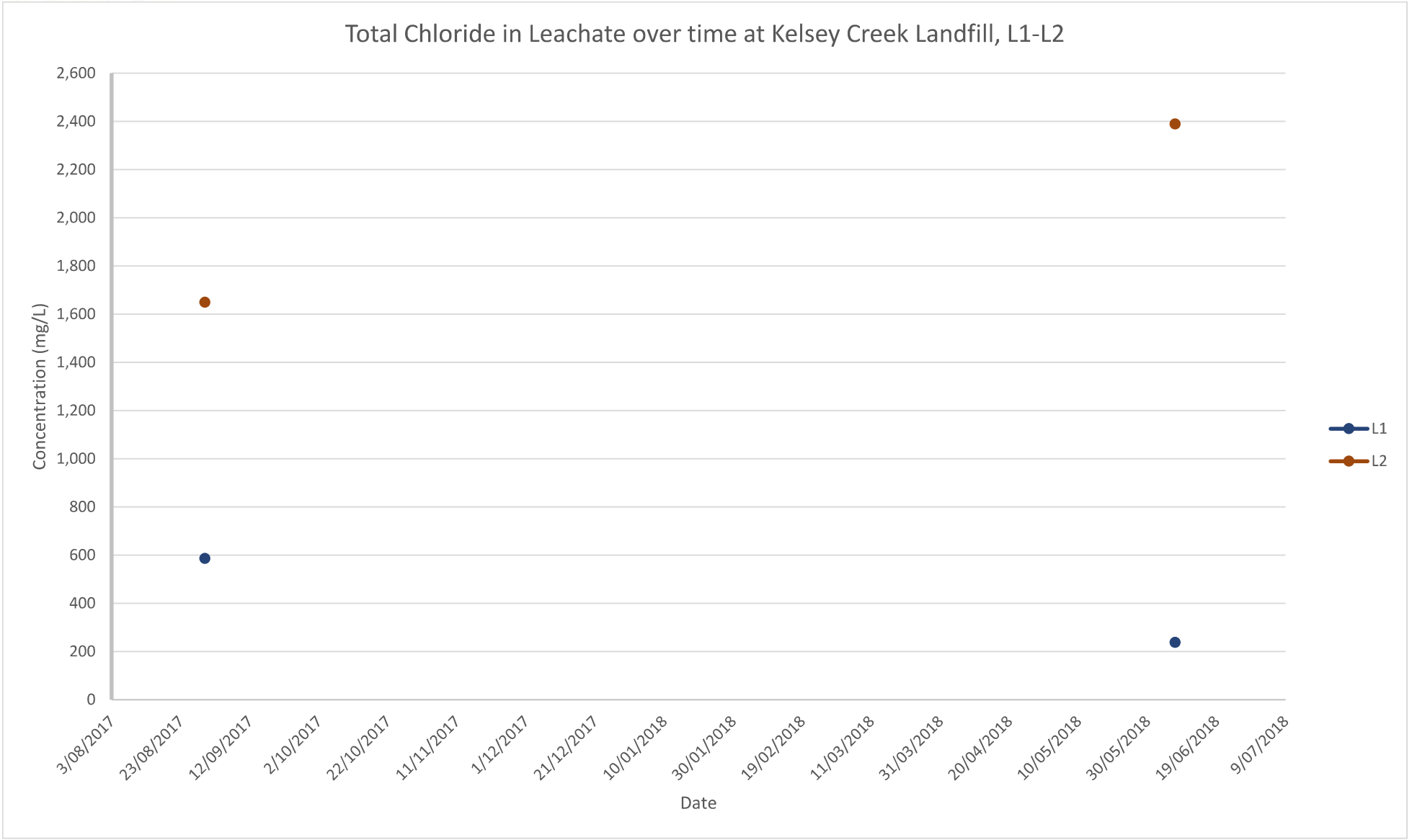
Appendix K Kelsey Creek Graphs - Leachate



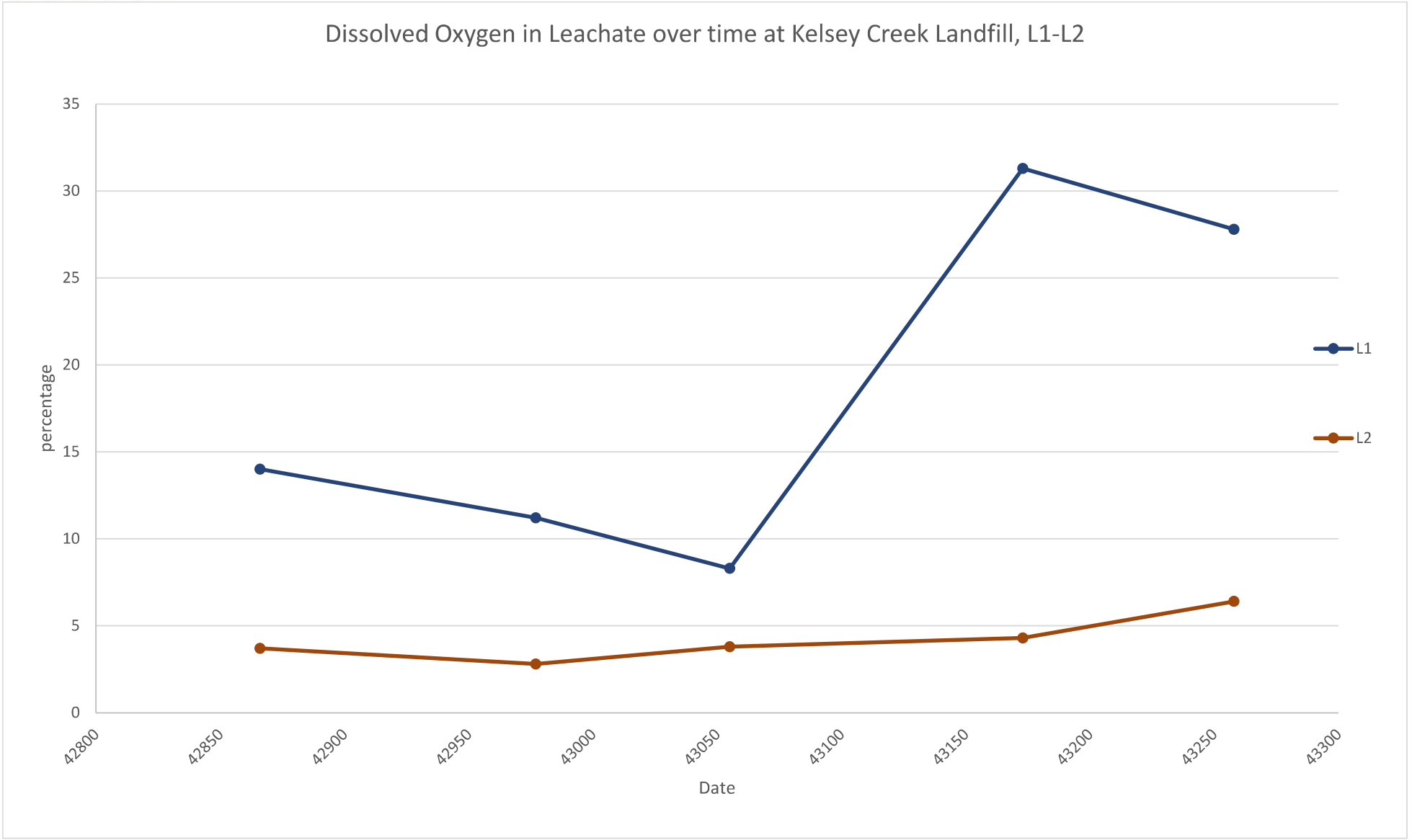
Appendix K Kelsey Creek Graphs - Leachate



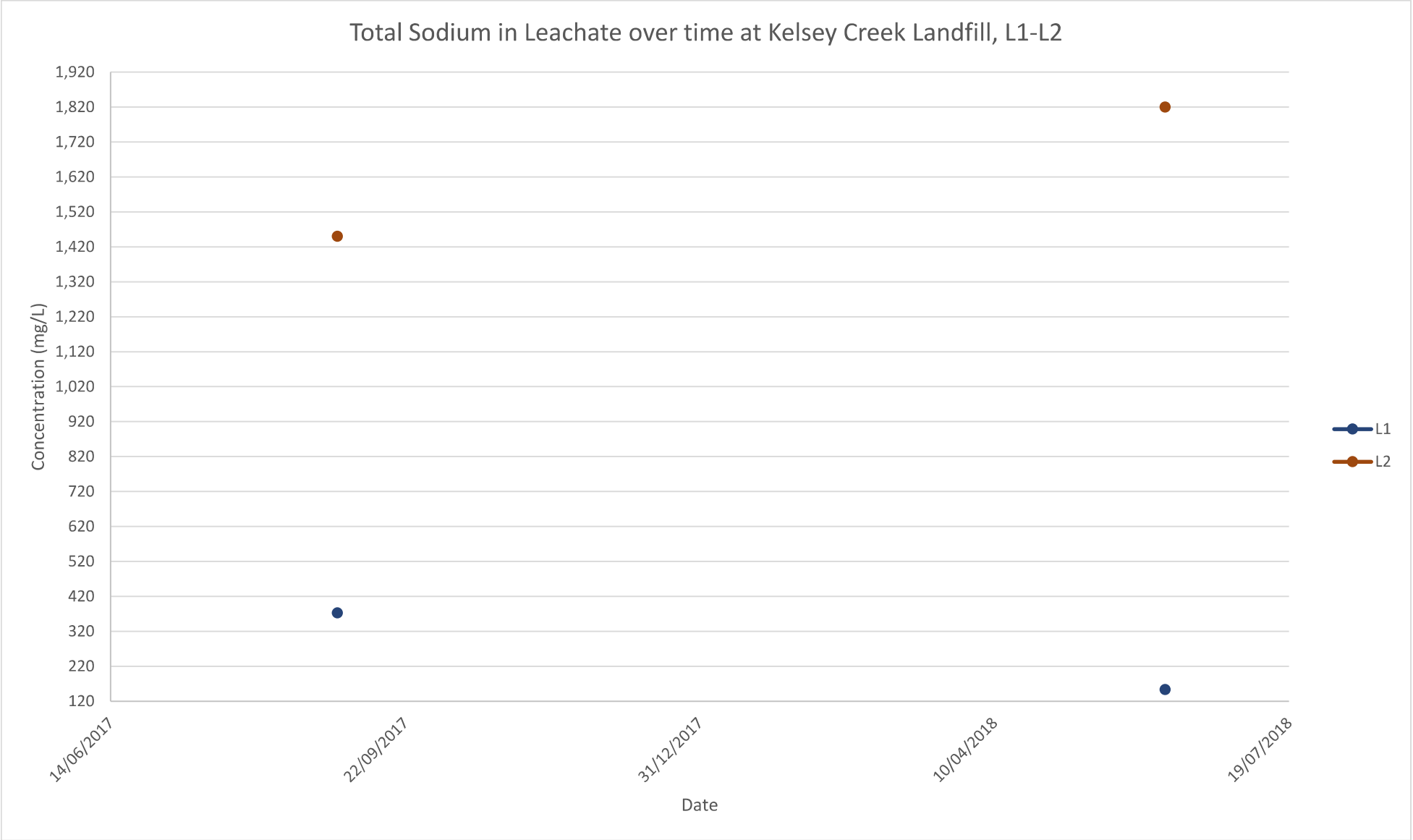
Appendix K Kelsey Creek Graphs - Leachate



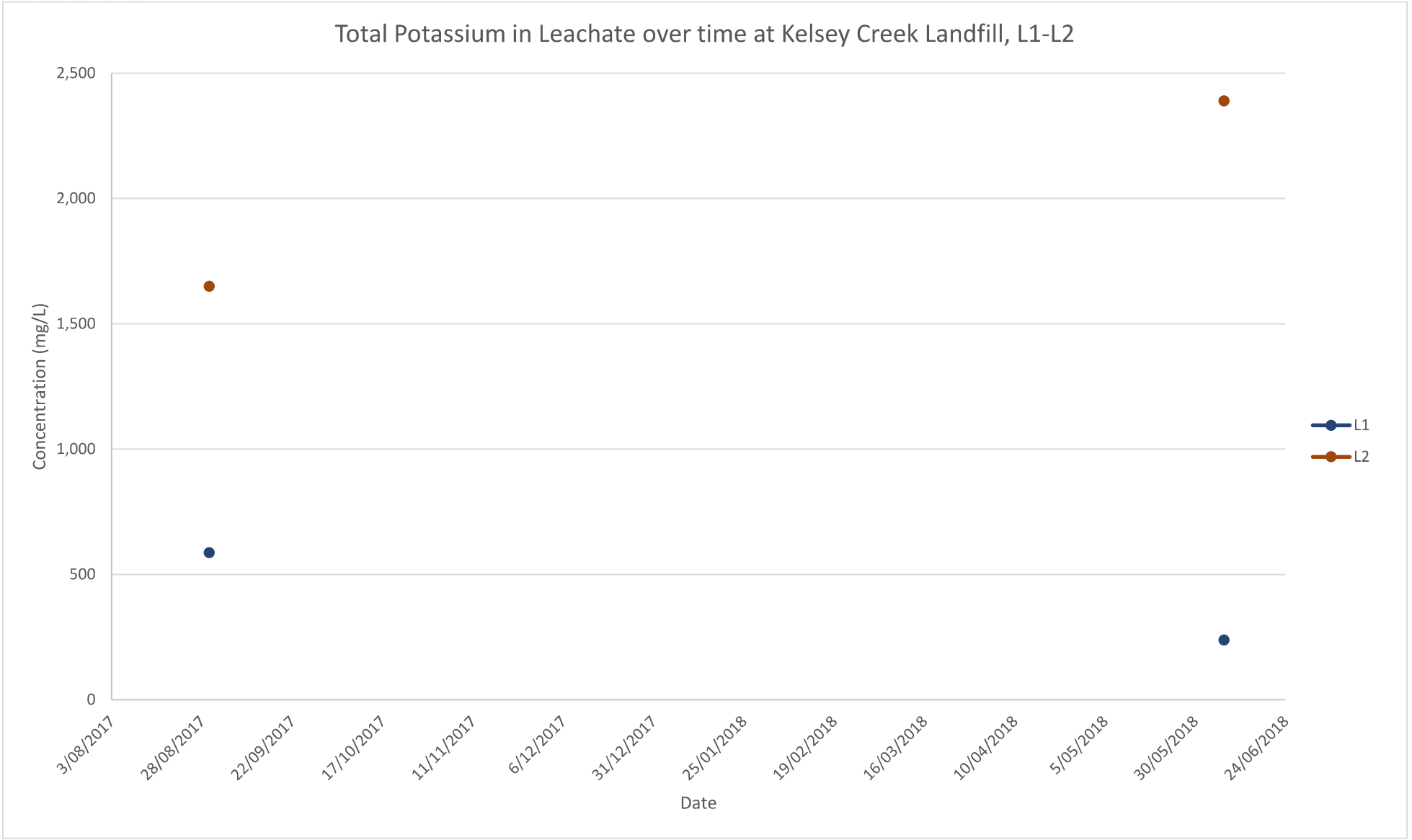
Appendix K Kelsey Creek Graphs - Leachate



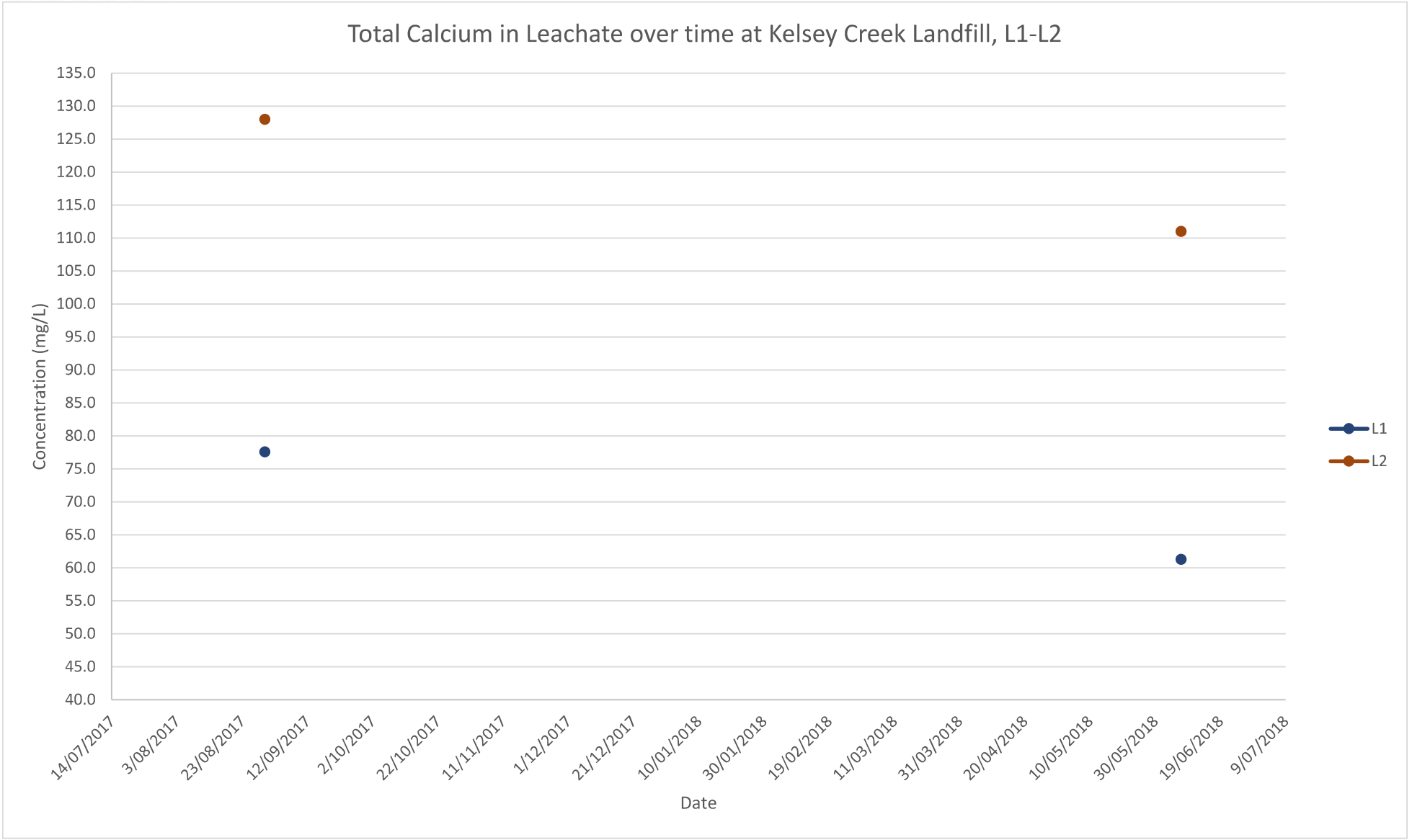
Appendix K Kelsey Creek Graphs - Leachate



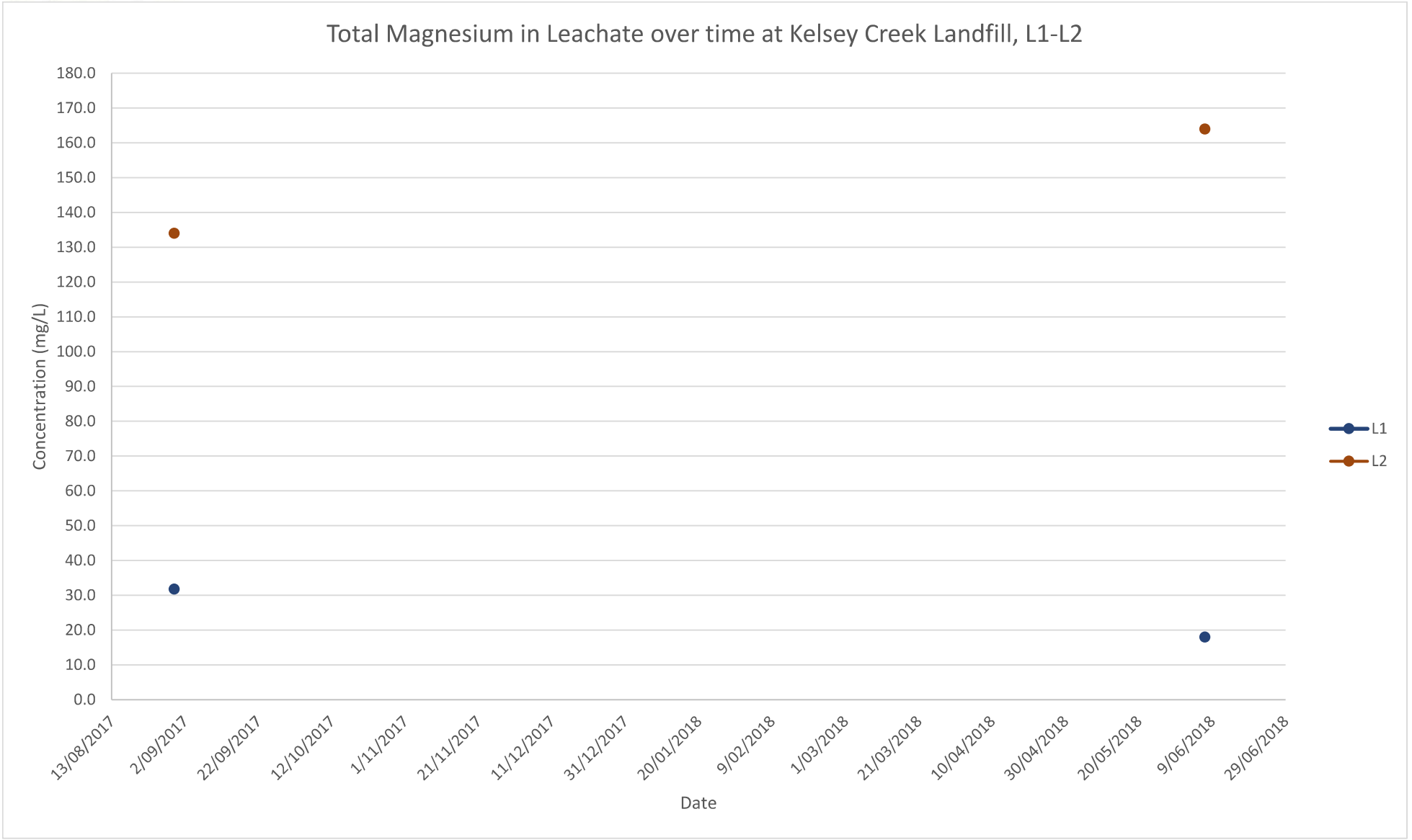
Appendix K Kelsey Creek Graphs - Leachate



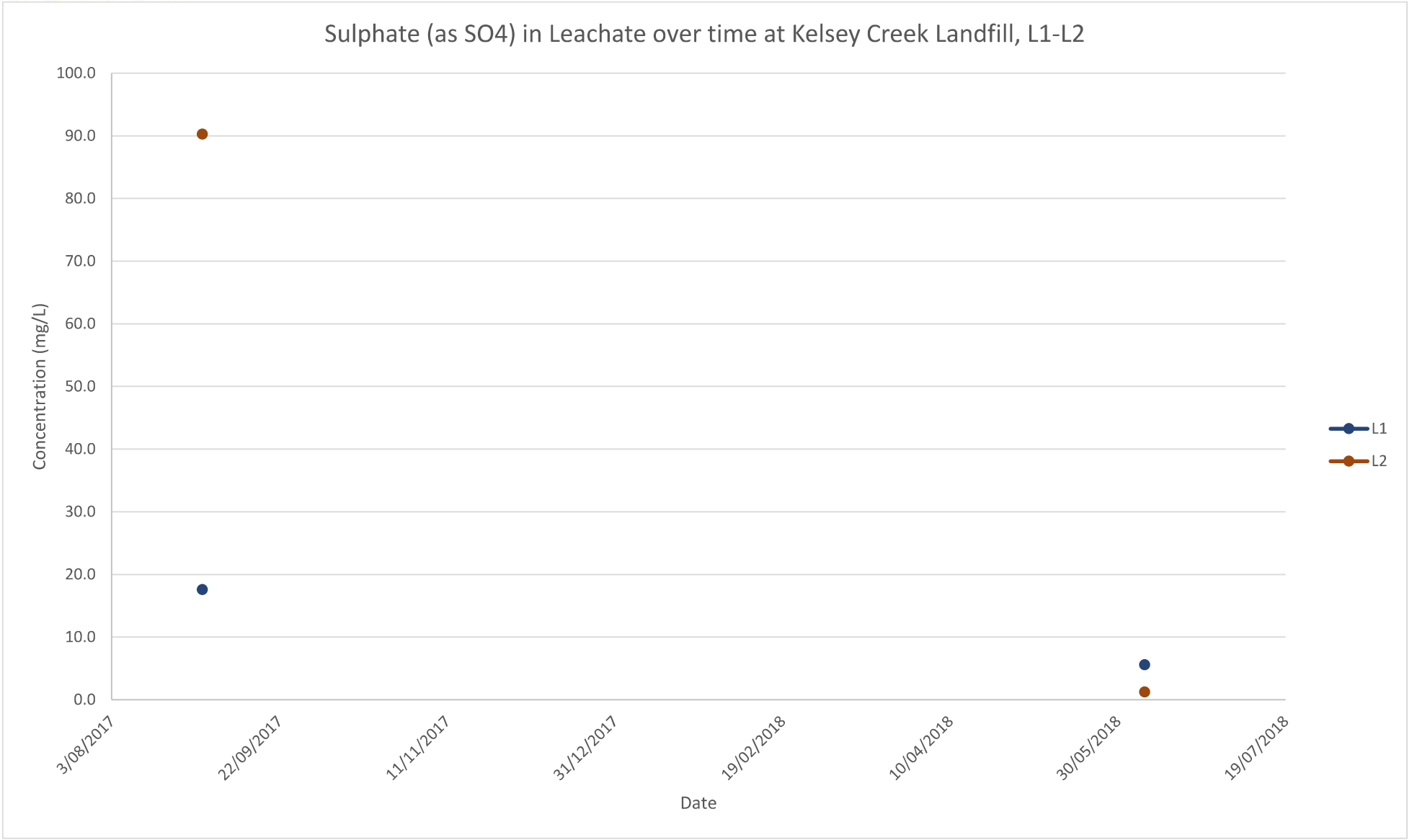
Appendix K Kelsey Creek Graphs - Leachate



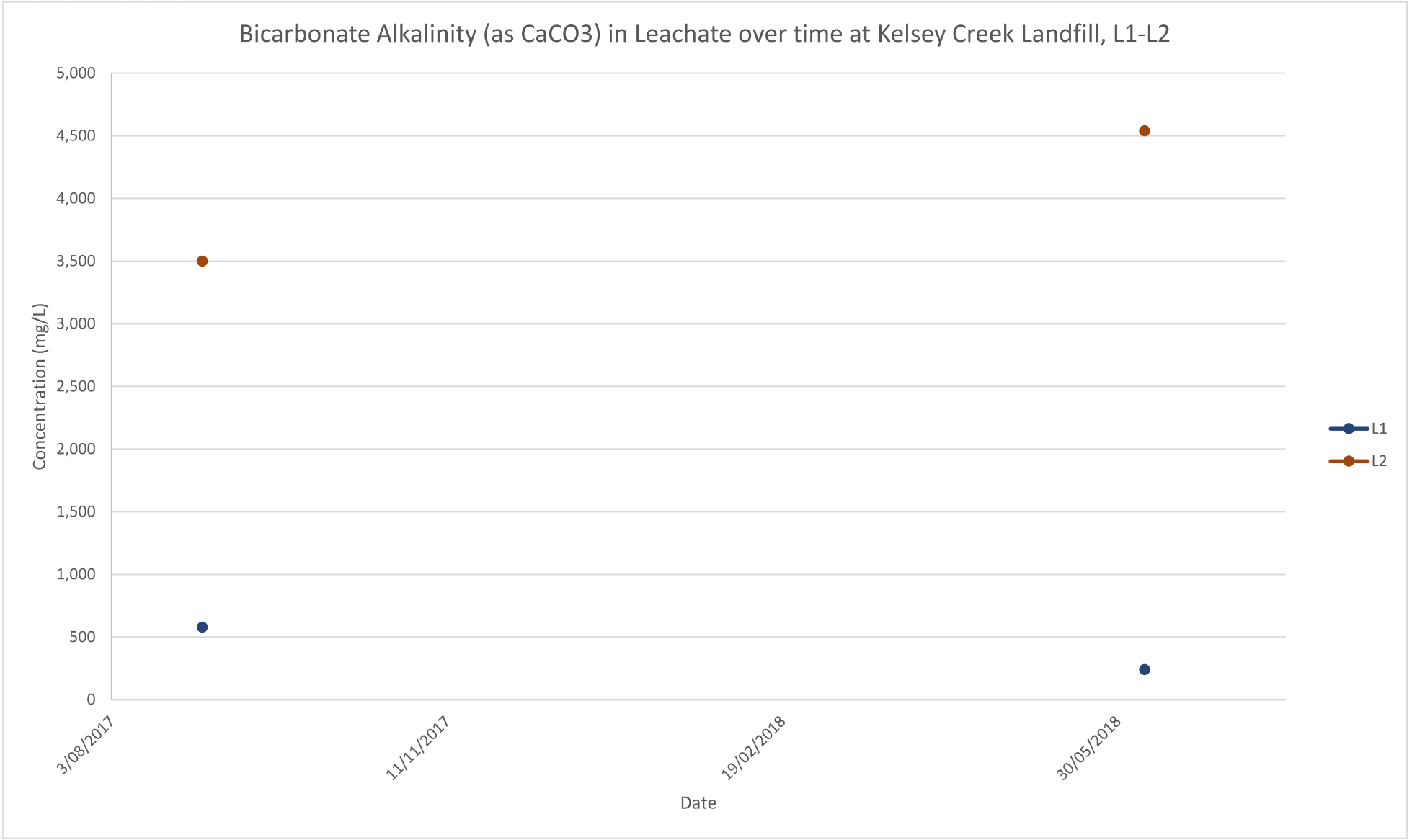
Appendix K Kelsey Creek Graphs - Leachate



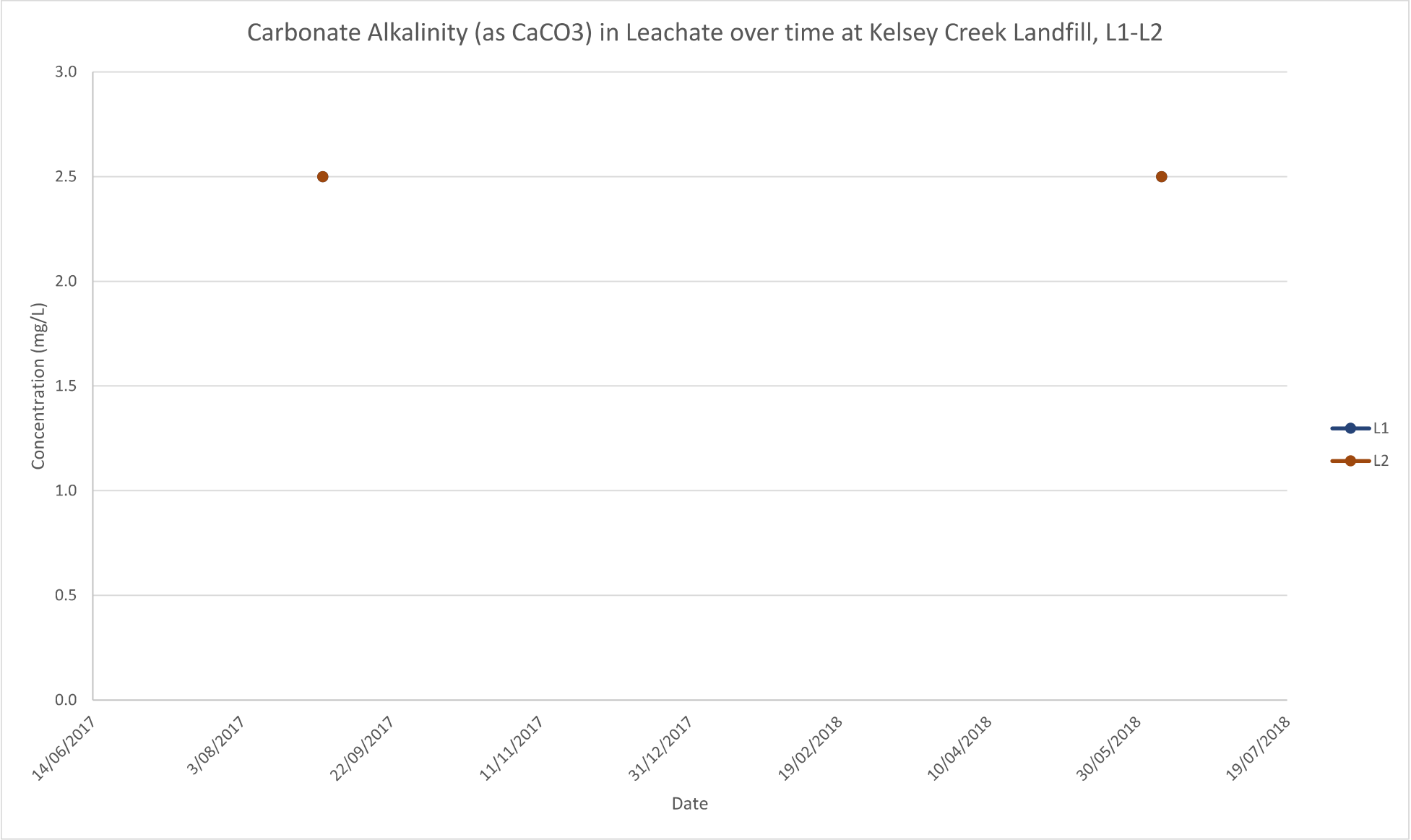
Appendix K Kelsey Creek Graphs - Leachate



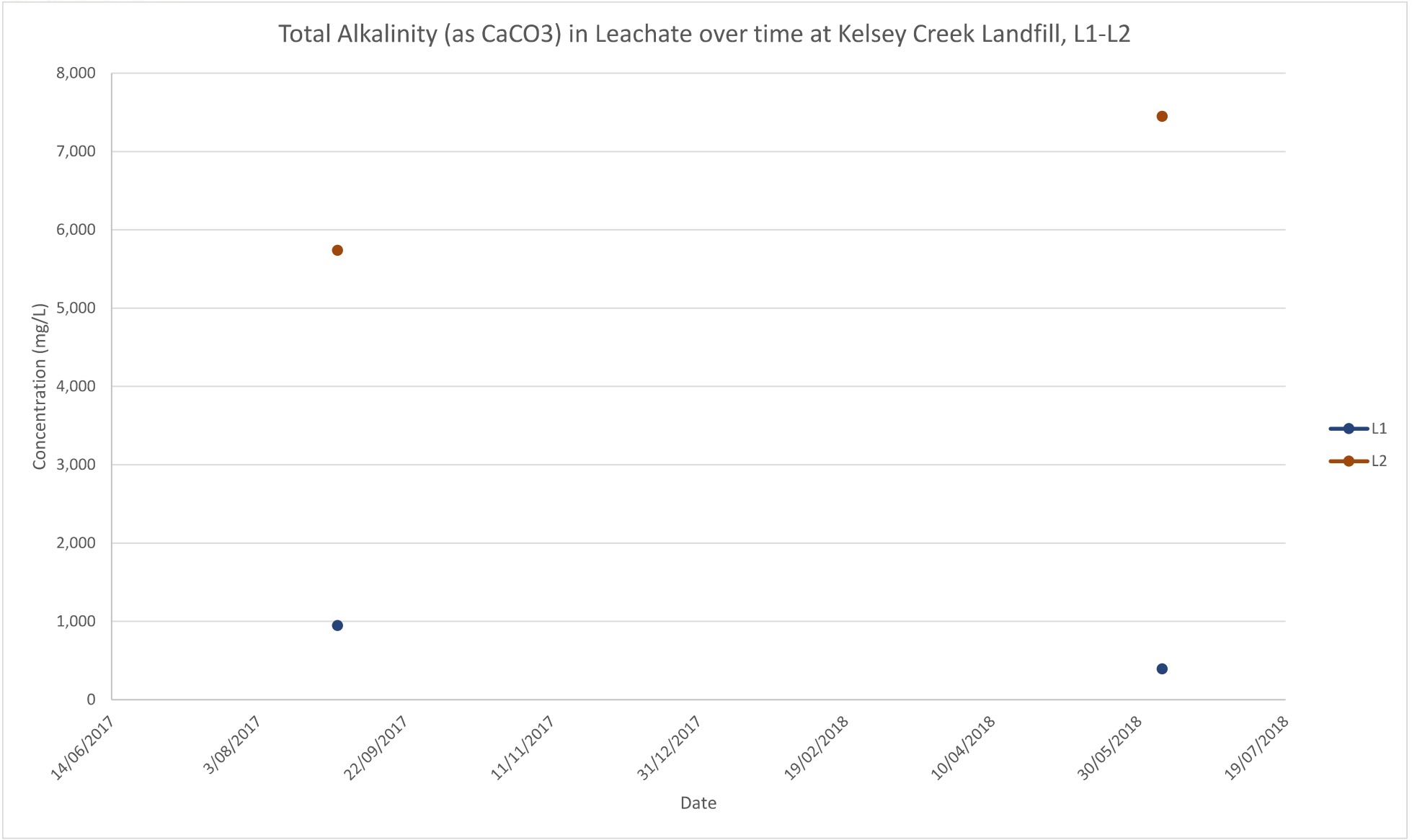
Appendix K Kelsey Creek Graphs - Leachate



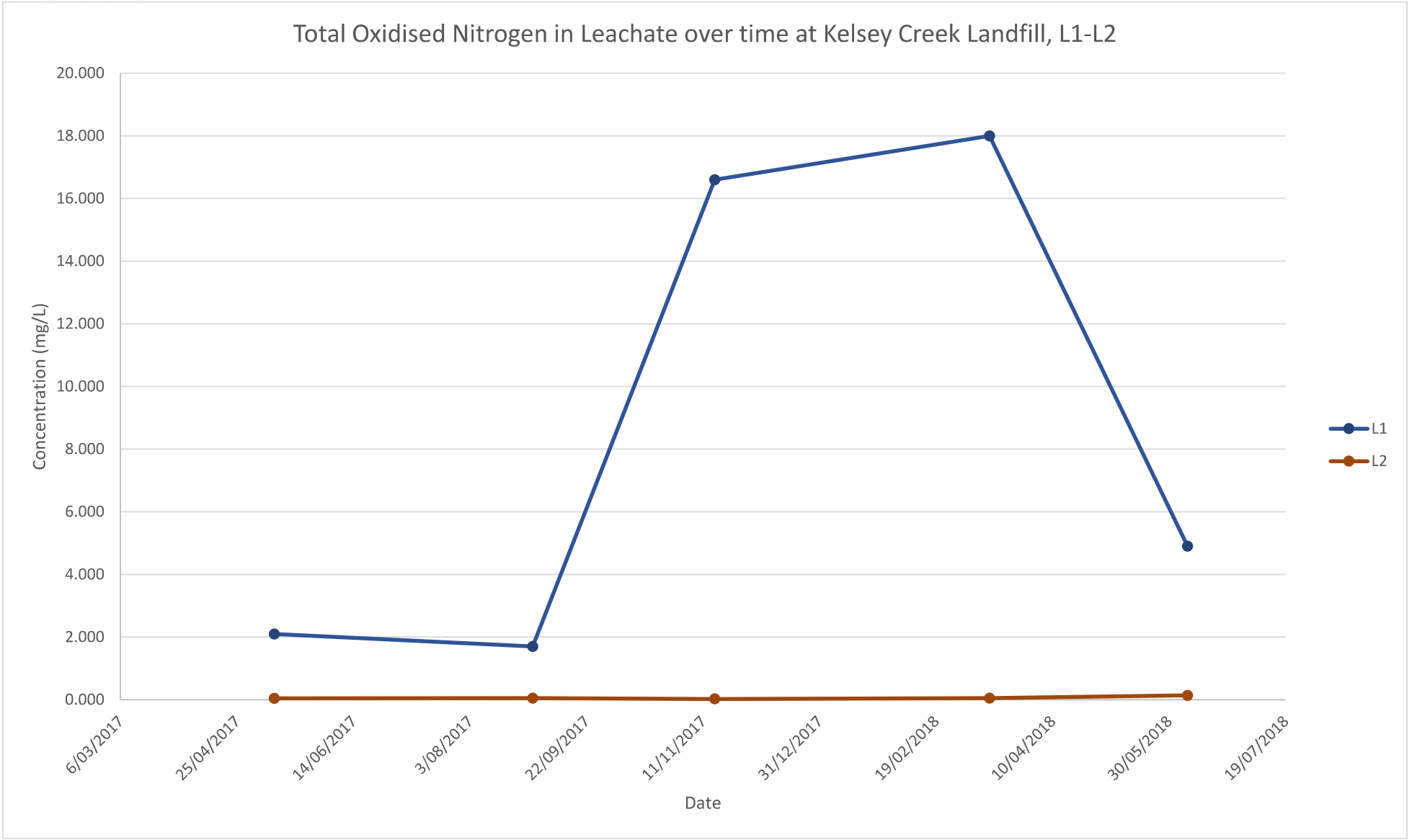
Appendix K Kelsey Creek Graphs - Leachate



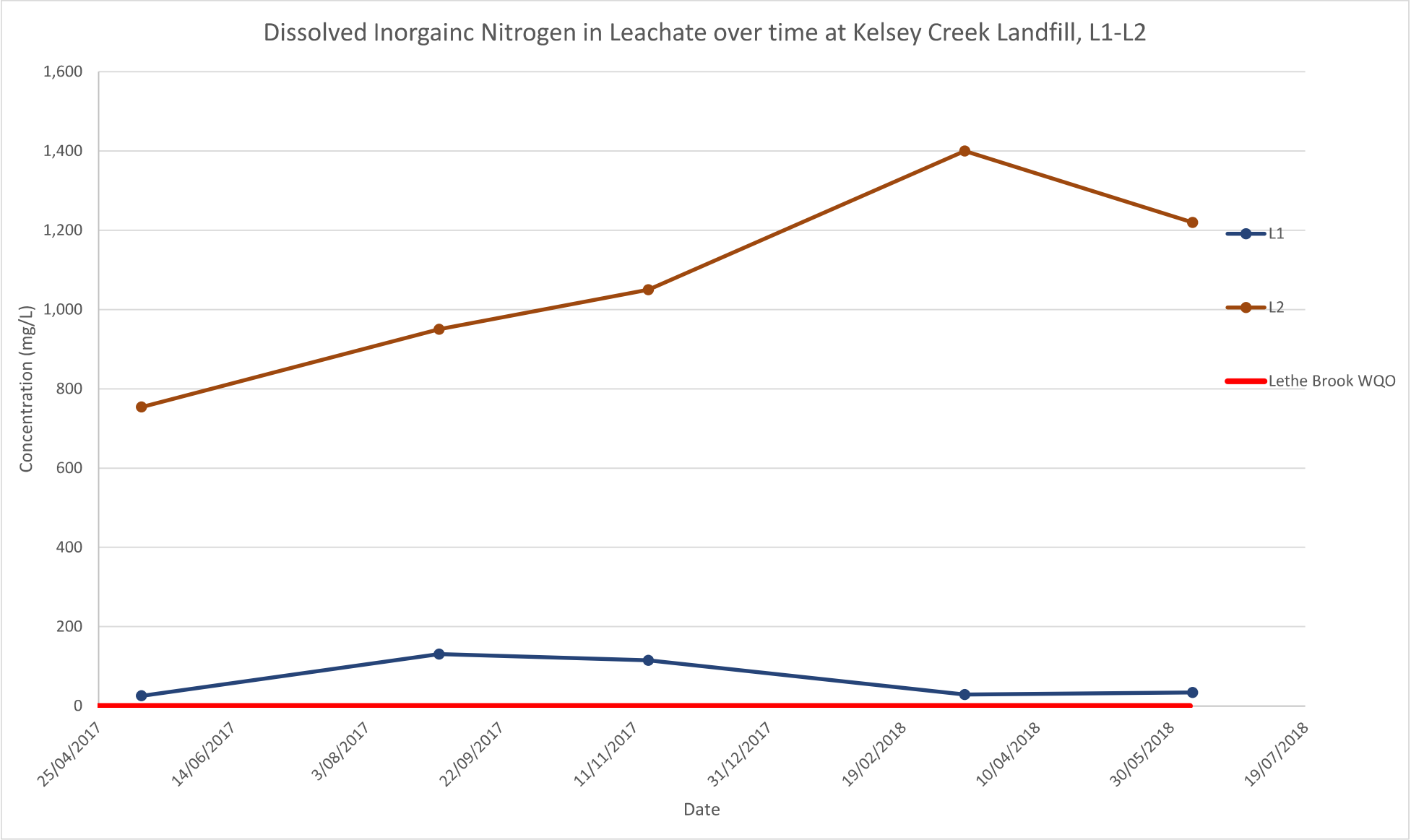
Appendix K Kelsey Creek Graphs - Leachate



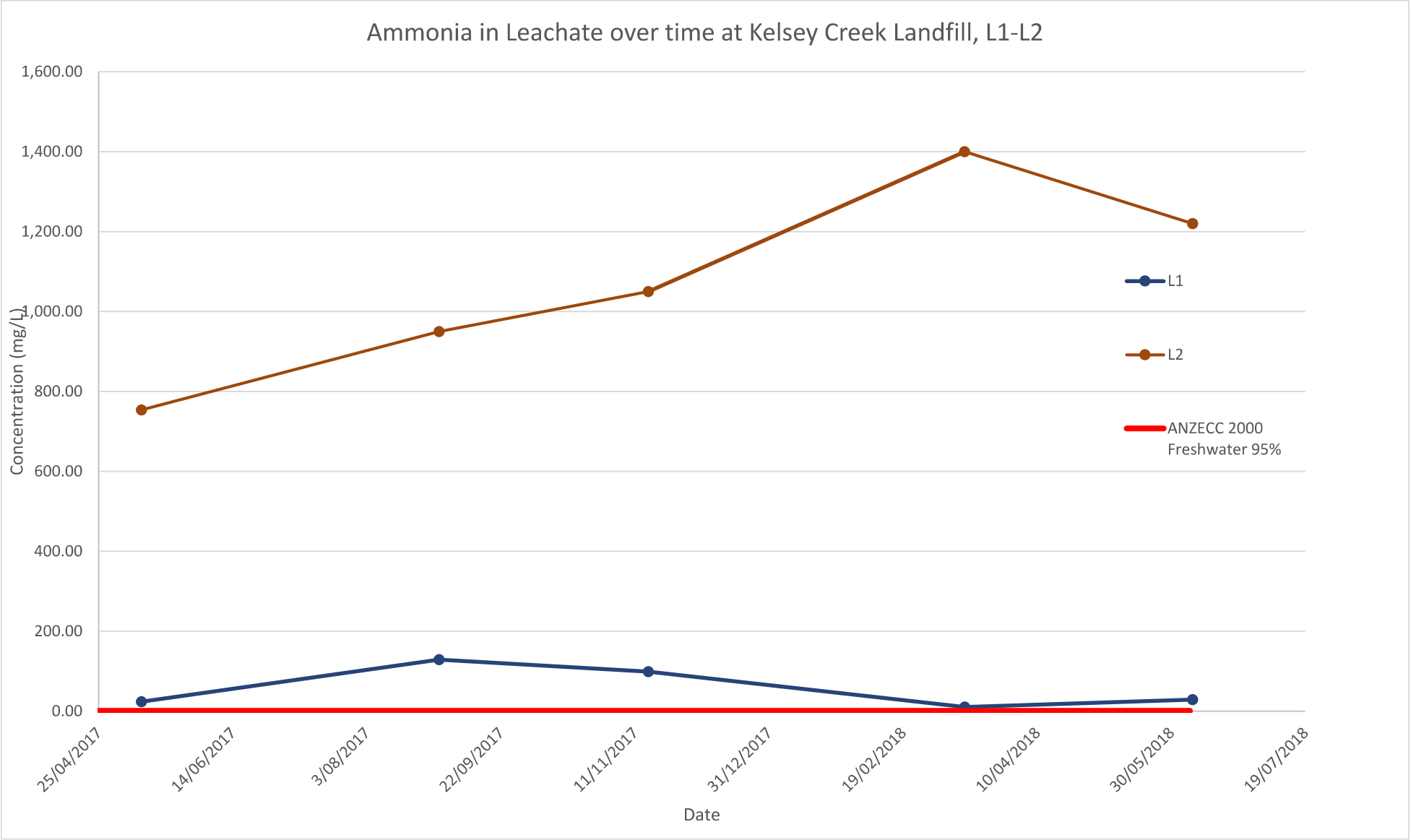
Appendix K Kelsey Creek Graphs - Leachate



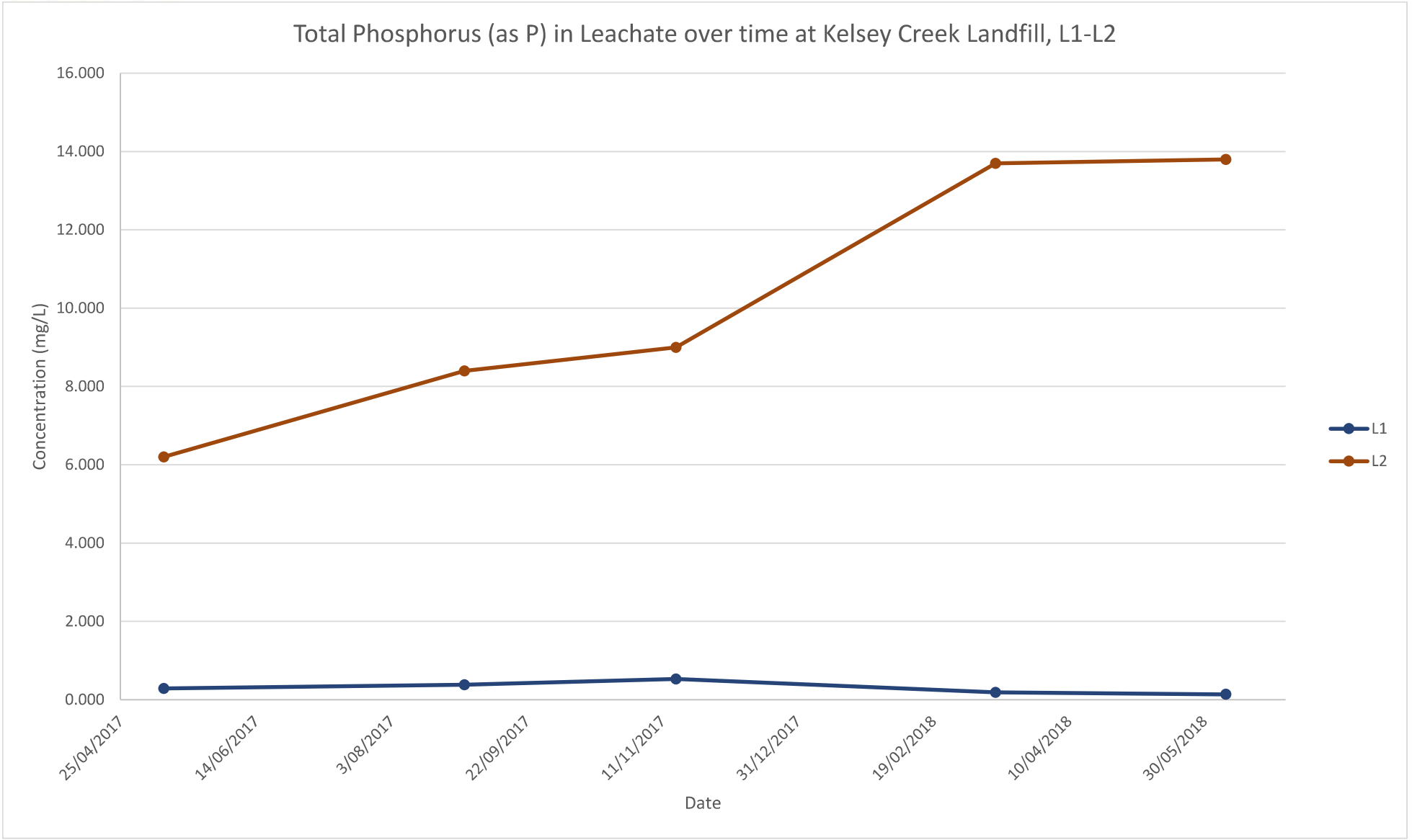
Appendix K Kelsey Creek Graphs - Leachate



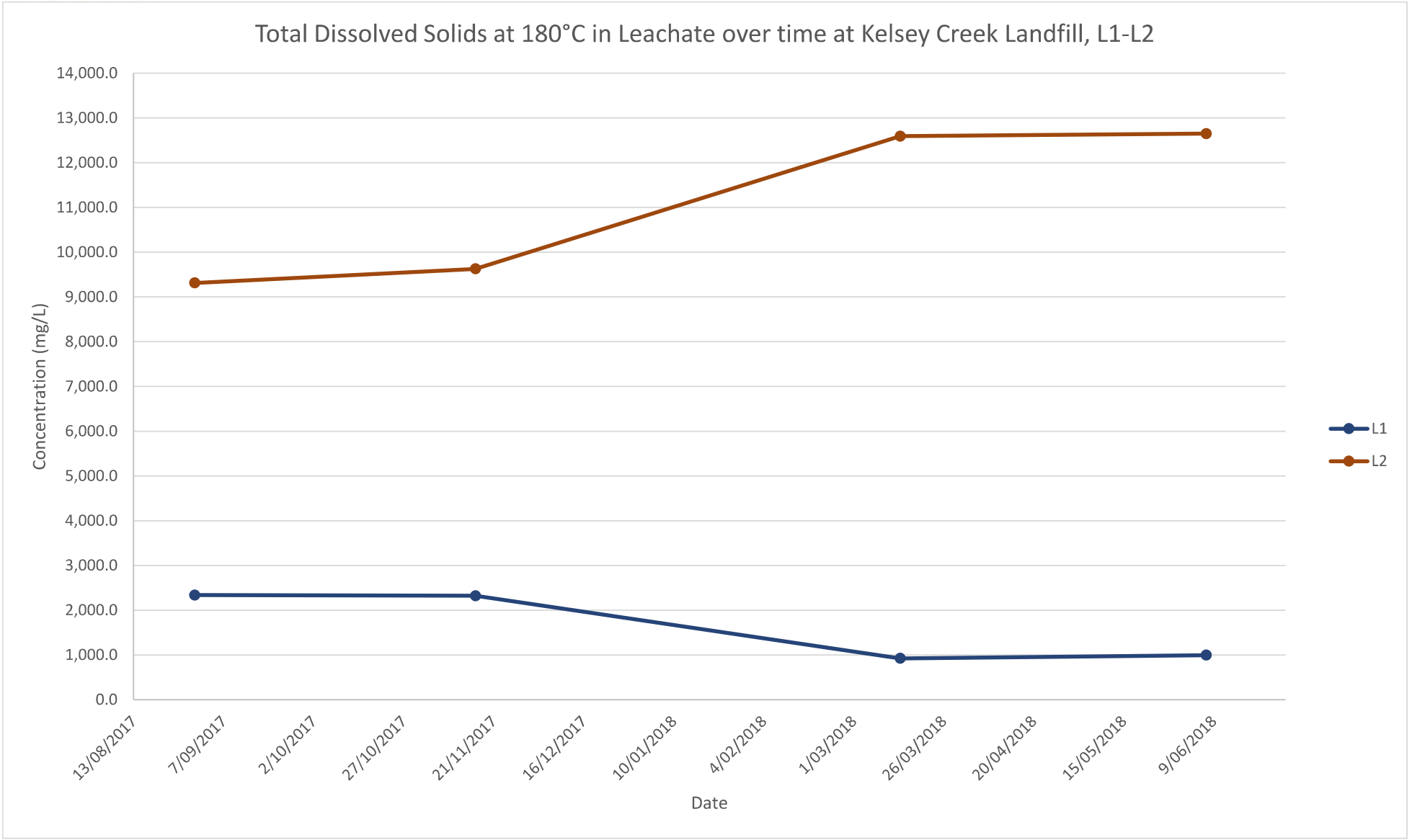
Appendix K Kelsey Creek Graphs - Leachate



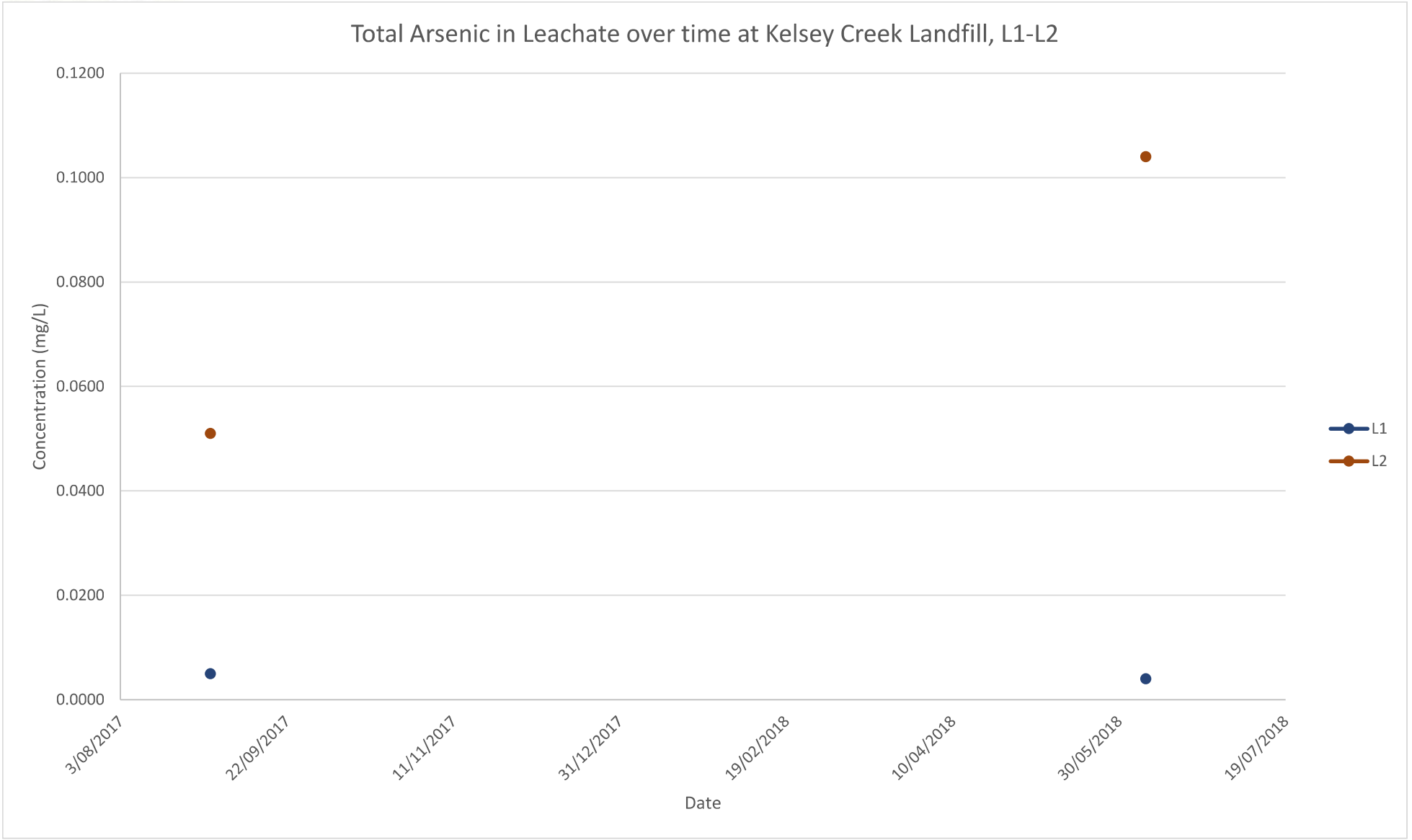
Appendix K Kelsey Creek Graphs - Leachate



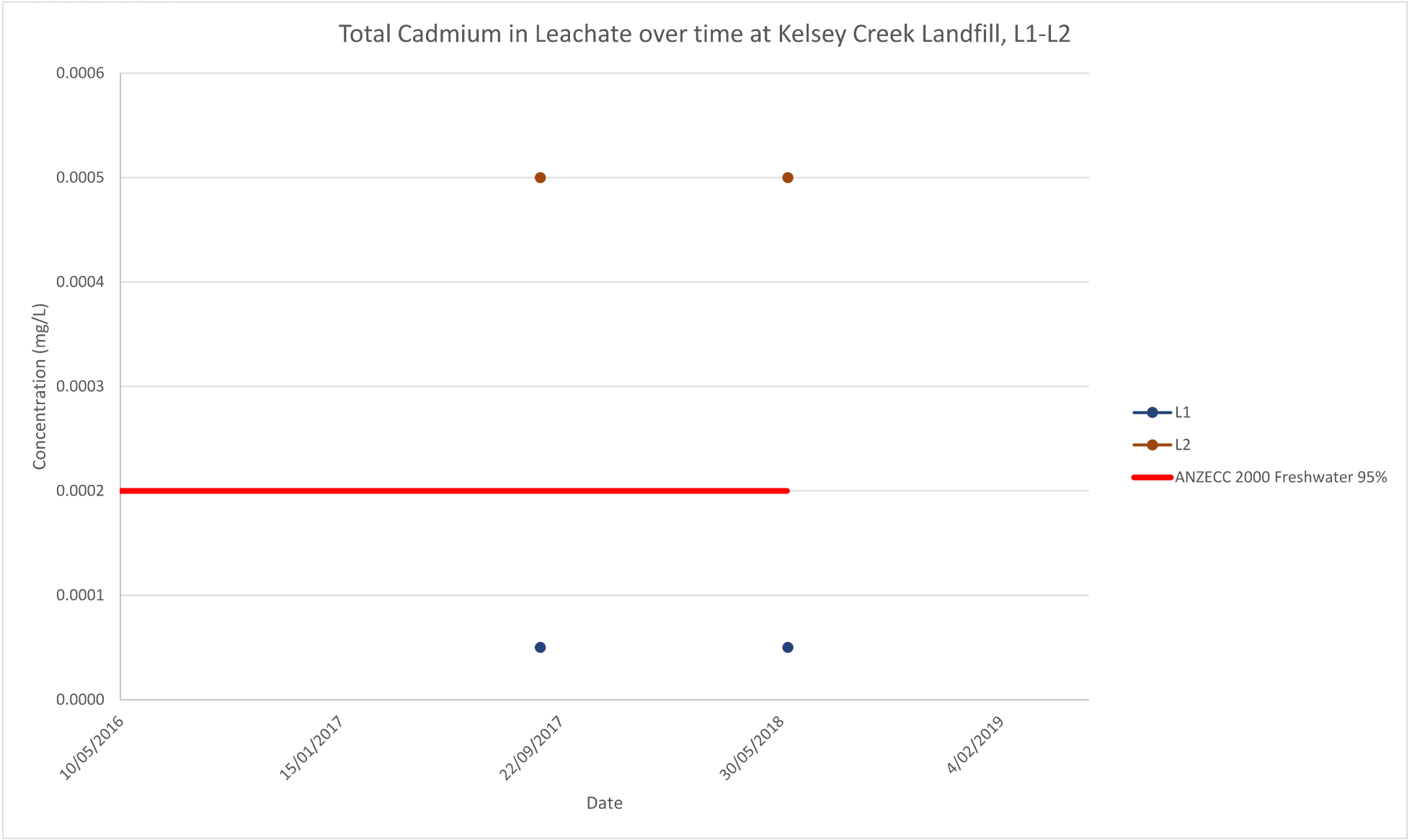
Appendix K Kelsey Creek Graphs - Leachate



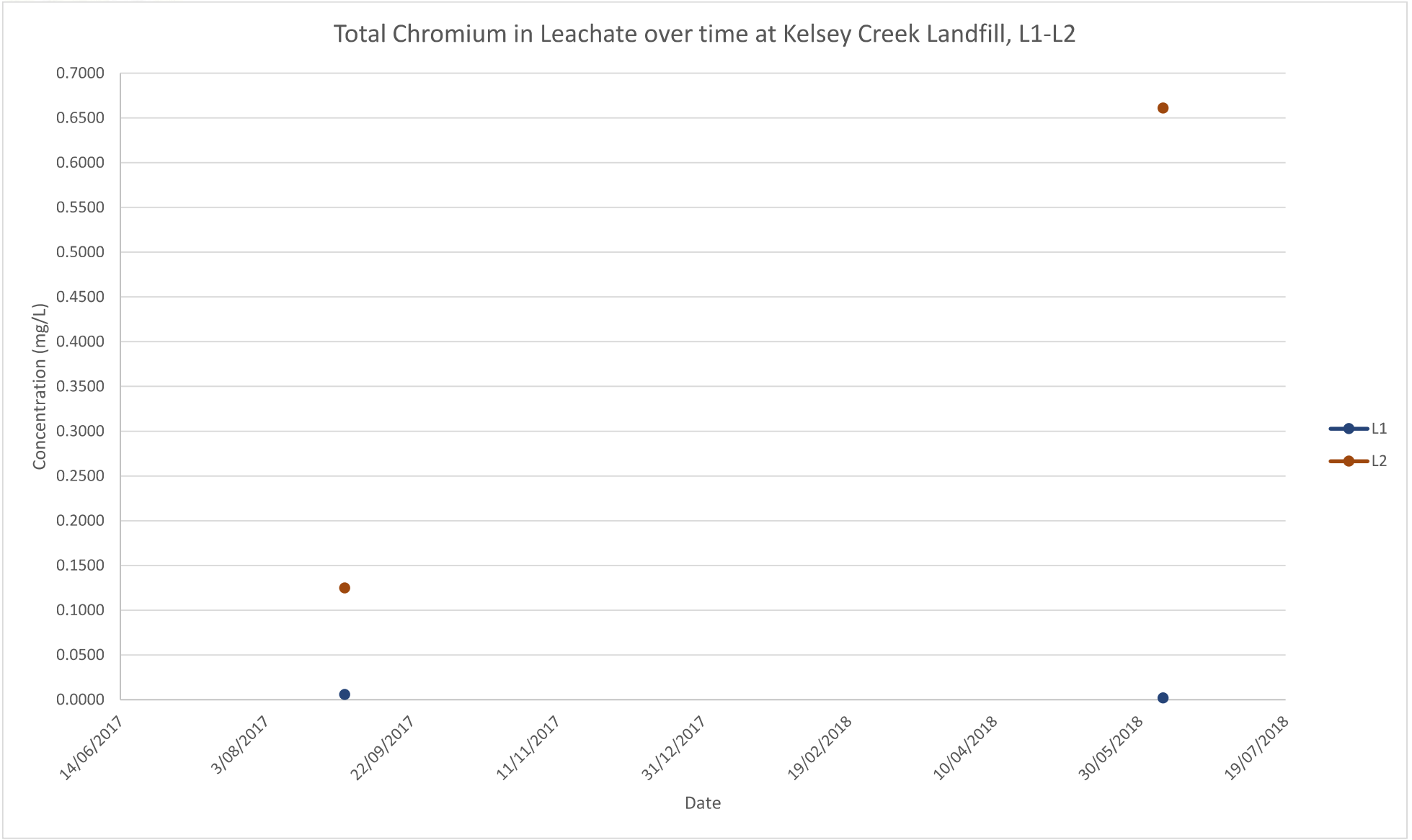
Appendix K Kelsey Creek Graphs - Leachate



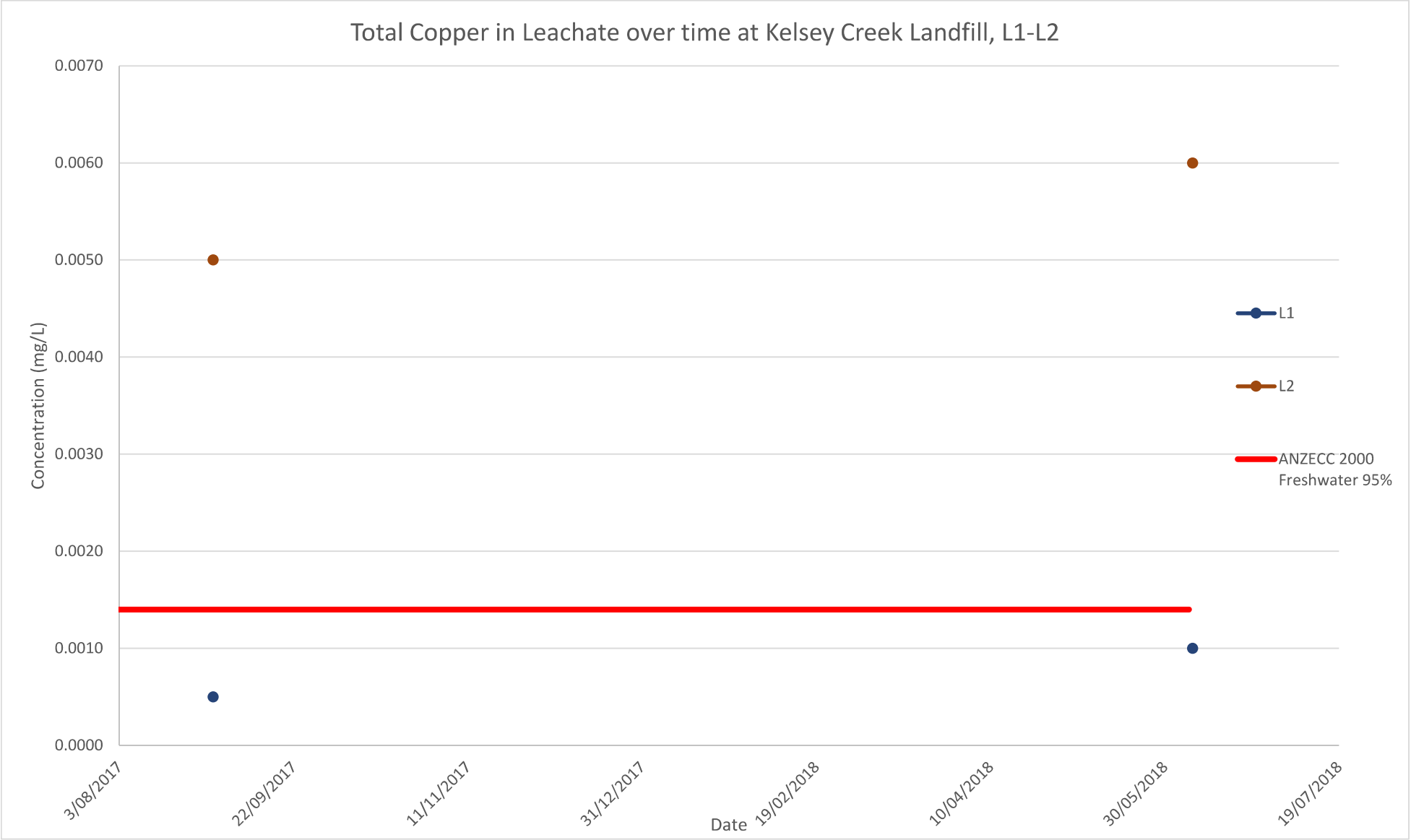
Appendix K Kelsey Creek Graphs - Leachate



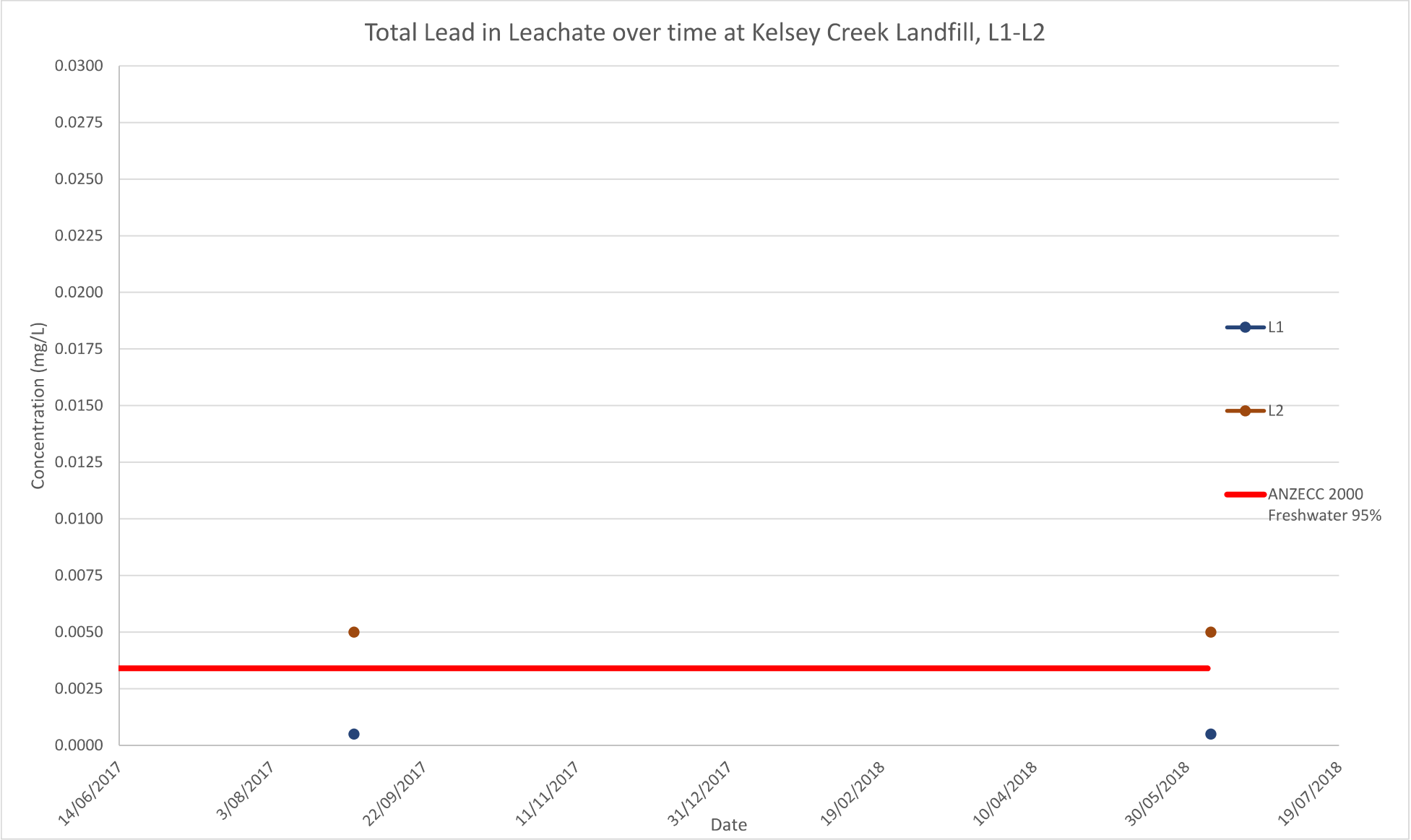
Appendix K Kelsey Creek Graphs - Leachate



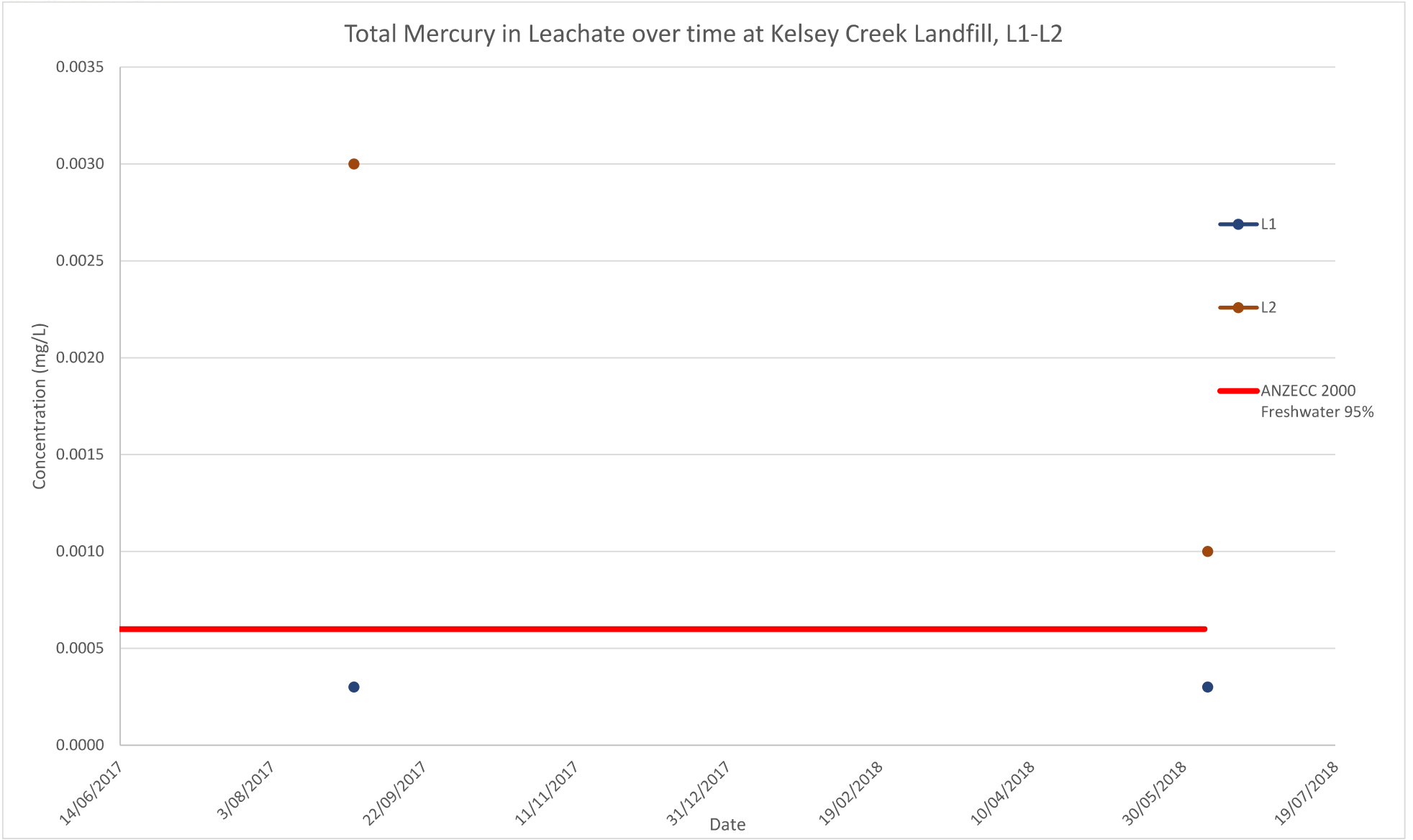
Appendix K Kelsey Creek Graphs - Leachate



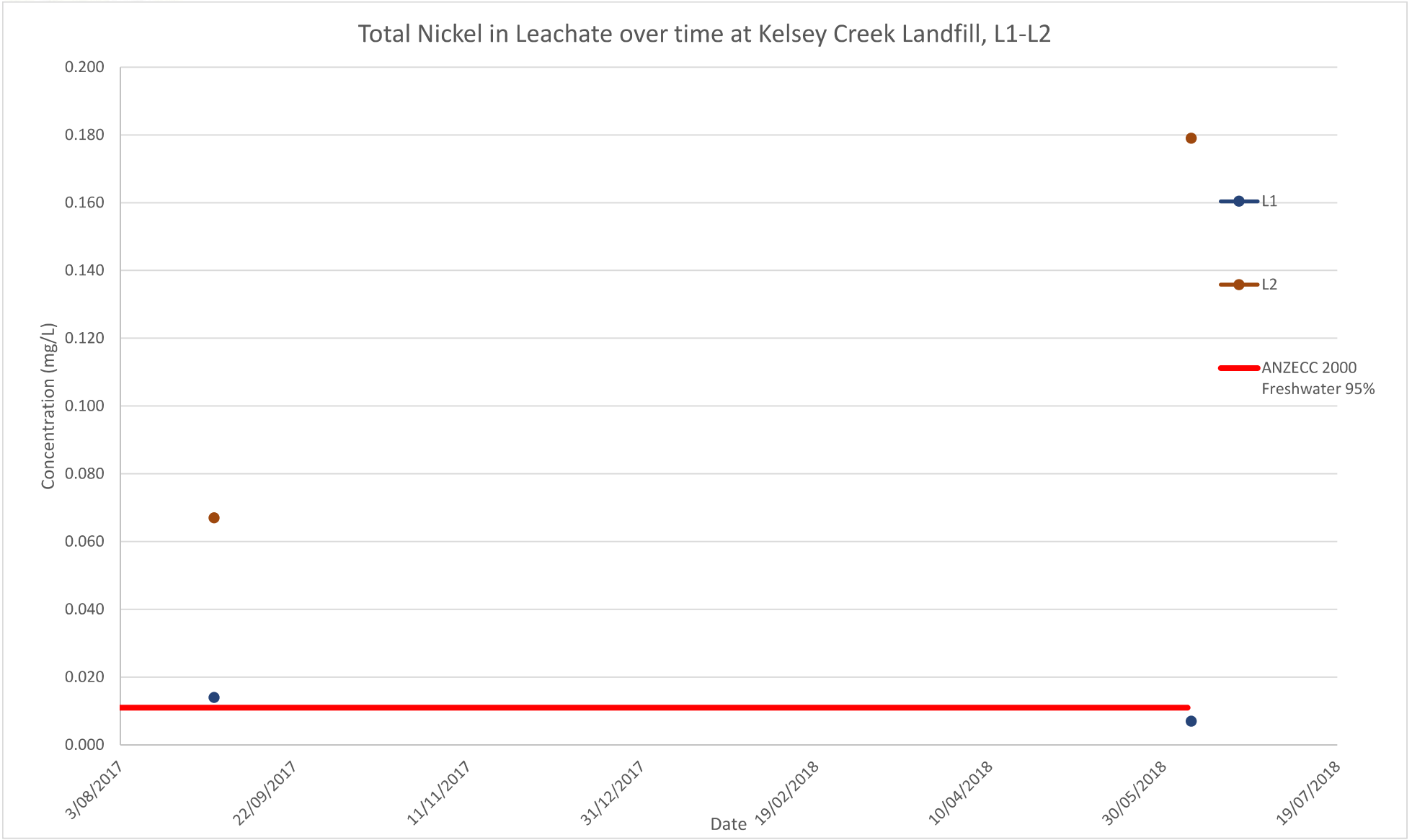
Appendix K Kelsey Creek Graphs - Leachate



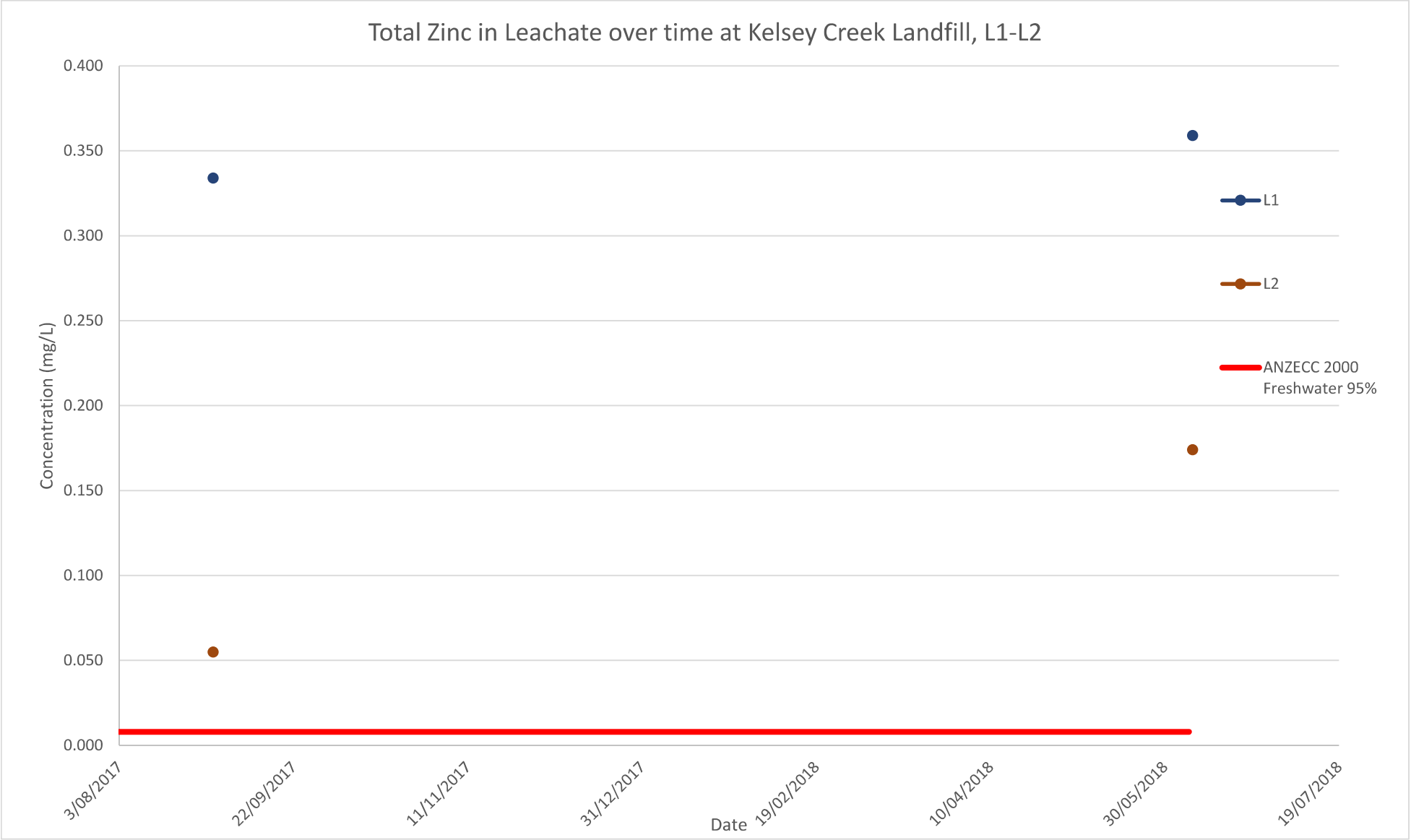
Appendix K Kelsey Creek Graphs - Leachate



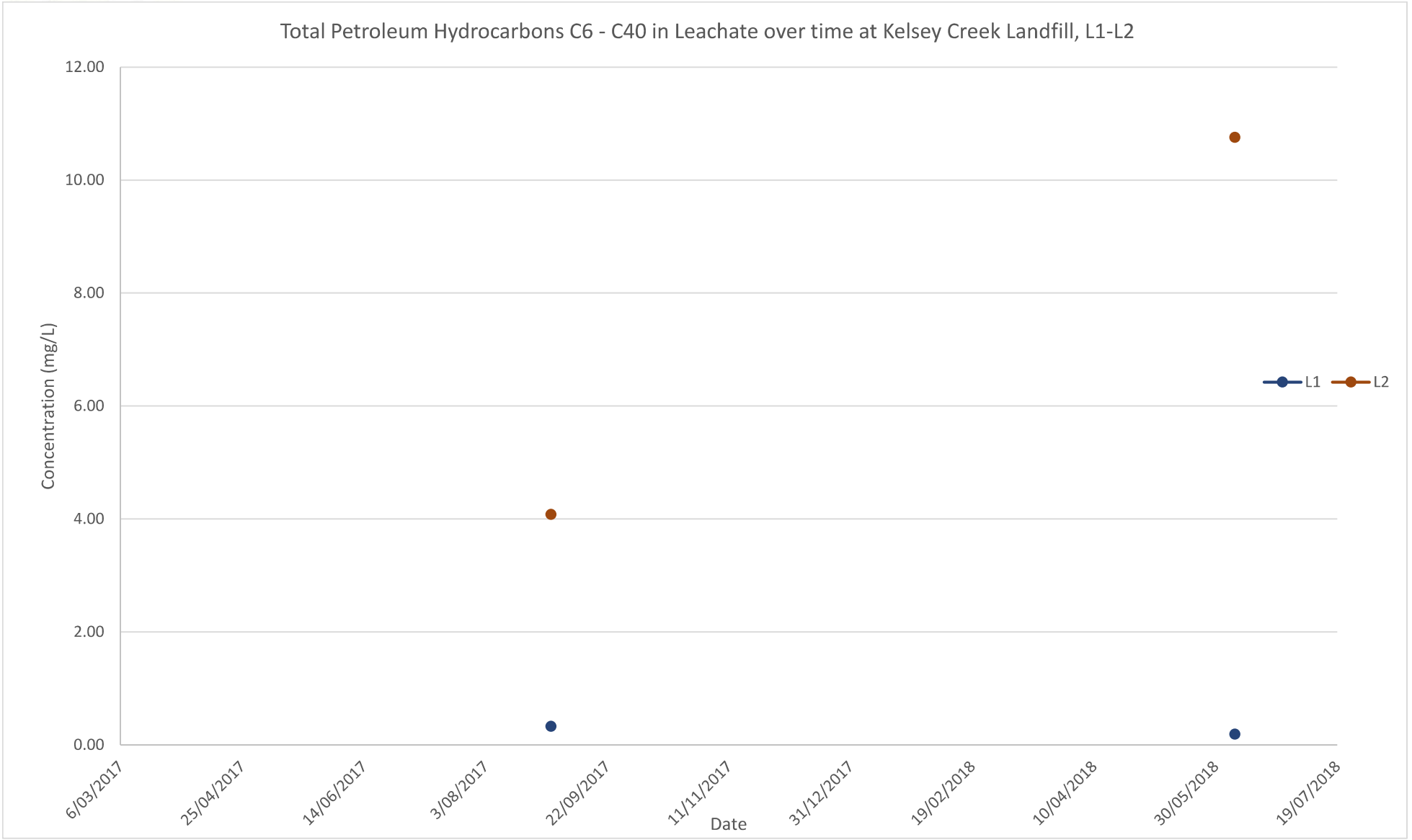
Appendix K Kelsey Creek Graphs - Leachate



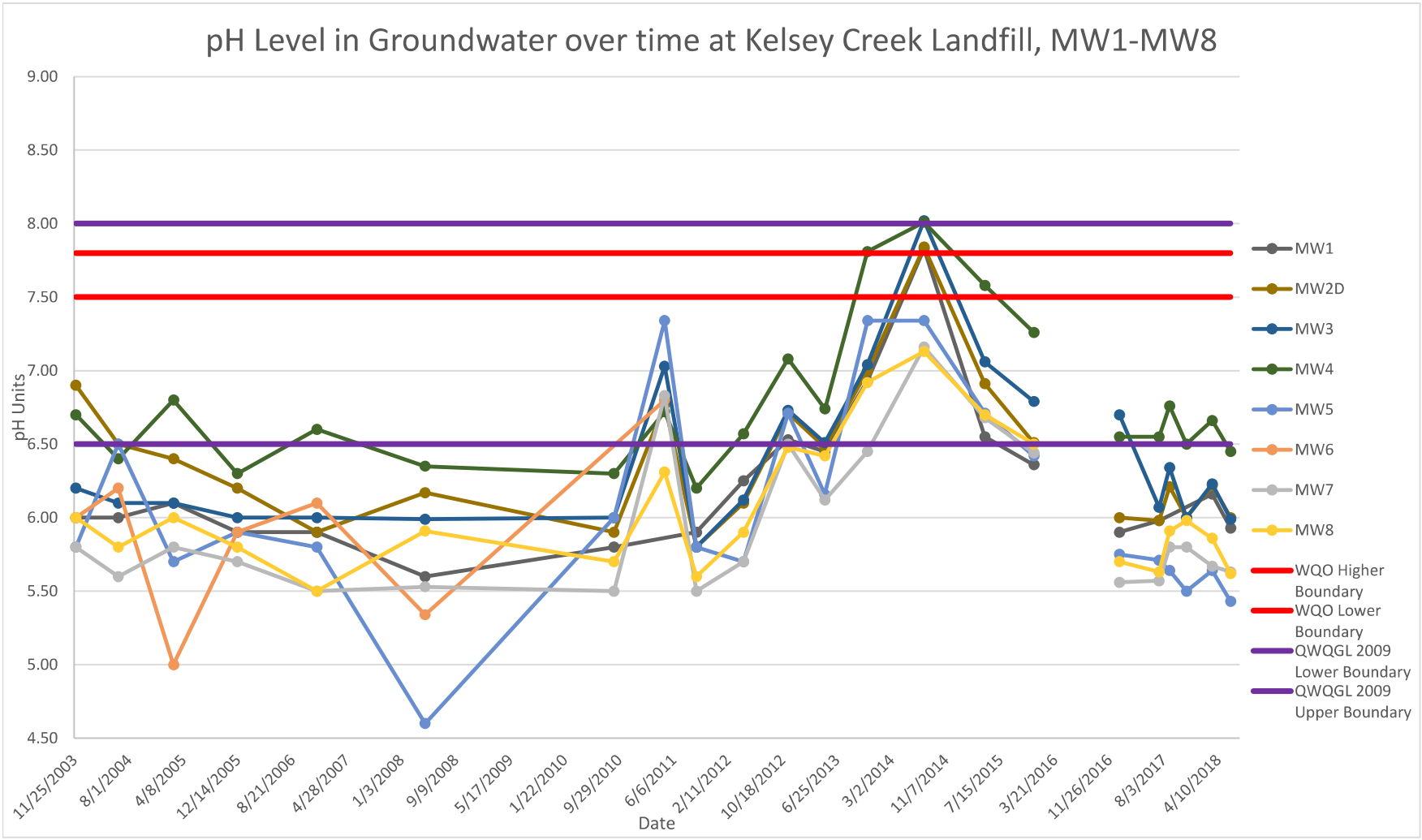
Appendix K Kelsey Creek Graphs - Leachate



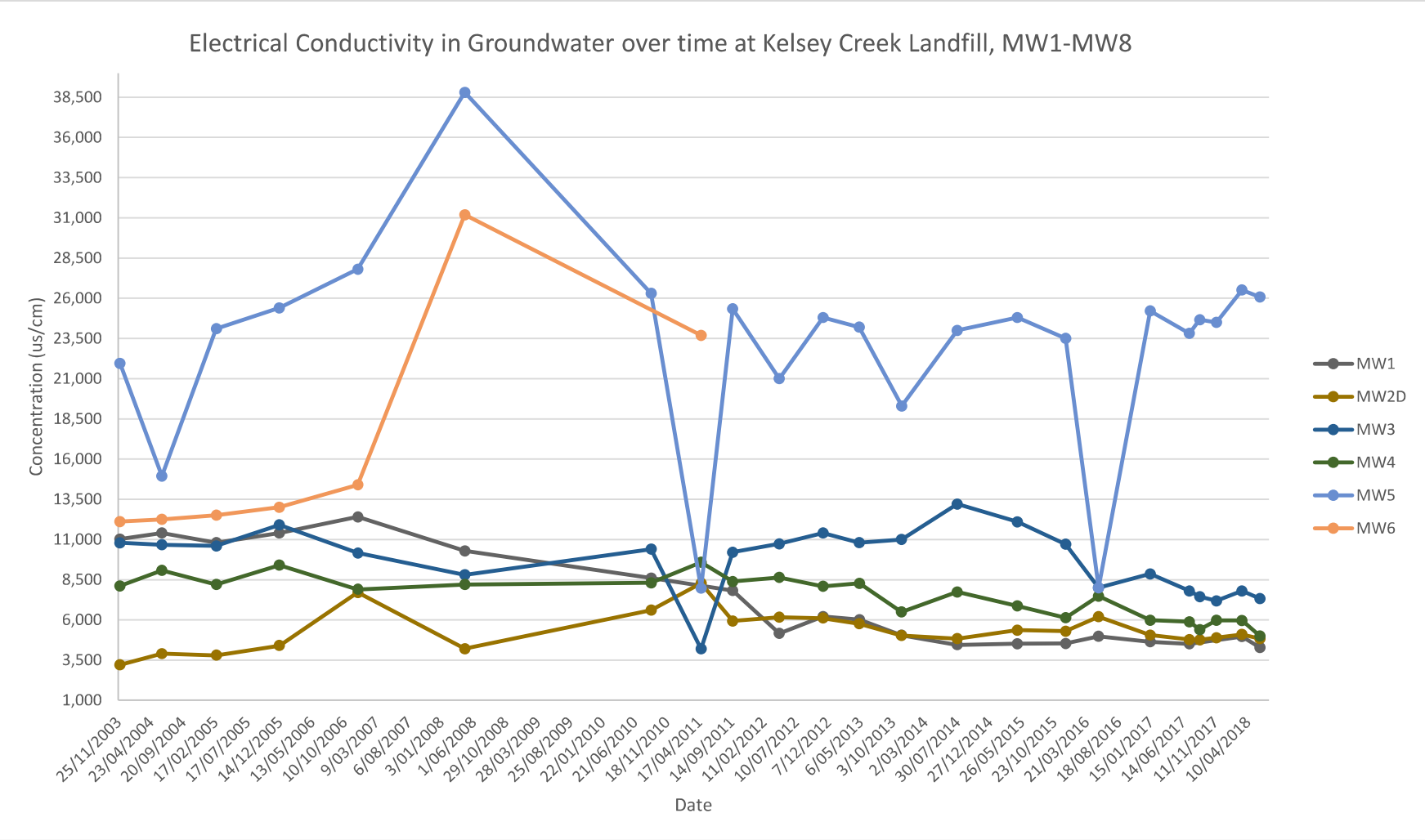
Appendix K Kelsey Creek Graphs - Leachate



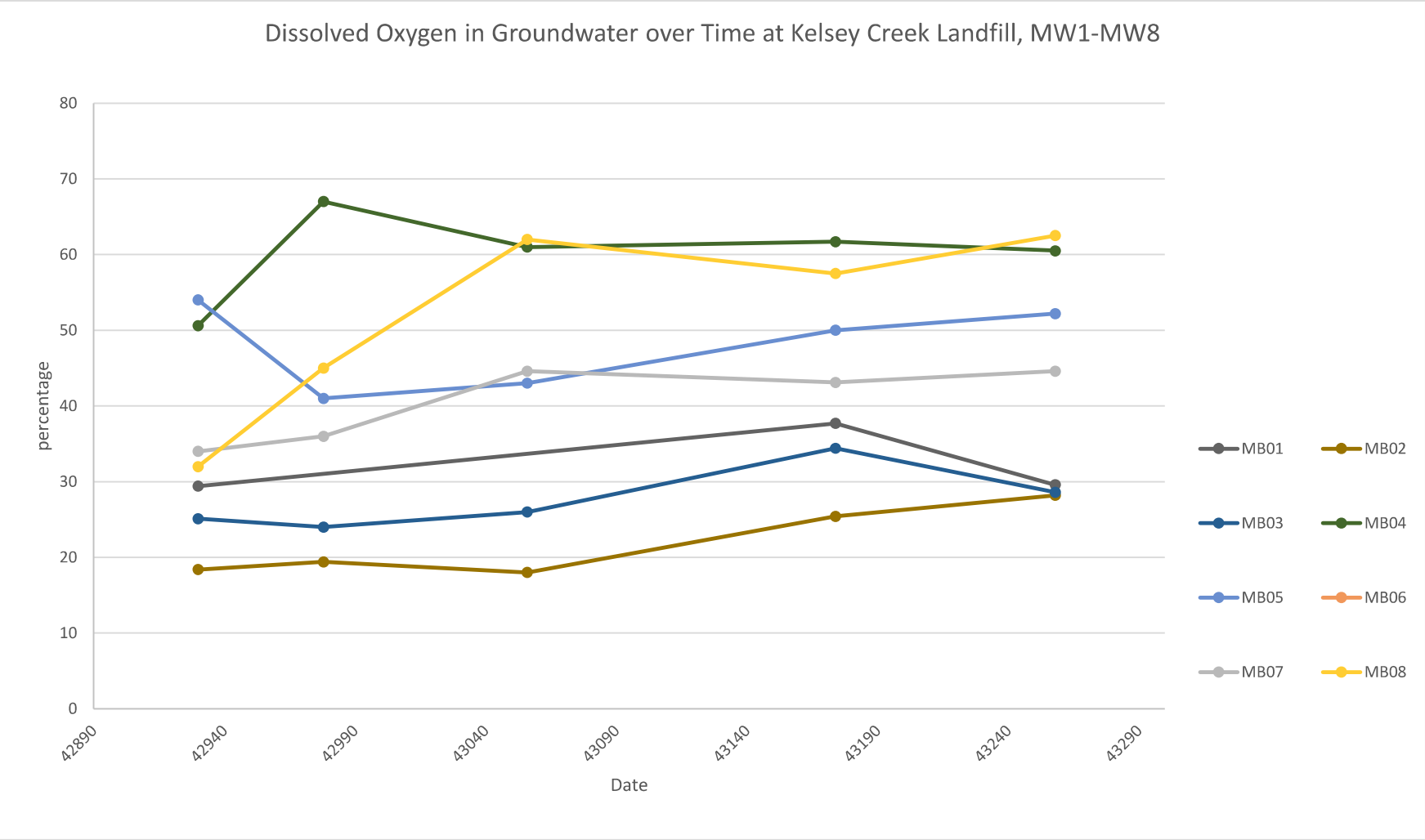
Appendix K Kelsey Creek Groundwater Graphs



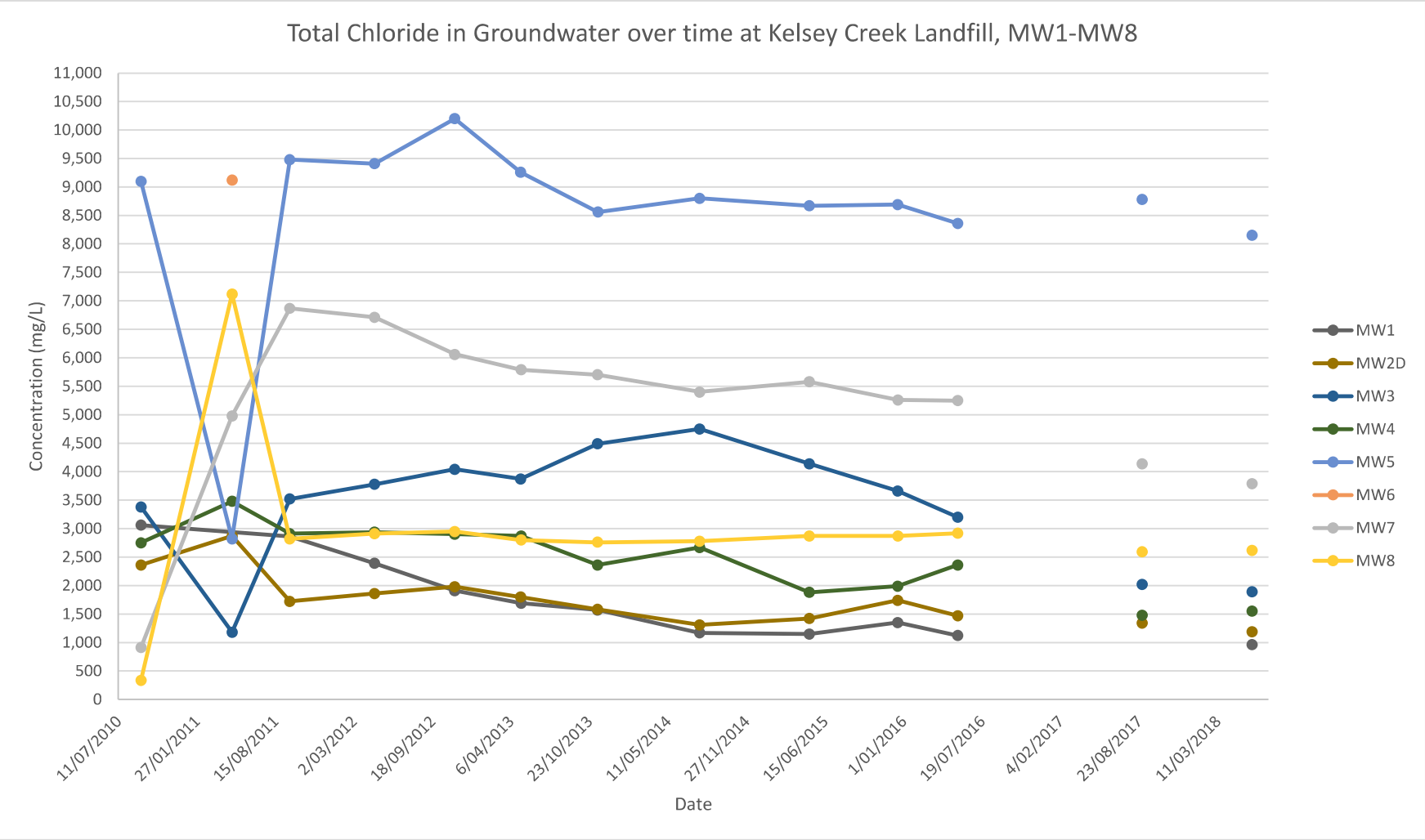
Appendix K Kelsey Creek Groundwater Graphs



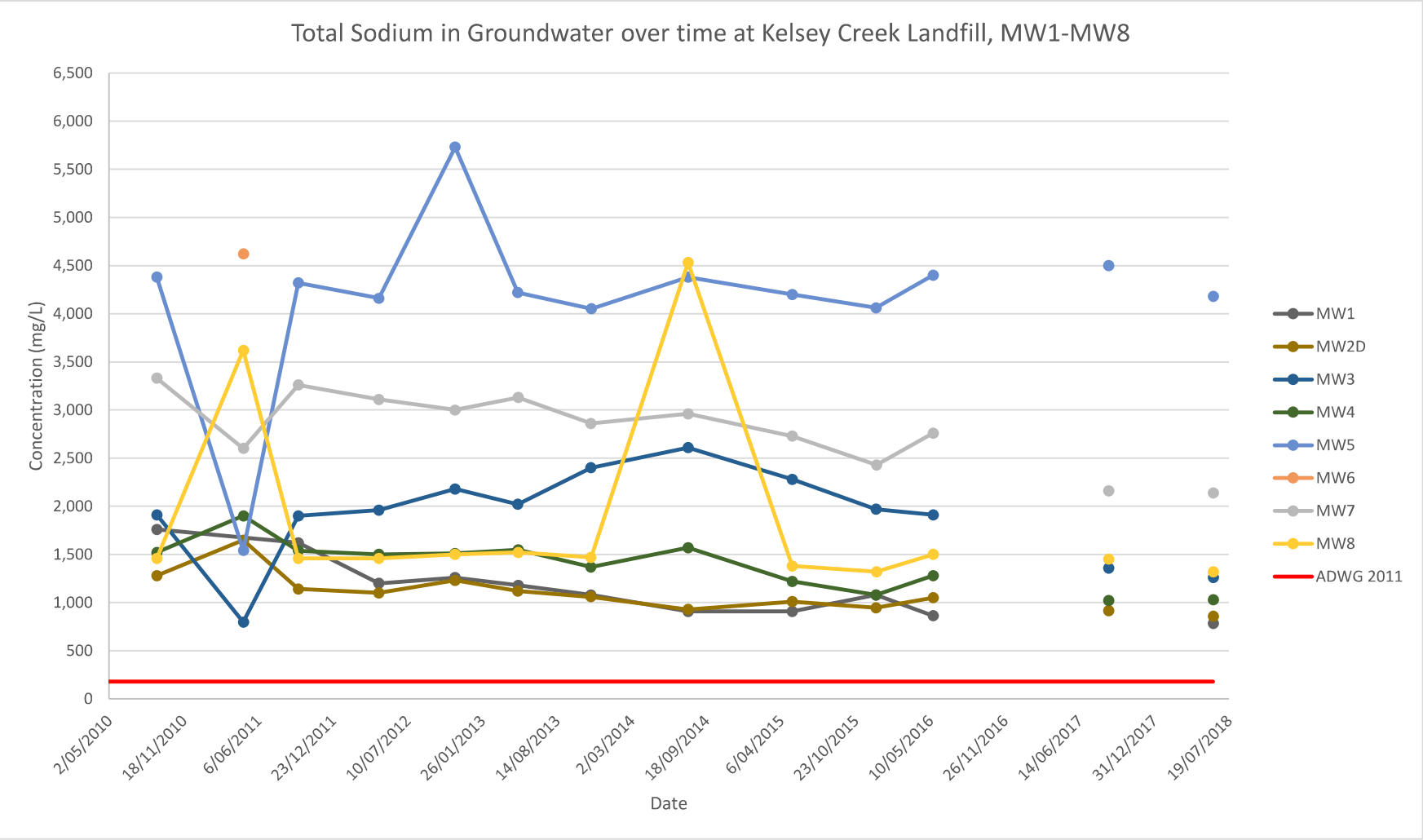
Appendix K Kelsey Creek Groundwater Graphs



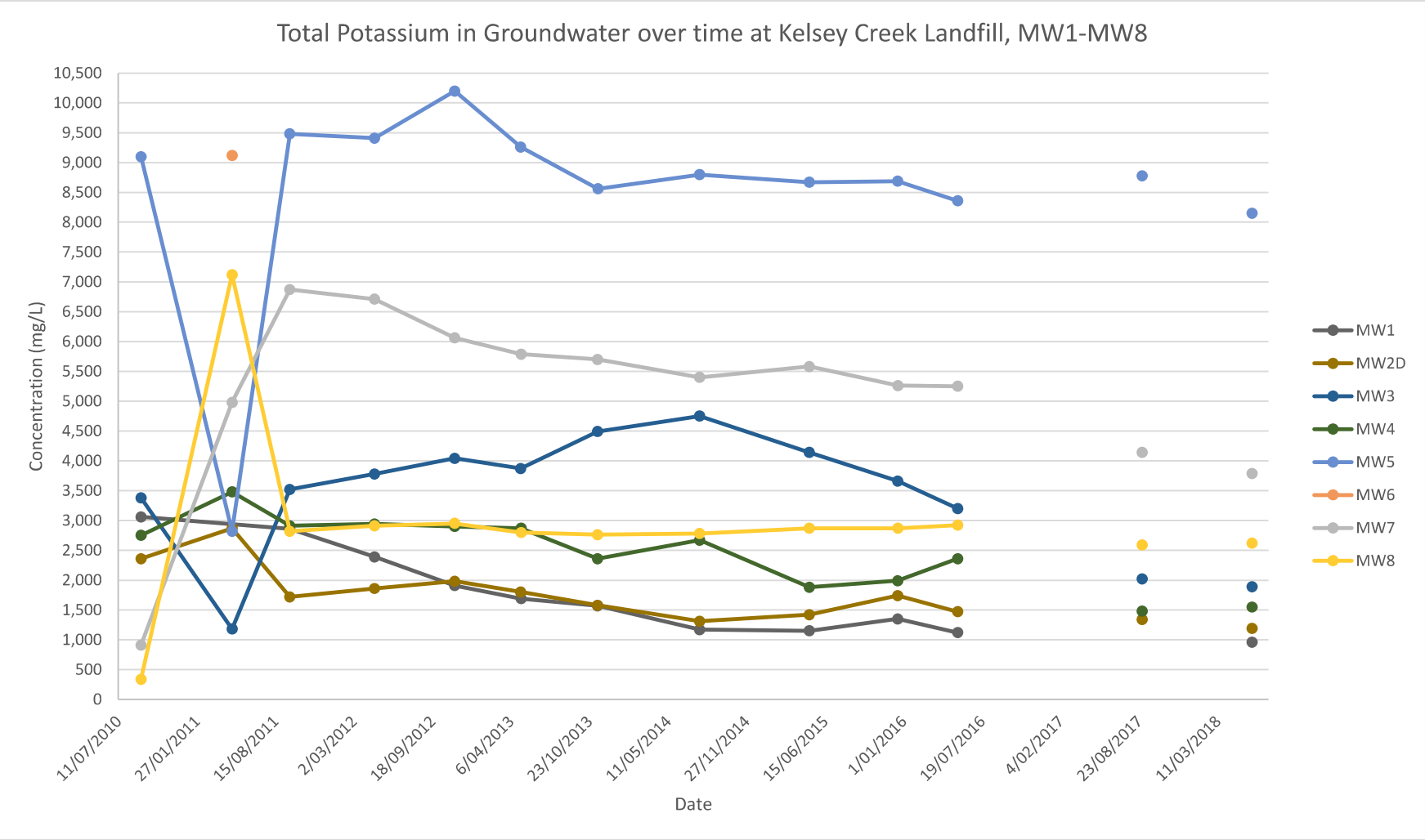
Appendix K Kelsey Creek Groundwater Graphs



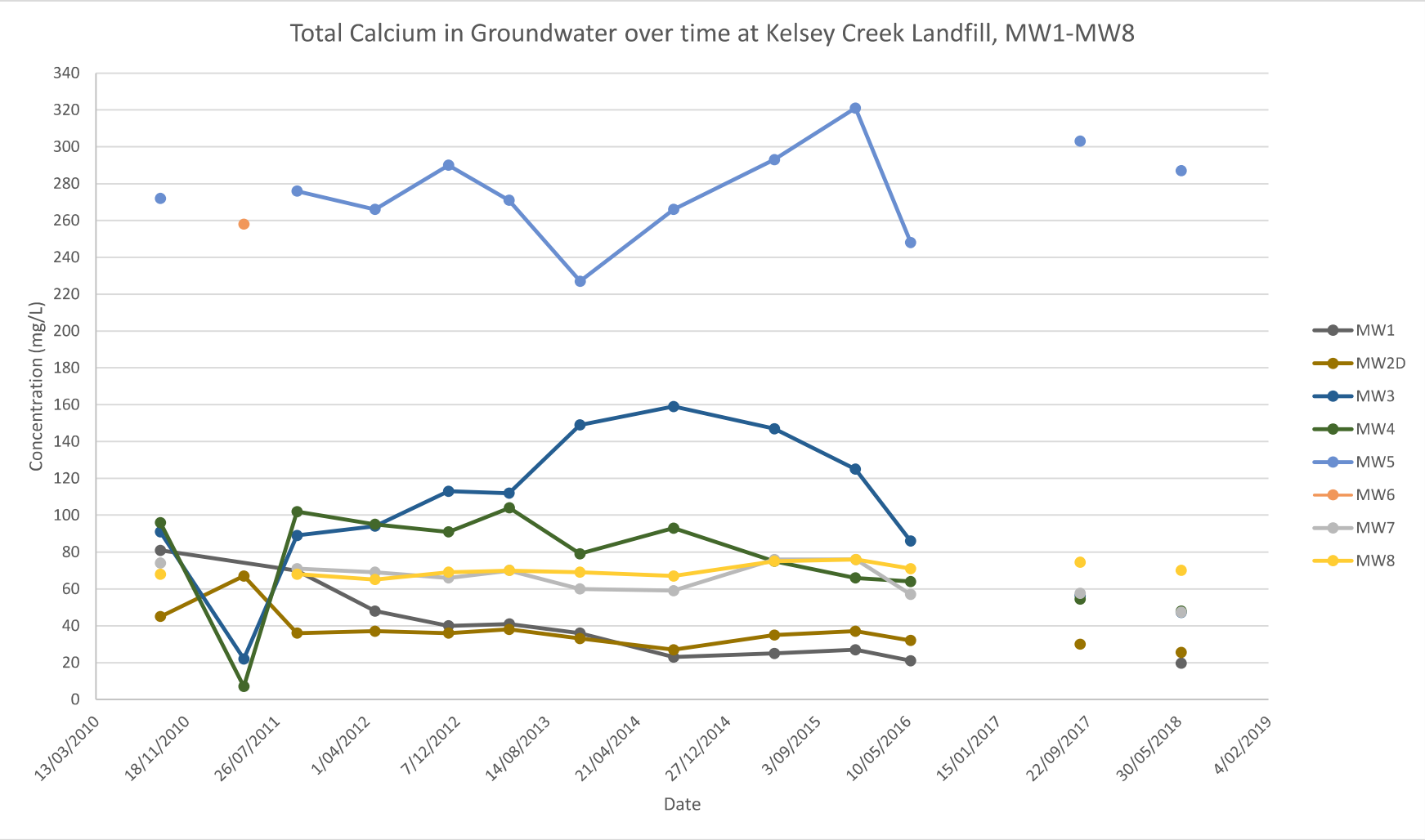
Appendix K Kelsey Creek Groundwater Graphs



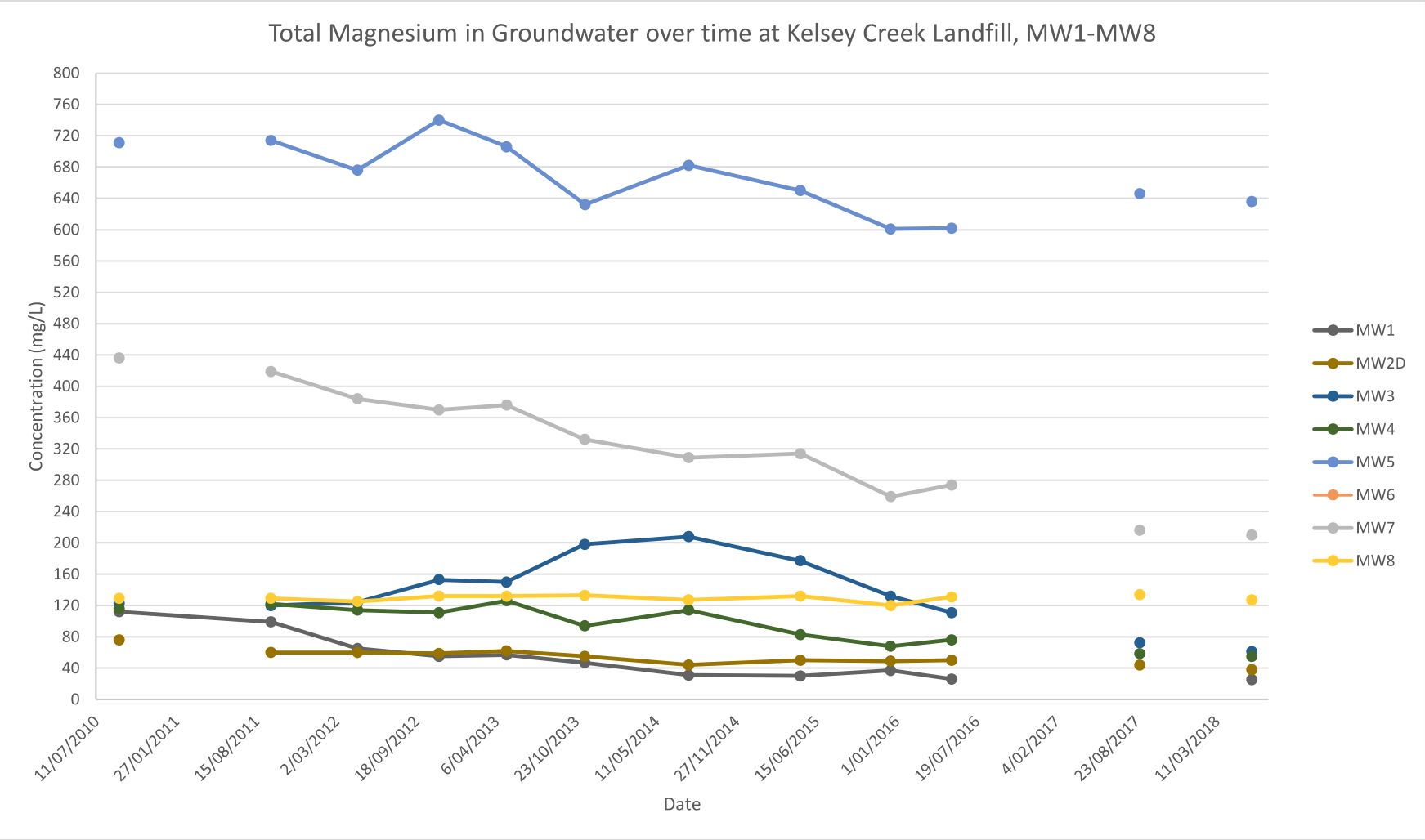
Appendix K Kelsey Creek Groundwater Graphs



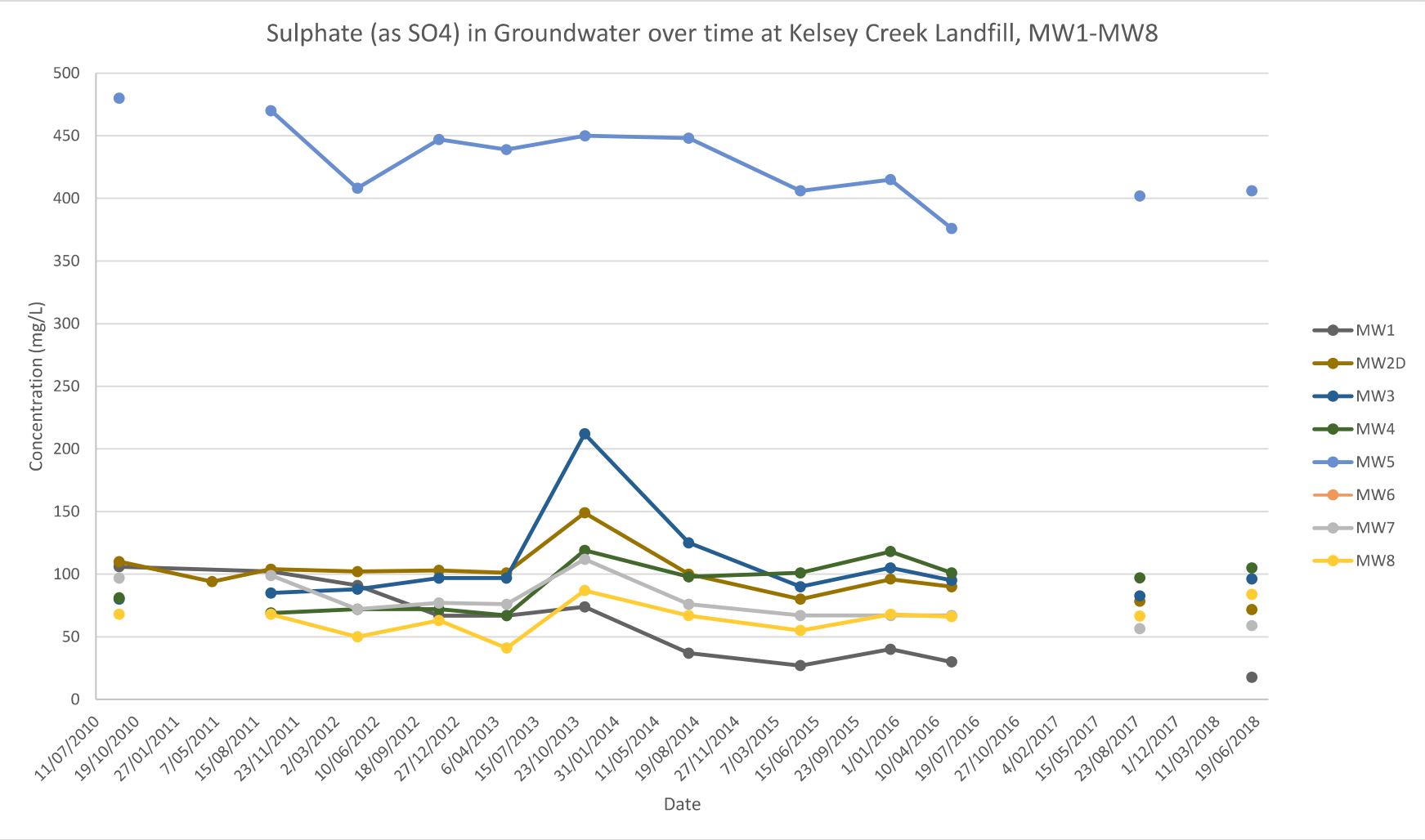
Appendix K Kelsey Creek Groundwater Graphs

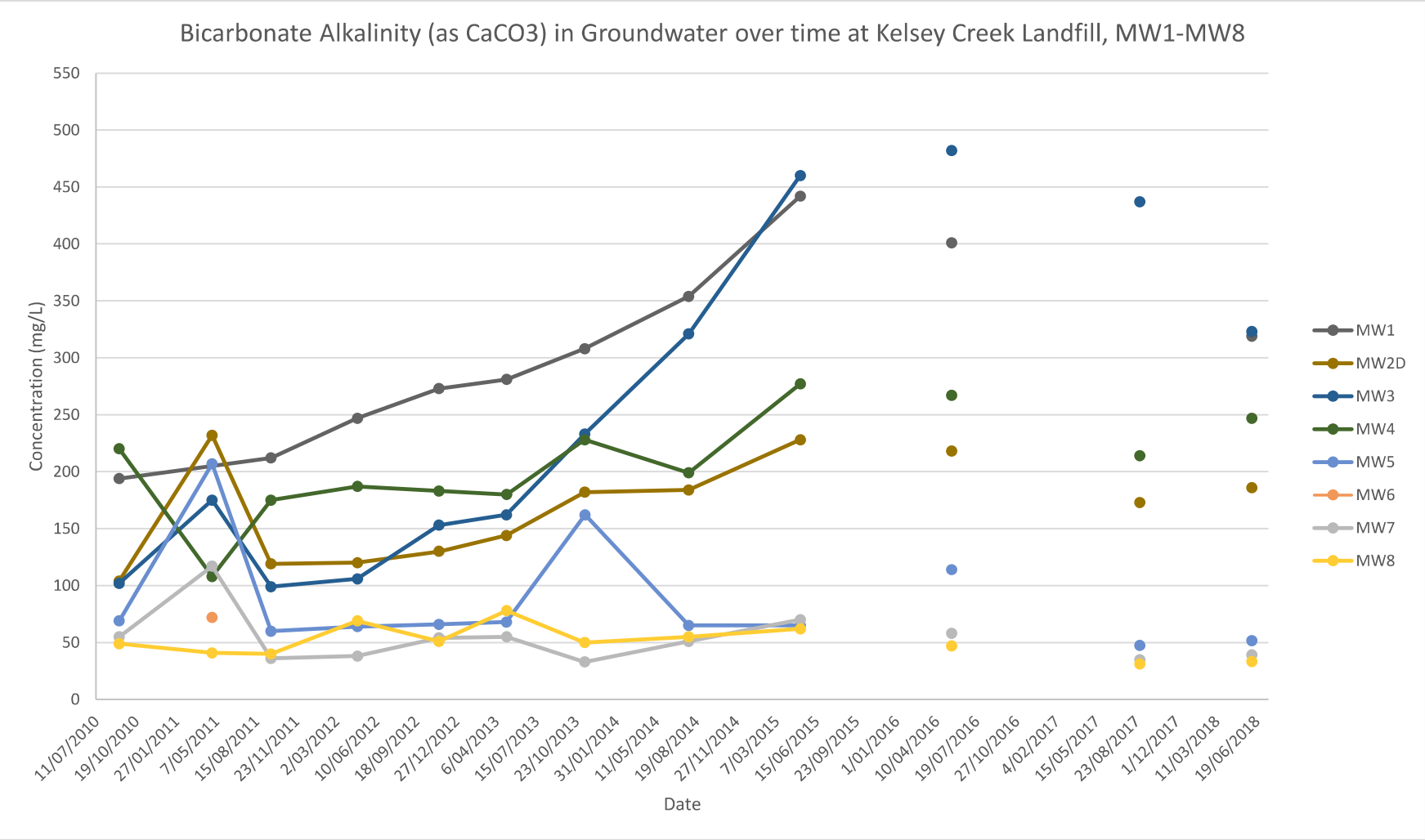


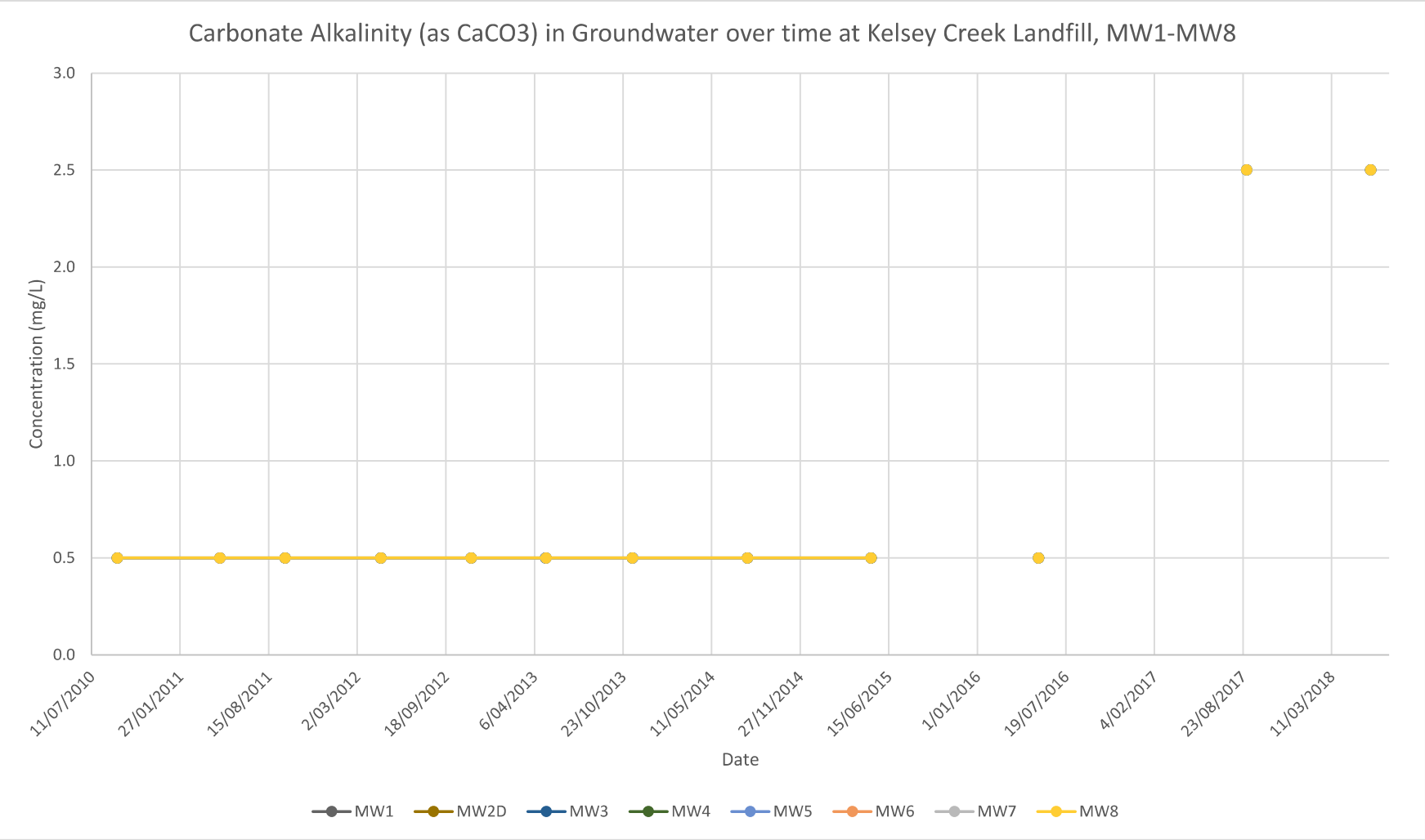
Appendix K Kelsey Creek Groundwater Graphs

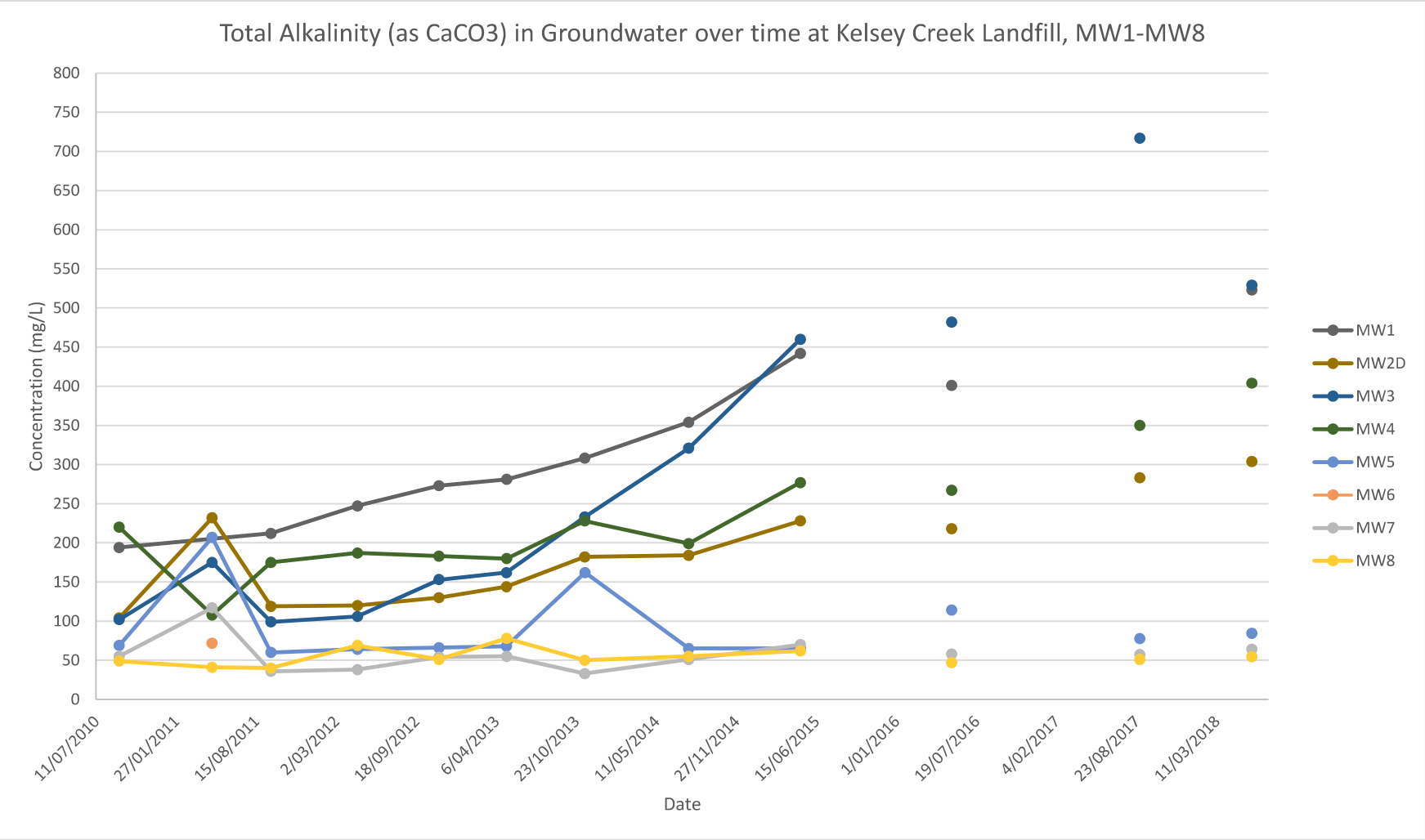


Appendix K Kelsey Creek Groundwater Graphs

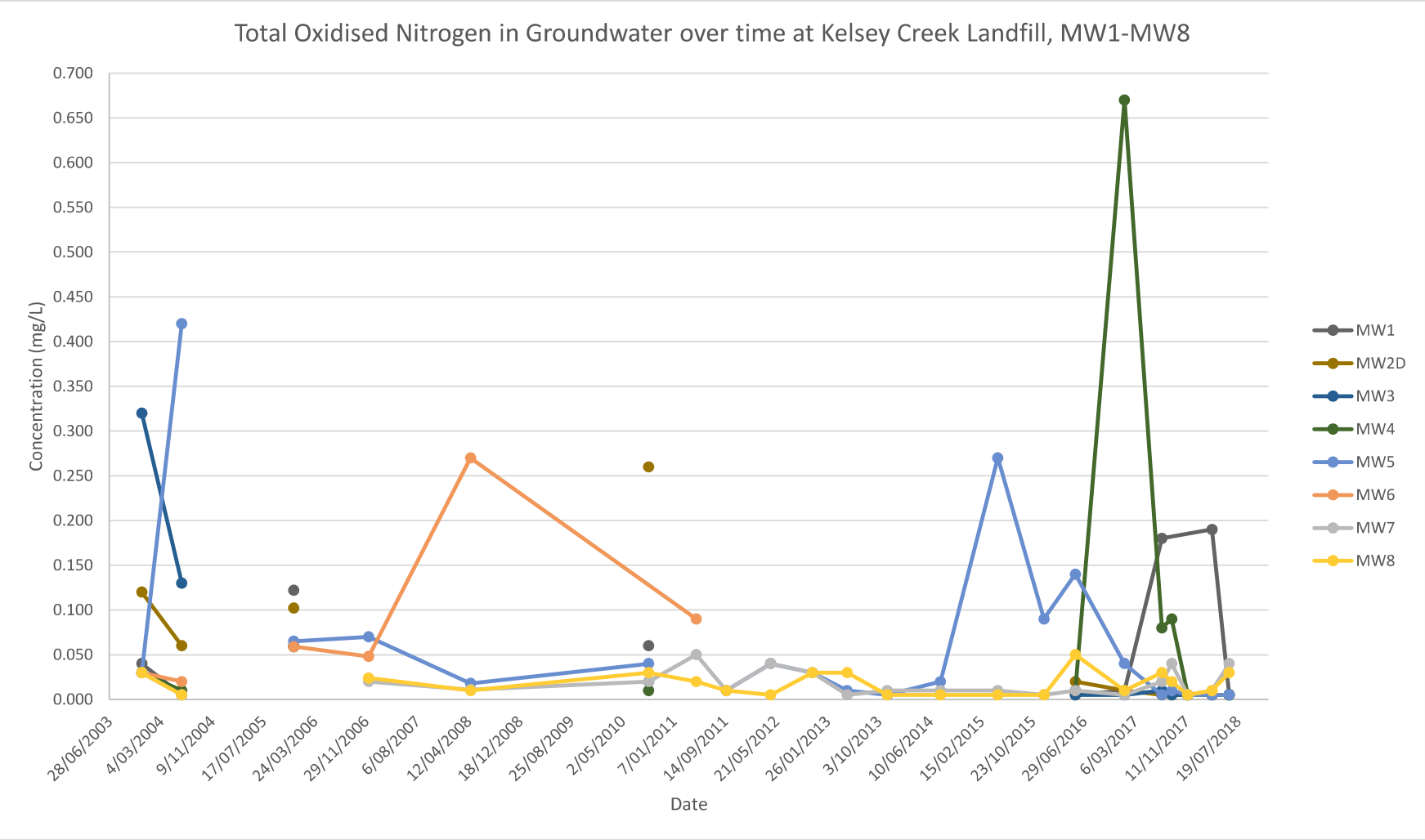


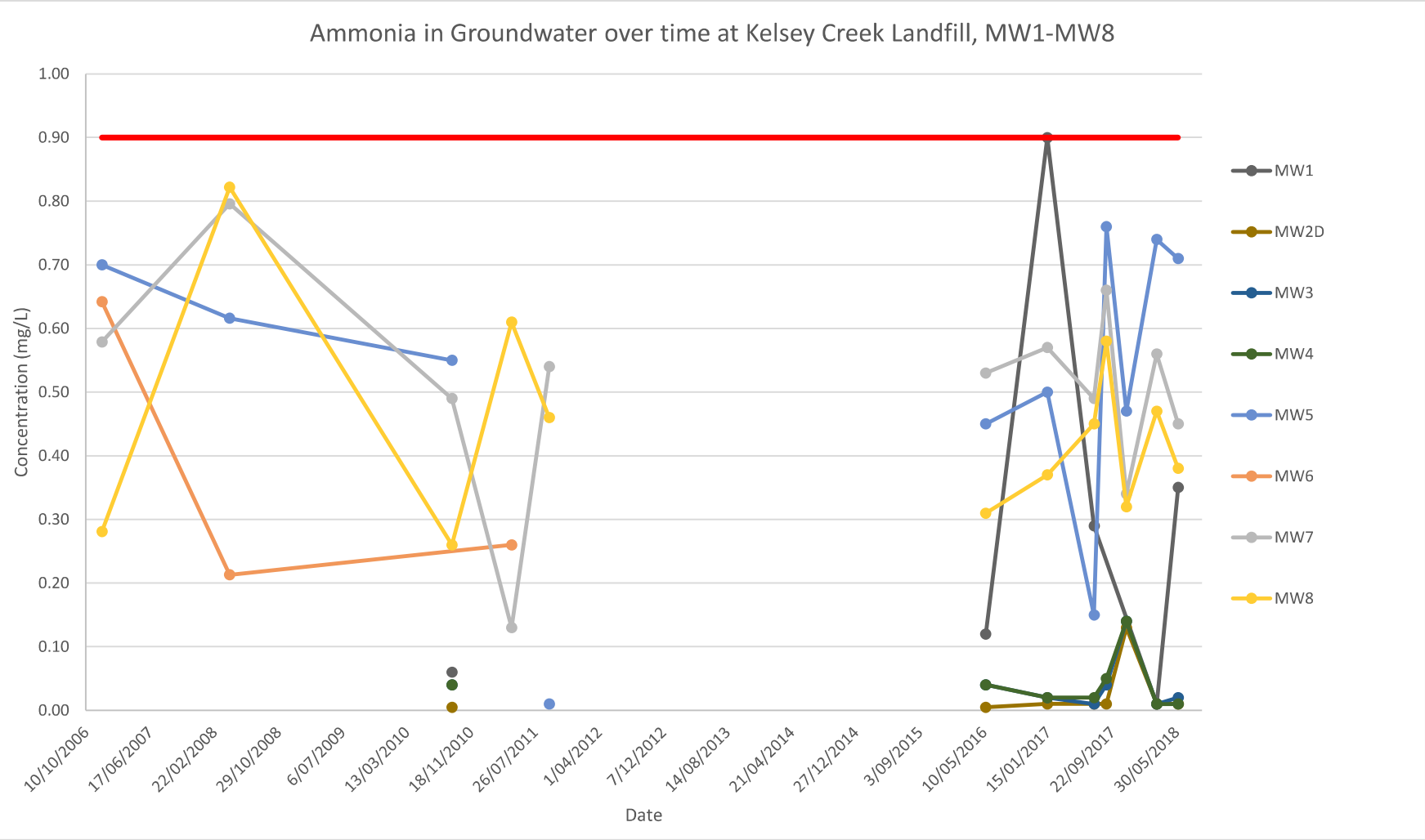

Bicarbonate Alkalinity (as CaCO3) in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
550
500
450
400
350
300
250
200
150
100
50
0
11/07/2010
19/10/2010
27/01/2011
7/05/2011
15/08/2011
23/11/2011
2/03/2012
10/06/2012
18/09/2012
27/12/2012
6/04/2013
15/07/2013
23/10/2013
31/01/2014
11/05/2014
19/08/2014
27/11/2014
7/03/2015
15/06/2015
23/09/2015
1/01/2016
10/04/2016
19/07/2016
27/10/2016
4/02/2017
15/05/2017
23/08/2017
1/12/2017
11/03/2018
19/06/2018
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8

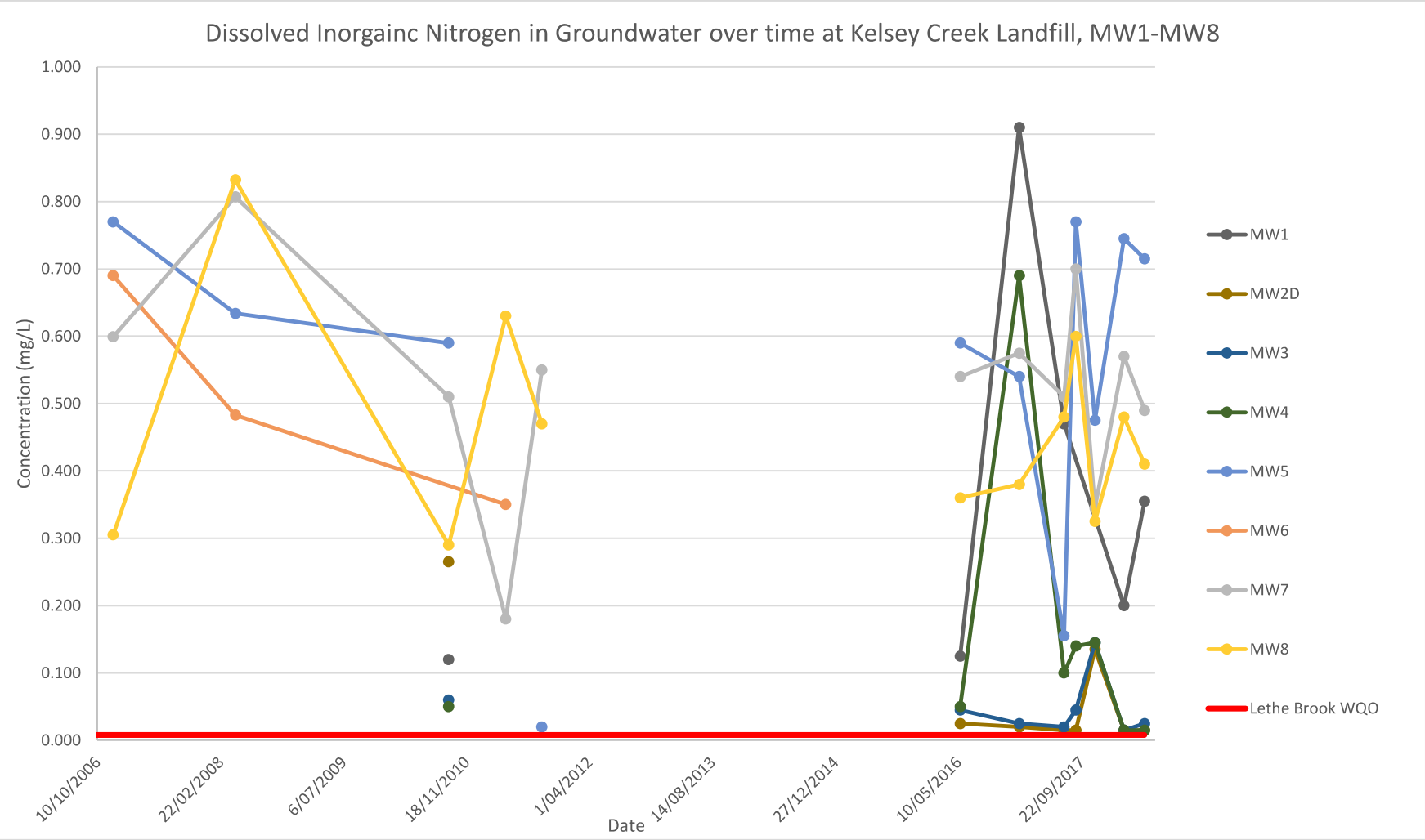

Carbonate Alkalinity (as CaCO3) in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
11/07/2010
27/01/2011
15/08/2011
2/03/2012
18/09/2012
6/04/2013
23/10/2013
11/05/2014
27/11/2014
15/06/2015
1/01/2016
19/07/2016
4/02/2017
23/08/2017
11/03/2018
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8


Total Alkalinity (as CaCO3) in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
11/07/2010
27/01/2011
15/08/2011
2/03/2012
18/09/2012
6/04/2013
23/10/2013
11/05/2014
27/11/2014
15/06/2015
1/01/2016
19/07/2016
4/02/2017
23/08/2017
11/03/2018
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8

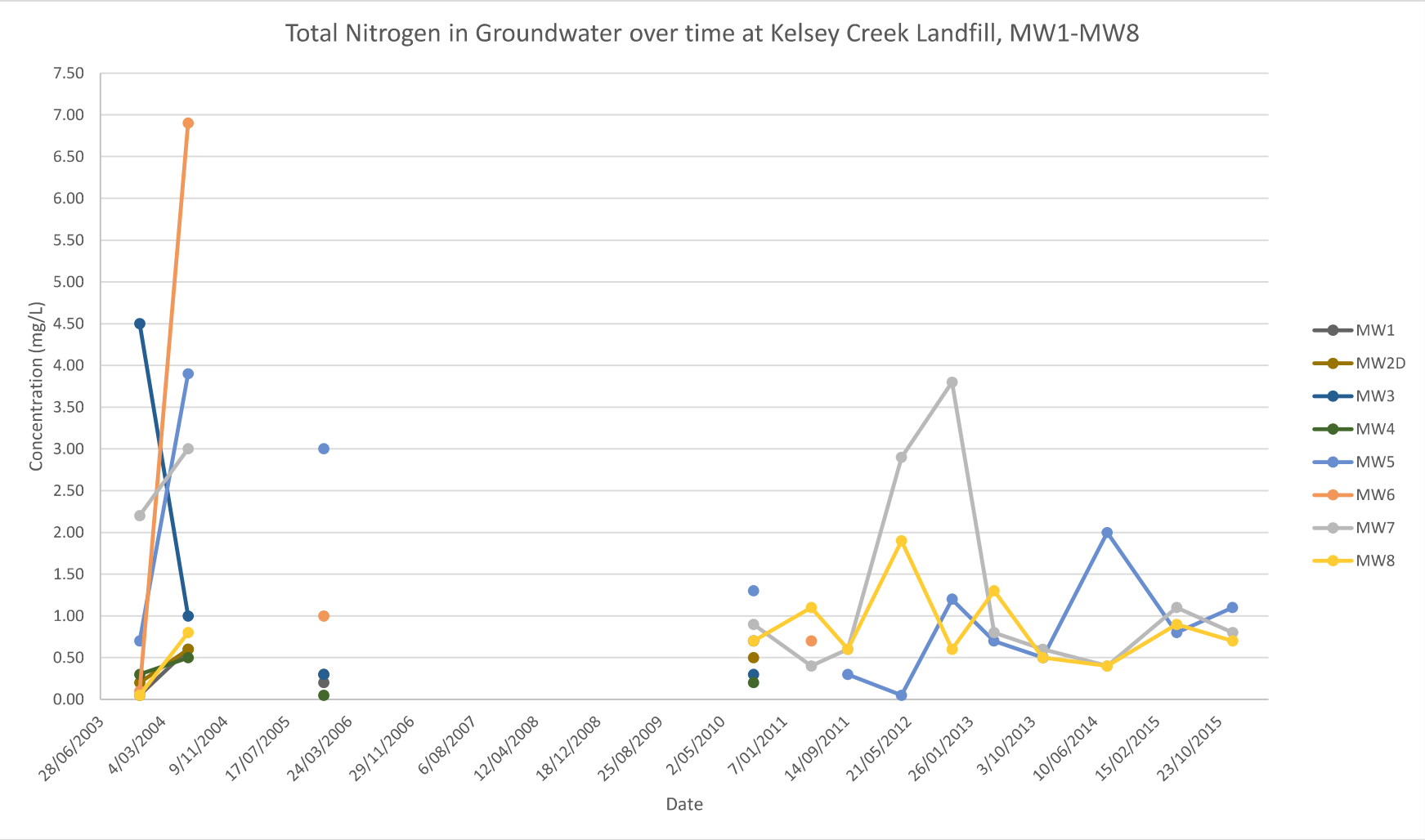
Appendix K Kelsey Creek Groundwater Graphs

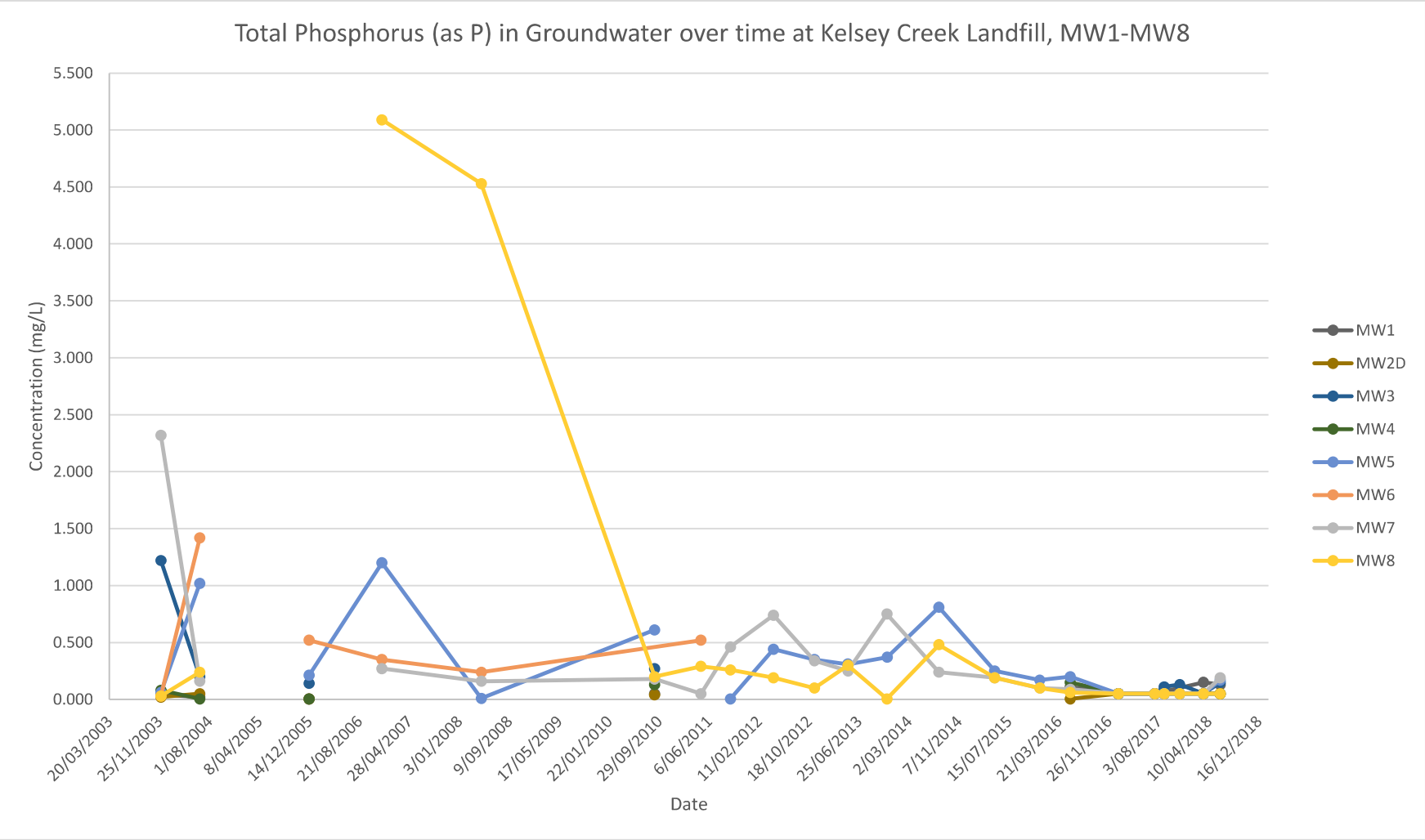


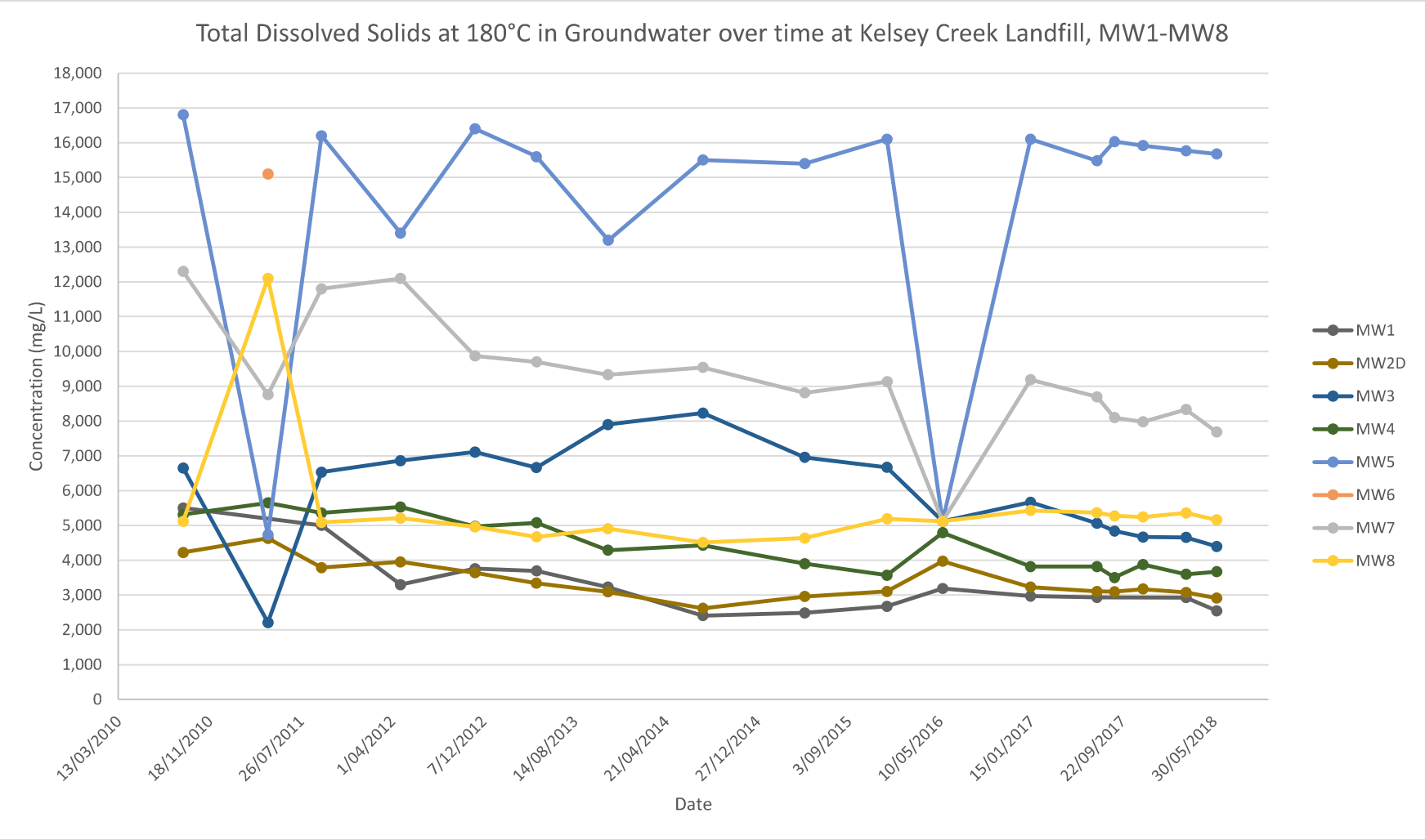

Ammonia in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
10/10/2006
17/06/2007
22/02/2008
29/10/2008
6/07/2009
13/03/2010
18/11/2010
26/07/2011
1/04/2012
7/12/2012
14/08/2013
21/04/2014
27/12/2014
3/09/2015
10/05/2016
15/01/2017
22/09/2017
30/05/2018
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8

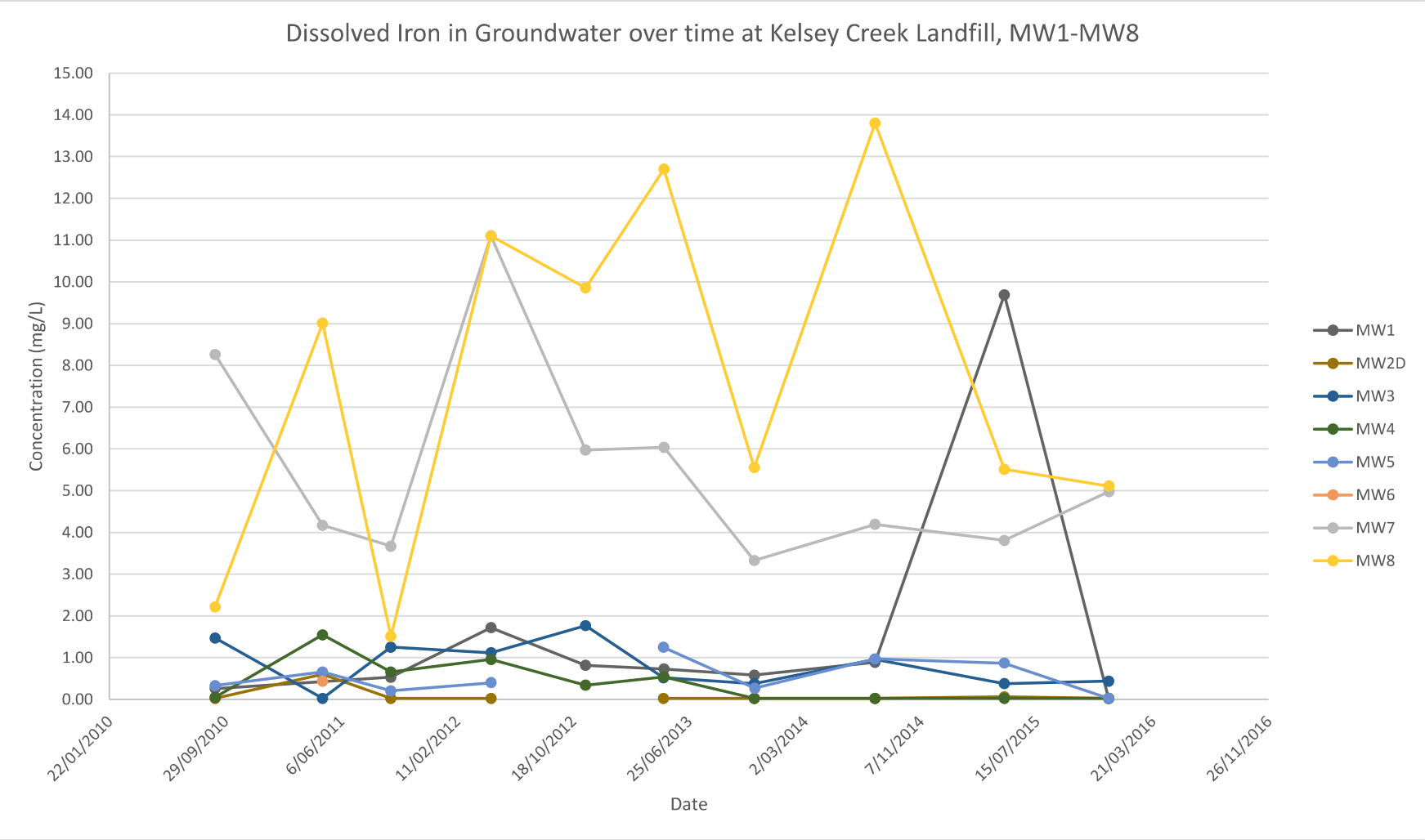

Dissolved Inorgainc Nitrogen in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
10/10/2006
22/02/2008
6/07/2009
18/11/2010
1/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
Lethe Brook WQO

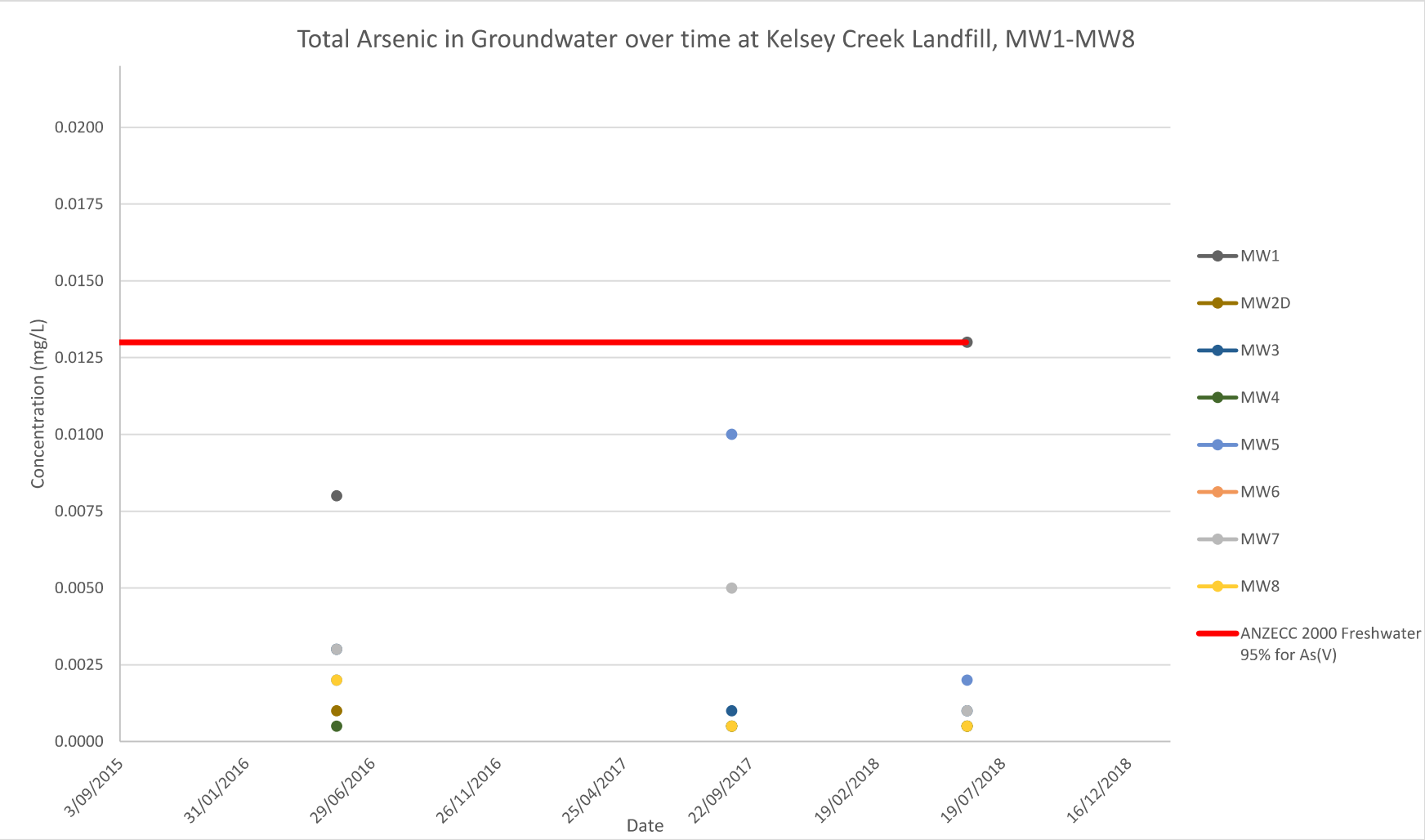
Appendix K Kelsey Creek Groundwater Graphs

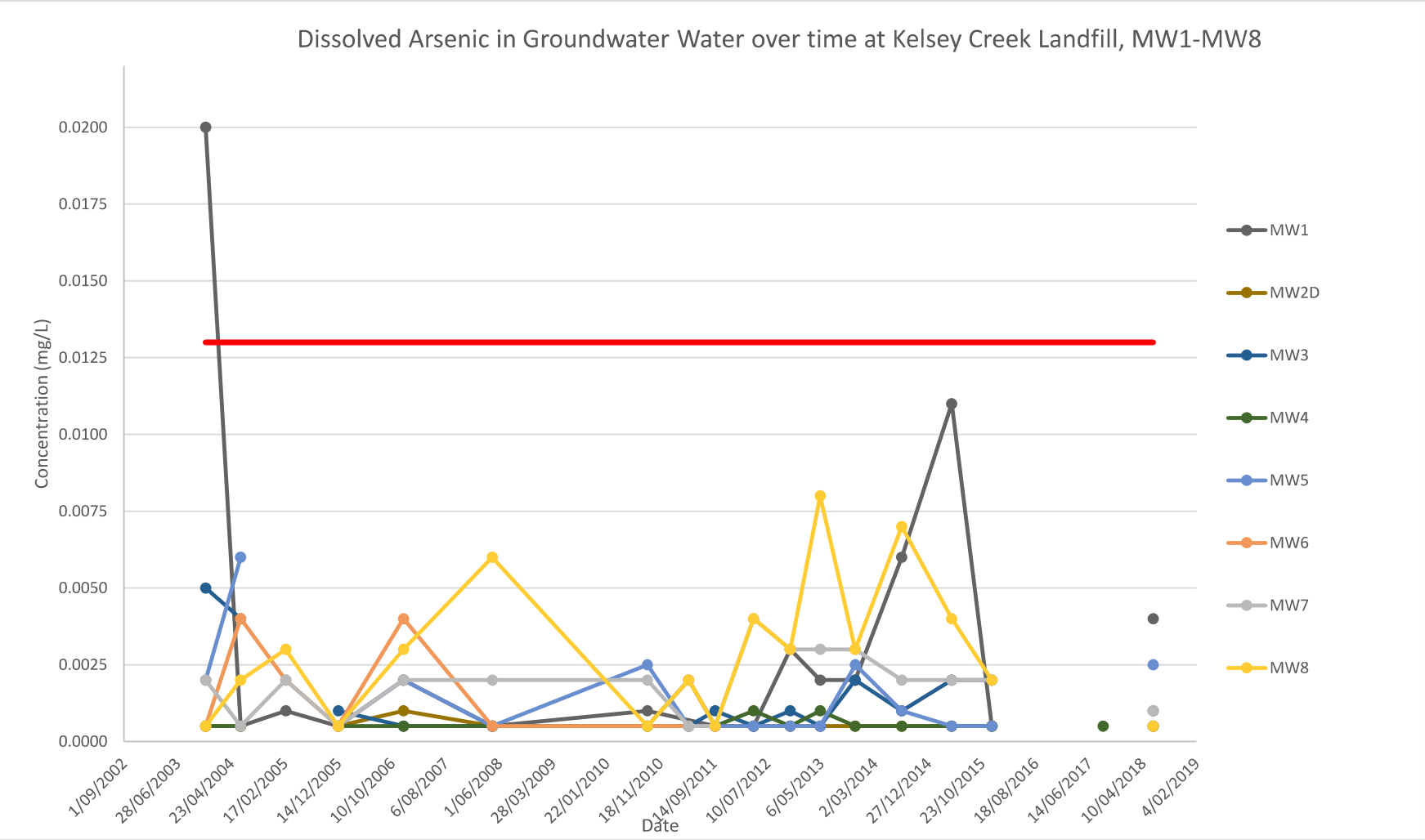


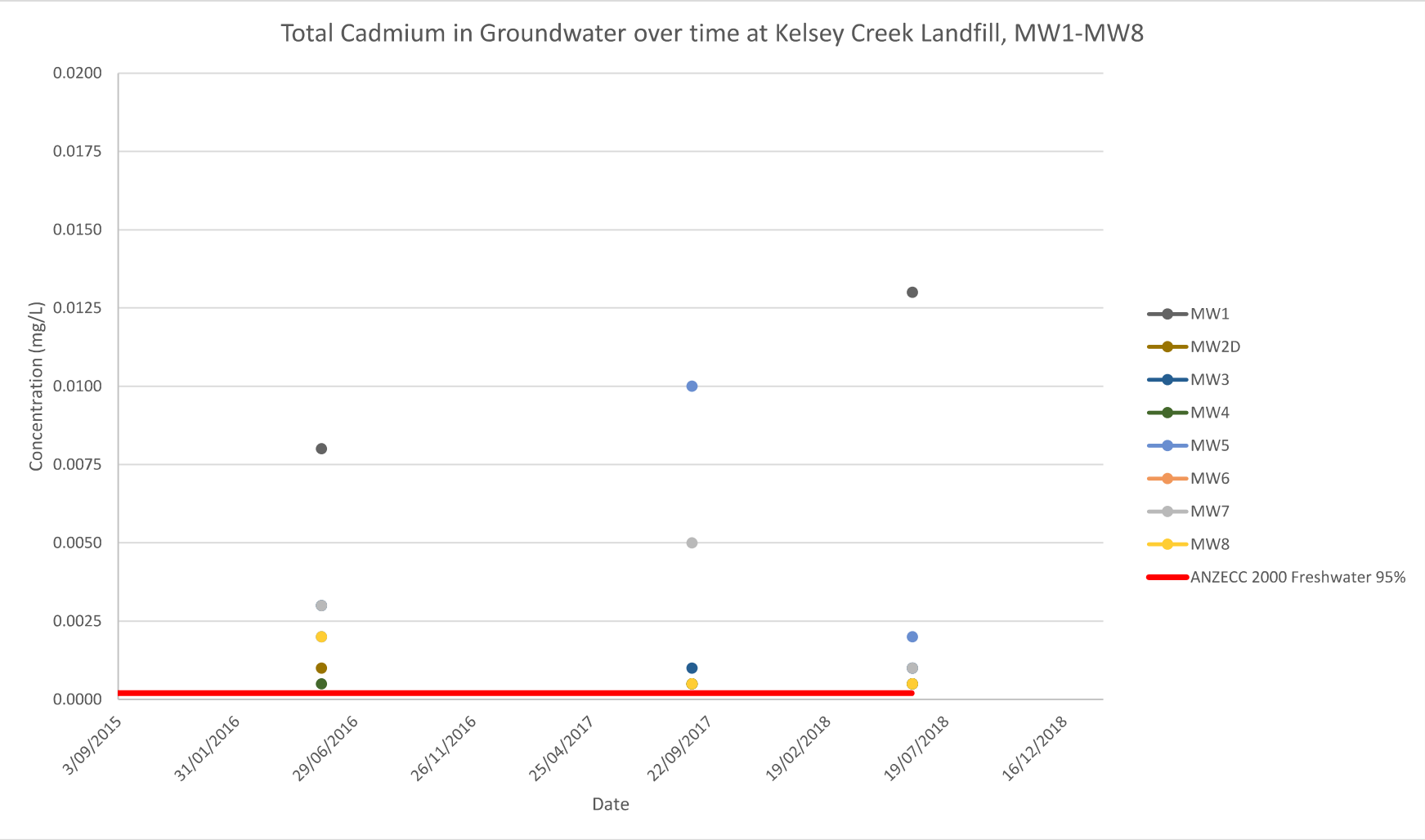

Total Phosphorus (as P) in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
5.500
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
20/03/2003
25/11/2003
1/08/2004
8/04/2005
14/12/2005
21/08/2006
28/04/2007
3/01/2008
9/09/2008
17/05/2009
22/01/2010
29/09/2010
6/06/2011
11/02/2012
18/10/2012
25/06/2013
2/03/2014
7/11/2014
15/07/2015
21/03/2016
26/11/2016
3/08/2017
10/04/2018
16/12/2018
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8

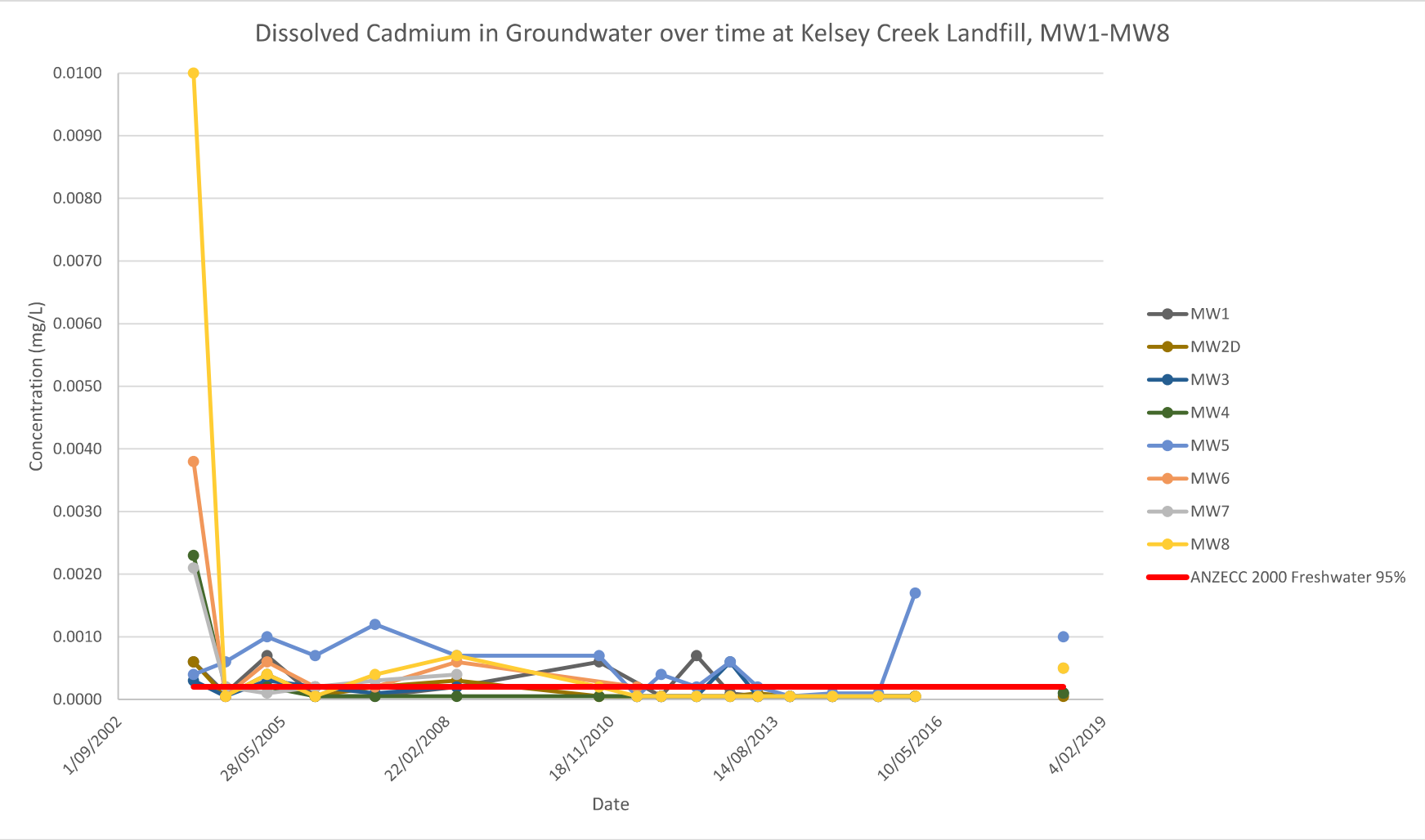

Total Dissolved Solids at 180°C in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
18,000
17,000
16,000
15,000
14,000
13,000
12,000
11,000
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
13/03/2010
18/11/2010
26/07/2011
1/04/2012
7/12/2012
14/08/2013
21/04/2014
27/12/2014
3/09/2015
10/05/2016
15/01/2017
22/09/2017
30/05/2018
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8

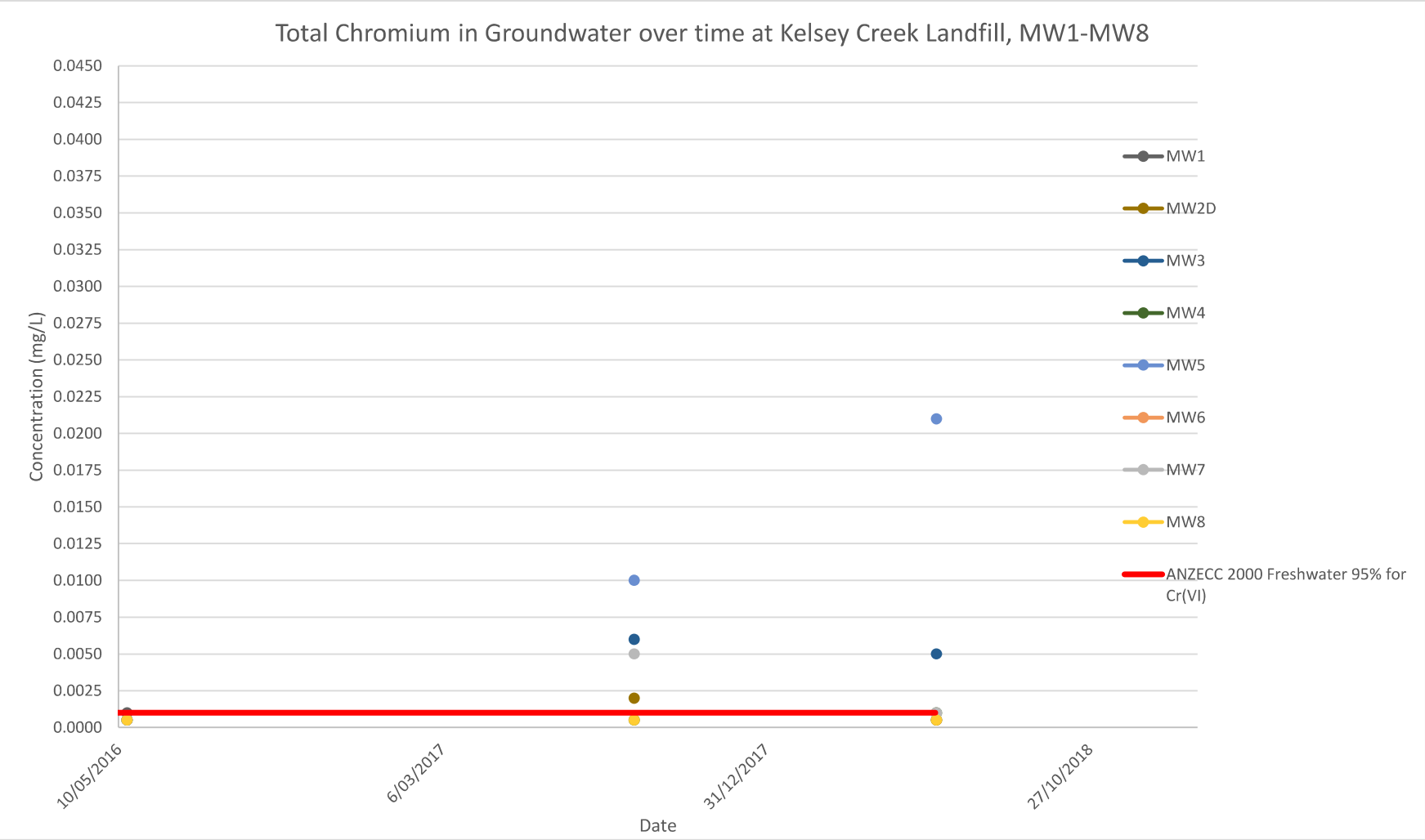

Dissolved Iron in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
22/01/2010
29/09/2010
6/06/2011
11/02/2012
18/10/2012
25/06/2013
2/03/2014
7/11/2014
15/07/2015
21/03/2016
26/11/2016
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8

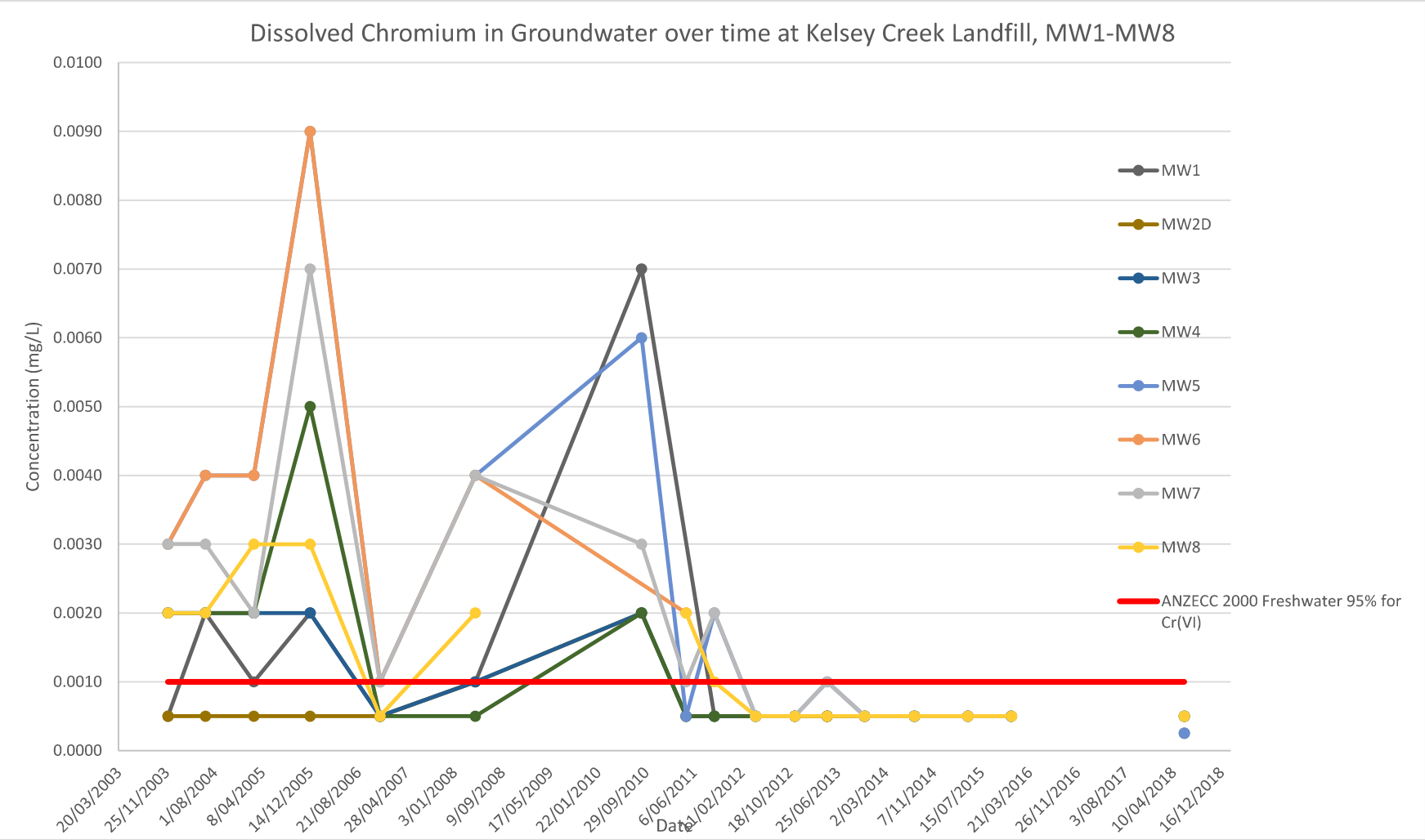

Total Arsenic in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
3/09/2015
31/01/2016
29/06/2016
26/11/2016
25/04/2017
22/09/2017
19/02/2018
19/07/2018
16/12/2018
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95% for As(V)

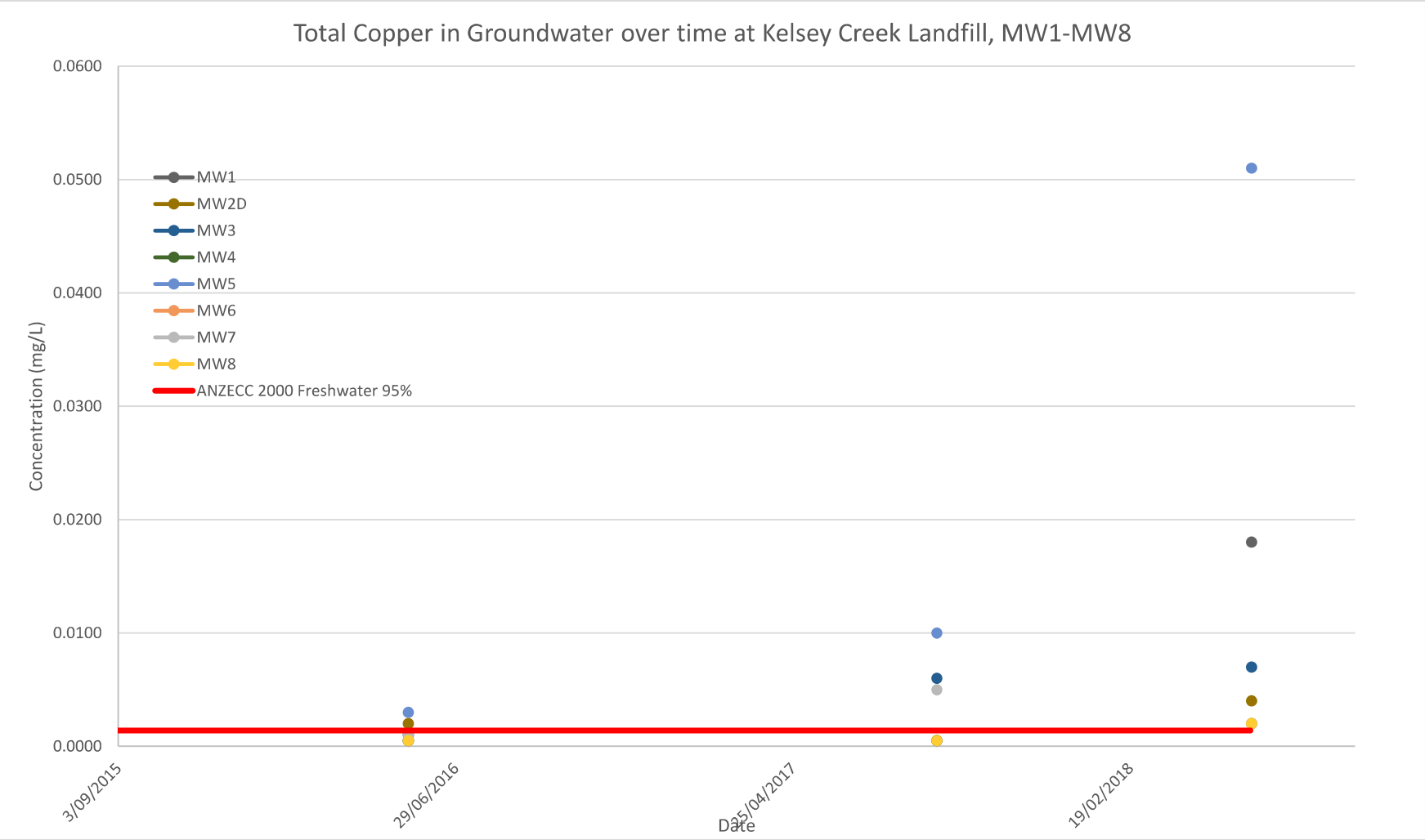

Dissolved Arsenic in Groundwater Water over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
1/09/2002
28/06/2003
23/04/2004
17/02/2005
14/12/2005
10/10/2006
6/08/2007
1/06/2008
28/03/2009
22/01/2010
18/11/2010
14/09/2011
10/07/2012
6/05/2013
2/03/2014
27/12/2014
23/10/2015
18/08/2016
14/06/2017
10/04/2018
4/02/2019
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8

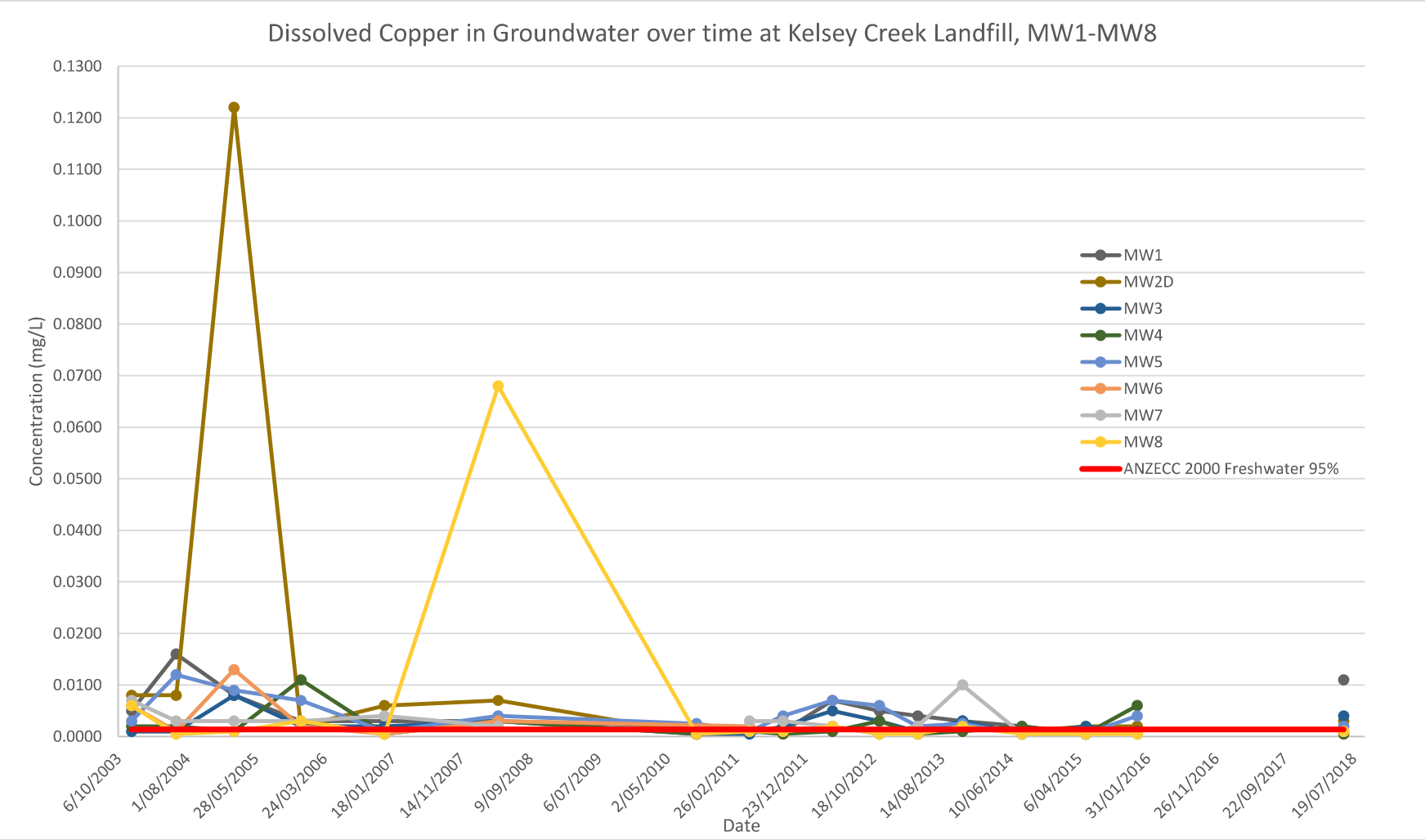

Total Cadmium in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
3/09/2015
31/01/2016
29/06/2016
26/11/2016
25/04/2017
22/09/2017
19/02/2018
19/07/2018
16/12/2018
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95%

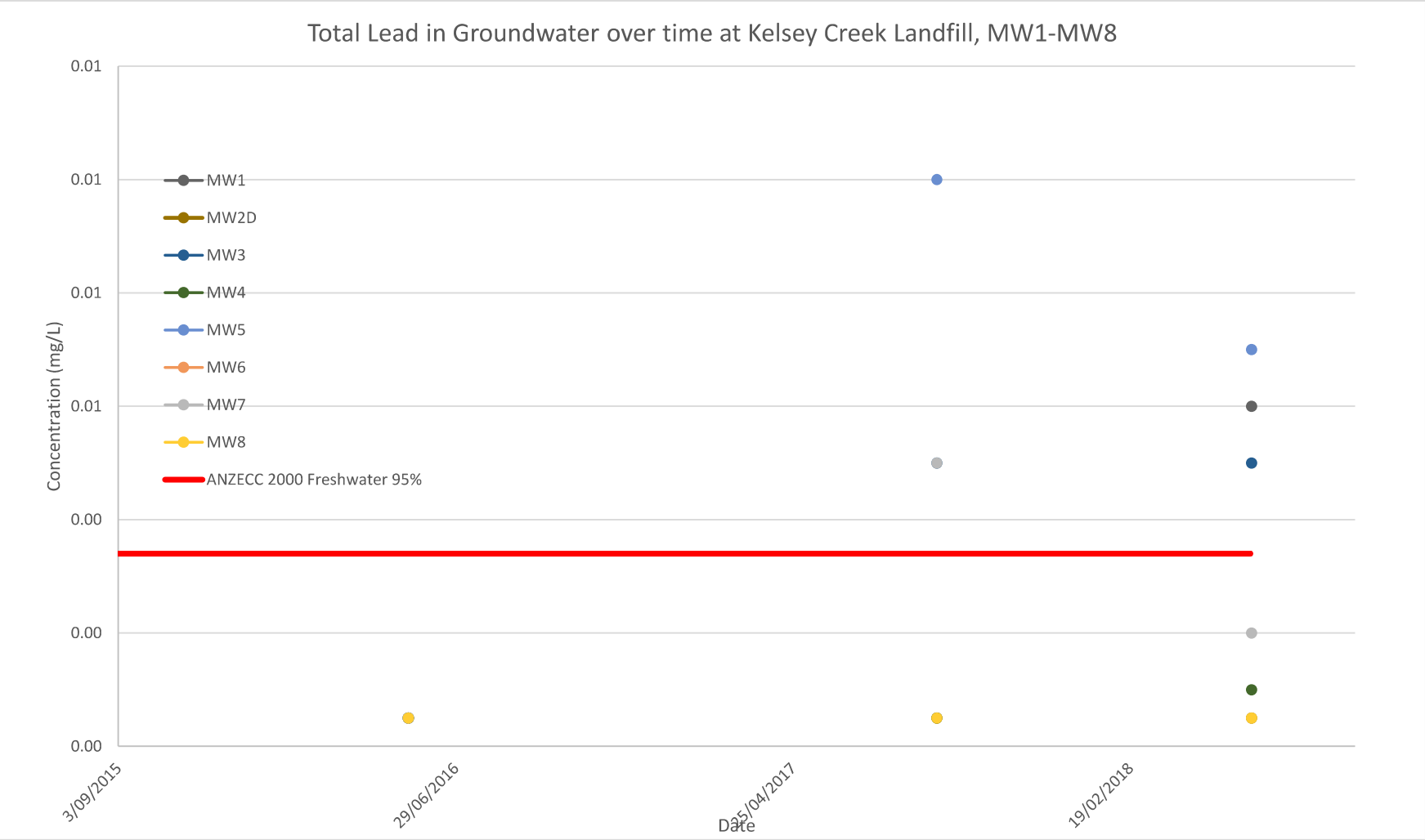

Dissolved Cadmium in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
0.0100
0.0090
0.0080
0.0070
0.0060
0.0050
0.0040
0.0030
0.0020
0.0010
0.0000
1/09/2002
28/05/2005
22/02/2008
18/11/2010
14/08/2013
10/05/2016
4/02/2019
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95%

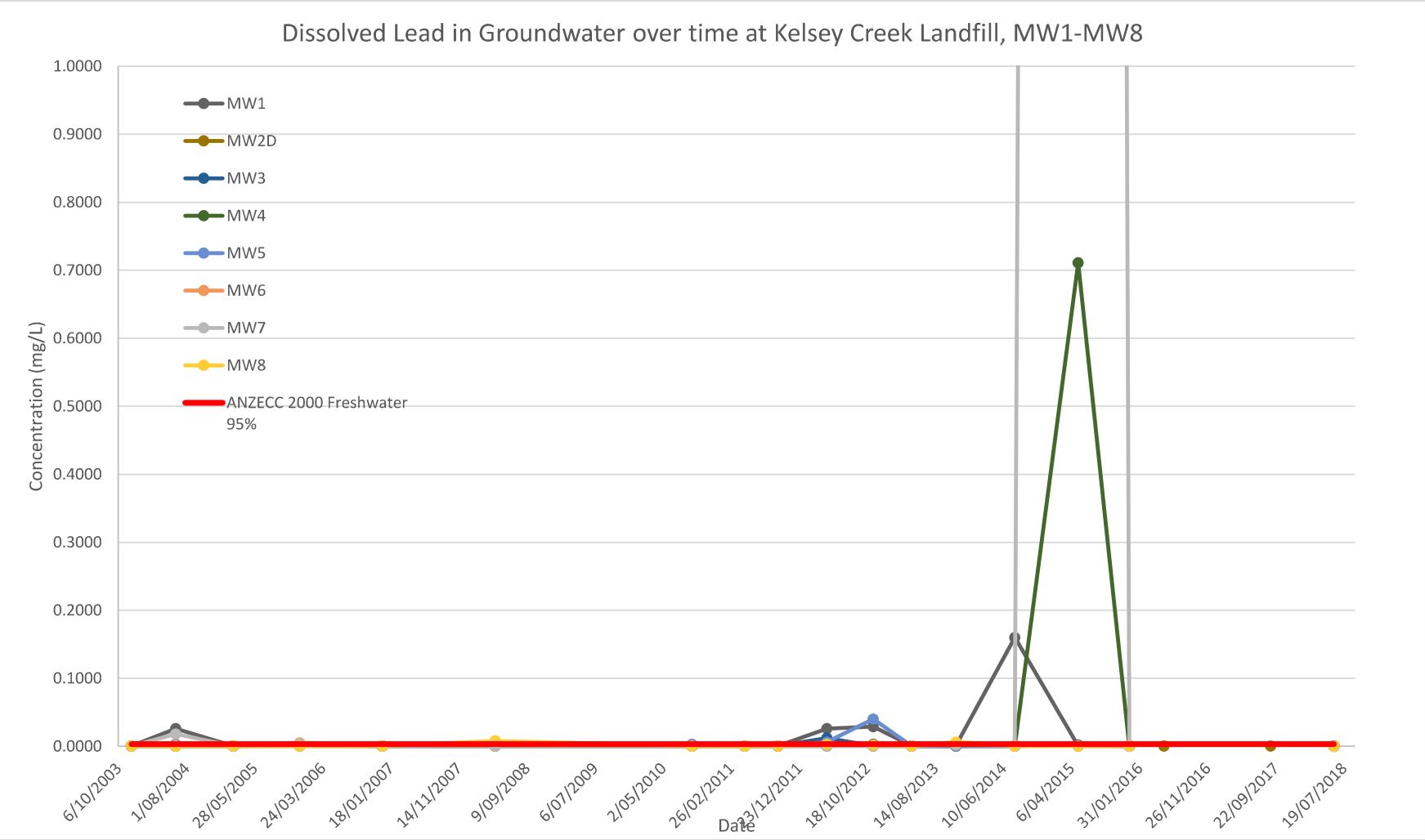

Total Chromium in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
0.0450
0.0425
0.0400
0.0375
0.0350
0.0325
0.0300
0.0275
0.0250
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
10/05/2016
6/03/2017
31/12/2017
27/10/2018
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95% for Cr(VI)

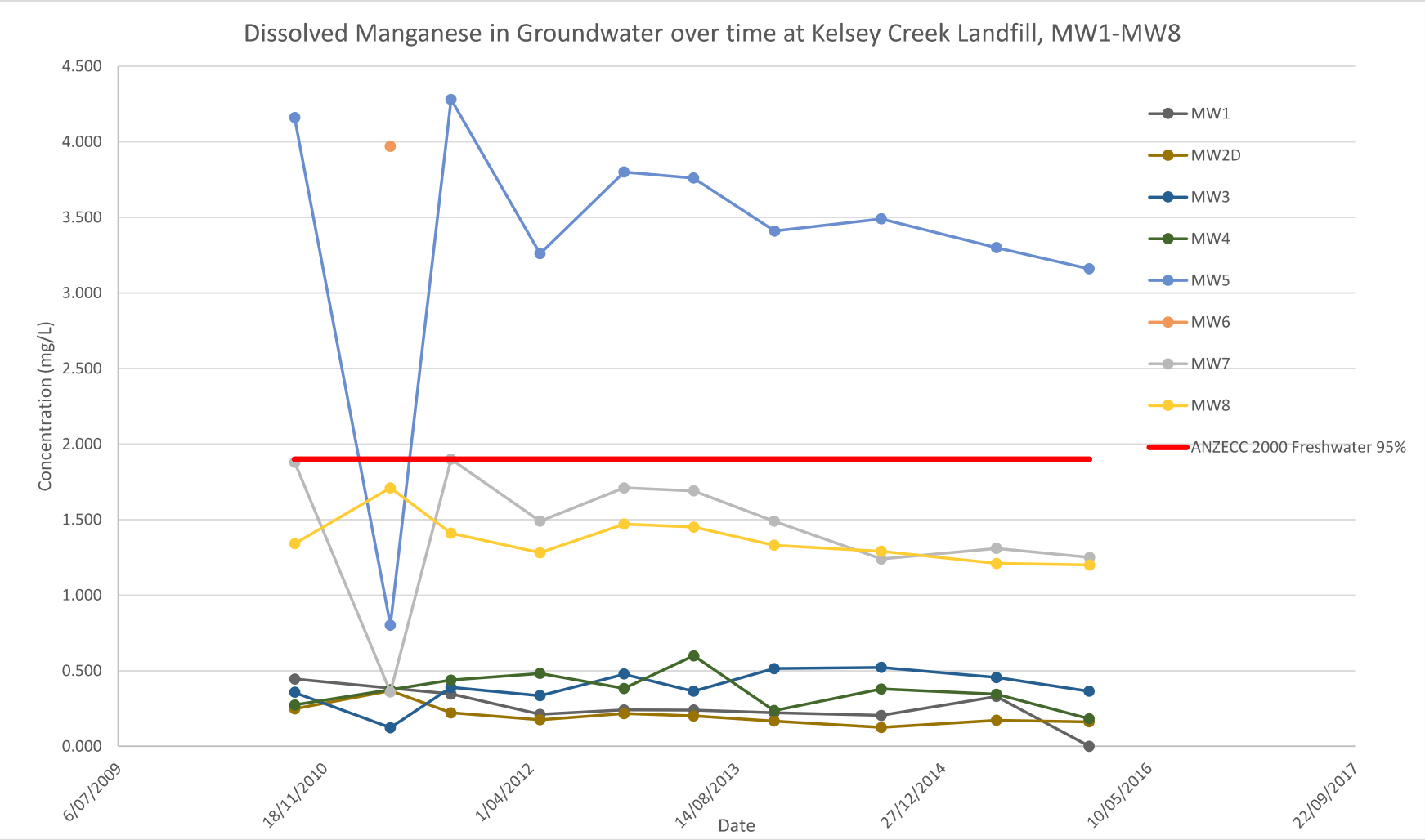

Dissolved Chromium in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
0.0100
0.0090
0.0080
0.0070
0.0060
0.0050
0.0040
0.0030
0.0020
0.0010
0.0000
20/03/2003
25/11/2003
1/08/2004
8/04/2005
14/12/2005
21/08/2006
28/04/2007
3/01/2008
9/09/2008
17/05/2009
22/01/2010
29/09/2010
6/06/2011
14/02/2012
18/10/2012
25/06/2013
2/03/2014
7/11/2014
15/07/2015
21/03/2016
26/11/2016
3/08/2017
10/04/2018
16/12/2018
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95% for Cr(VI)

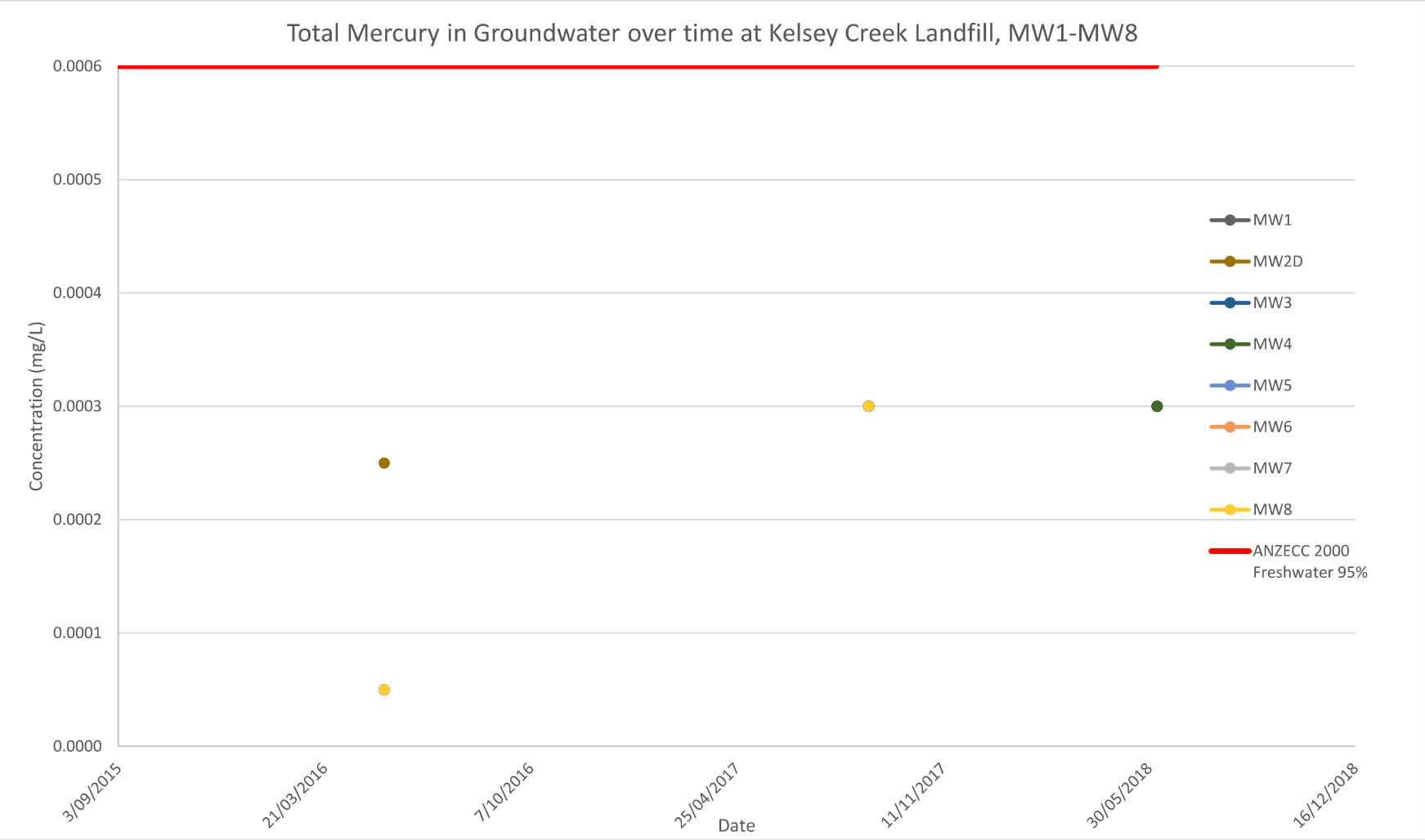

Total Copper in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
Concentration (mg/L)
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95%
3/09/2015
29/06/2016
25/04/2017
19/02/2018
Date

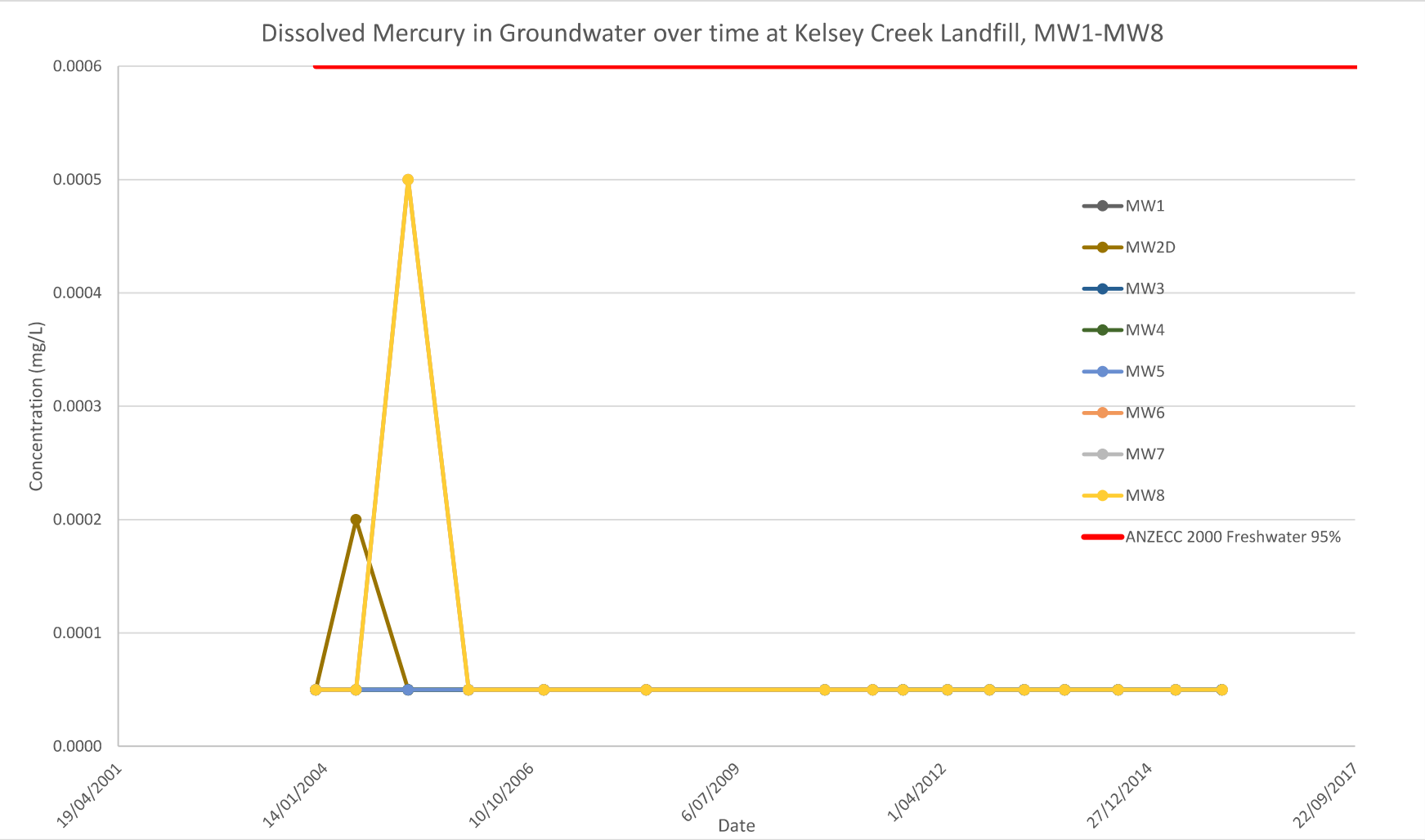

Dissolved Copper in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
0.1300
0.1200
0.1100
0.1000
0.0900
0.0800
0.0700
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
6/10/2003
1/08/2004
28/05/2005
24/03/2006
18/01/2007
14/11/2007
9/09/2008
6/07/2009
2/05/2010
26/02/2011
23/12/2011
18/10/2012
14/08/2013
10/06/2014
6/04/2015
31/01/2016
26/11/2016
22/09/2017
19/07/2018
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95%

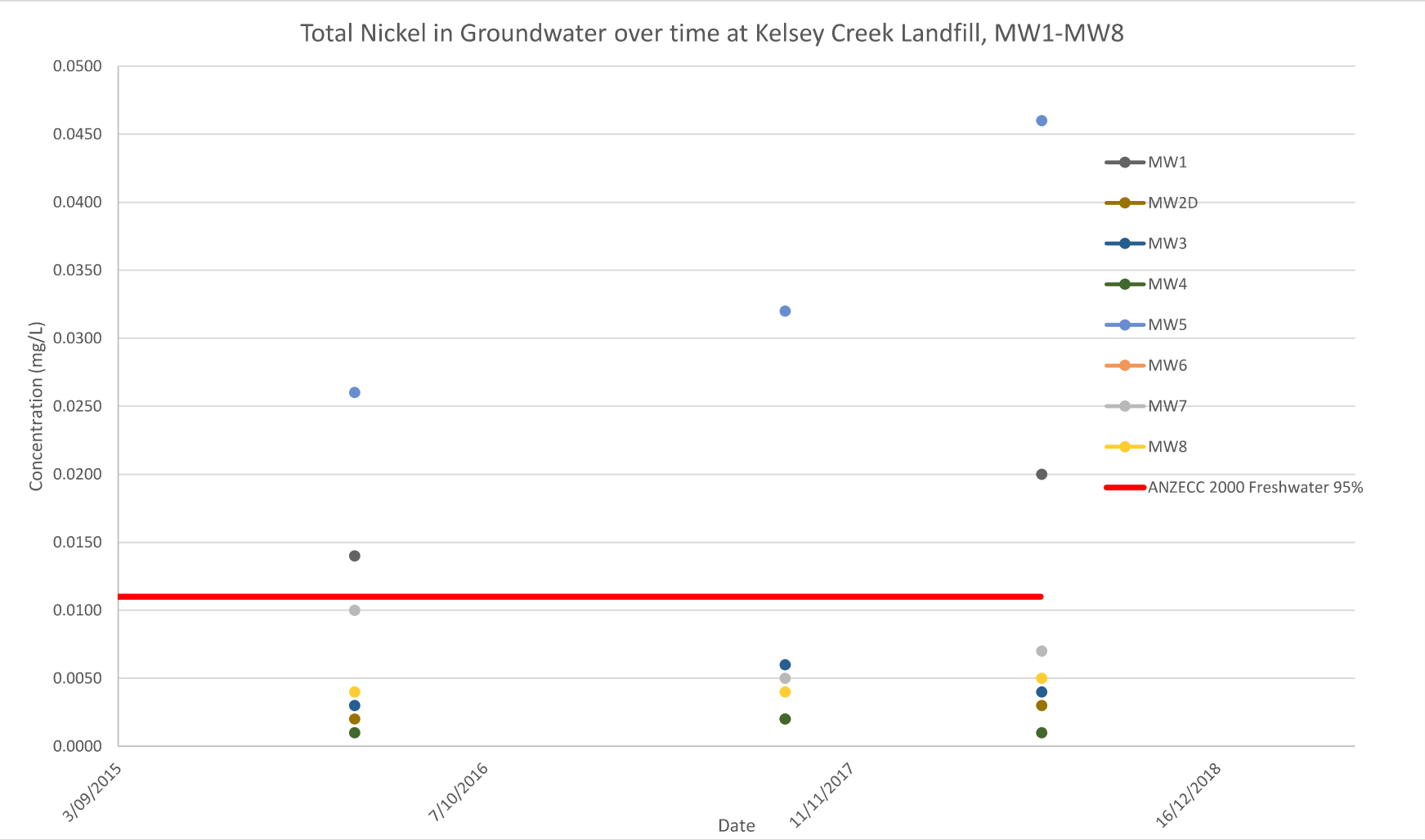

Total Lead in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
0.01
0.01
0.01
0.01
0.00
0.00
0.00
Concentration (mg/L)
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95%
3/09/2015
29/06/2016
25/04/2017
19/02/2018
Date

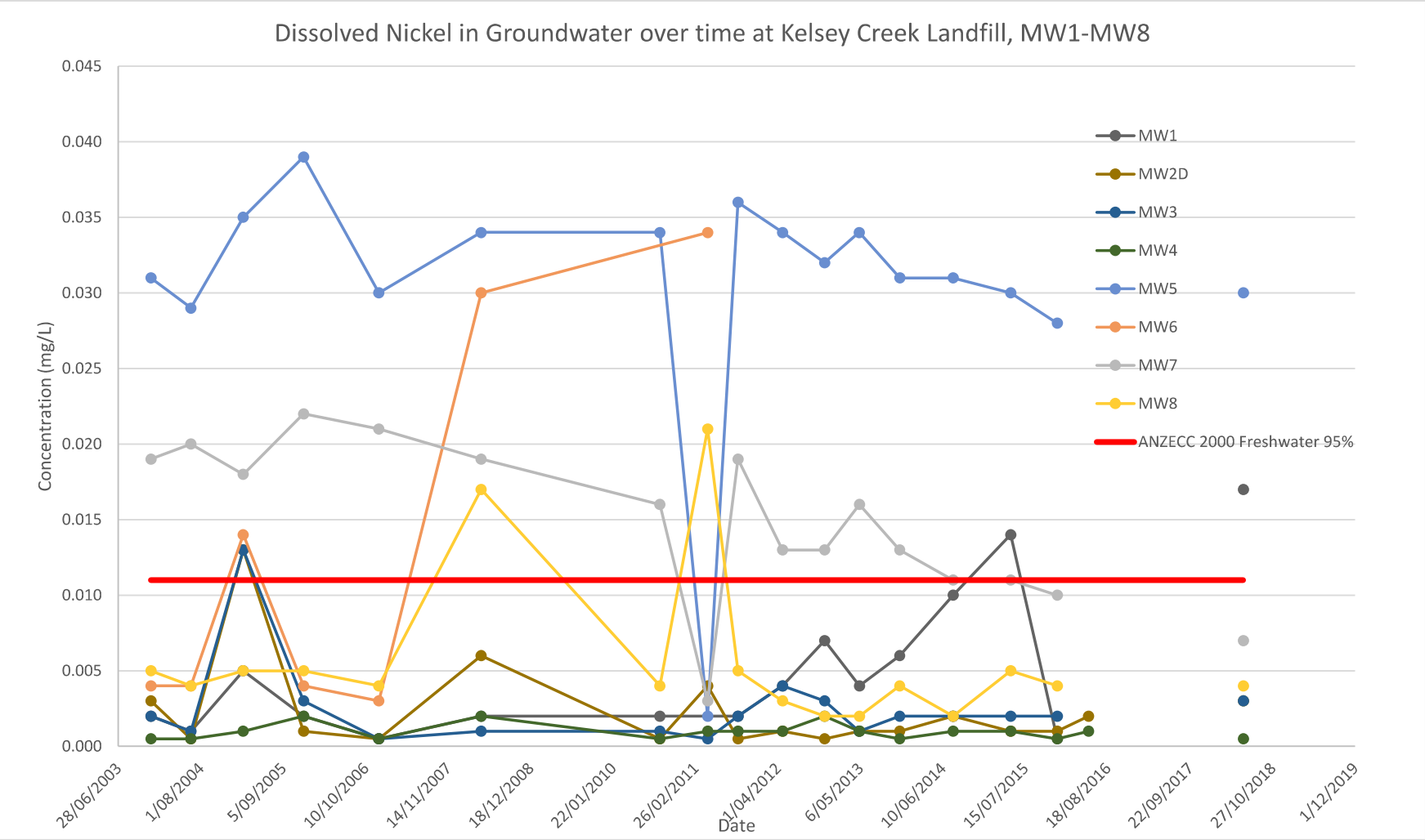

Dissolved Lead in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
1.0000
0.9000
0.8000
0.7000
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95%
6/10/2003
1/08/2004
28/05/2005
24/03/2006
18/01/2007
14/11/2007
9/09/2008
6/07/2009
2/05/2010
26/02/2011
23/12/2011
18/10/2012
14/08/2013
10/06/2014
6/04/2015
31/01/2016
26/11/2016
22/09/2017
19/07/2018
Date

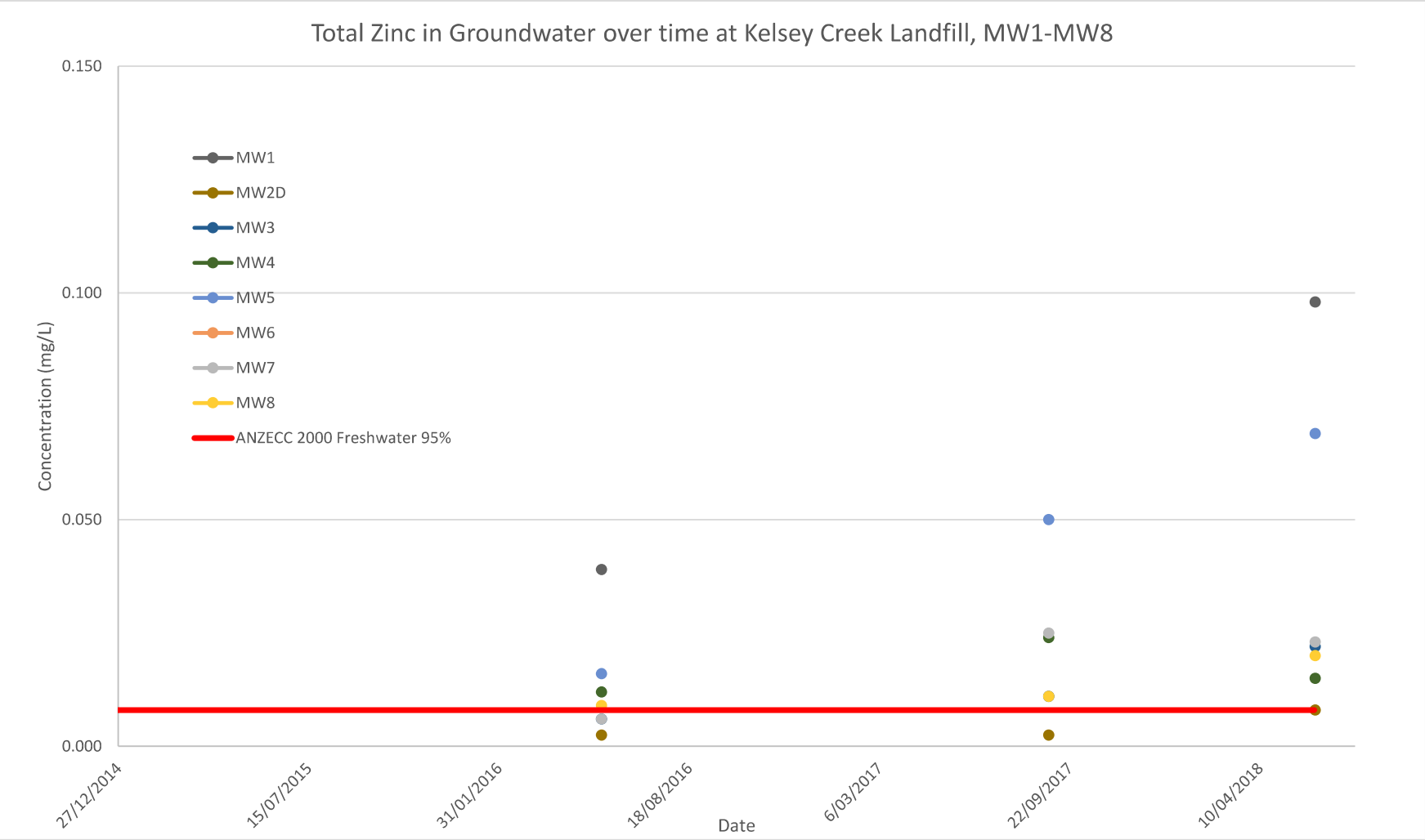

Dissolved Manganese in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
6/07/2009
18/11/2010
1/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95%

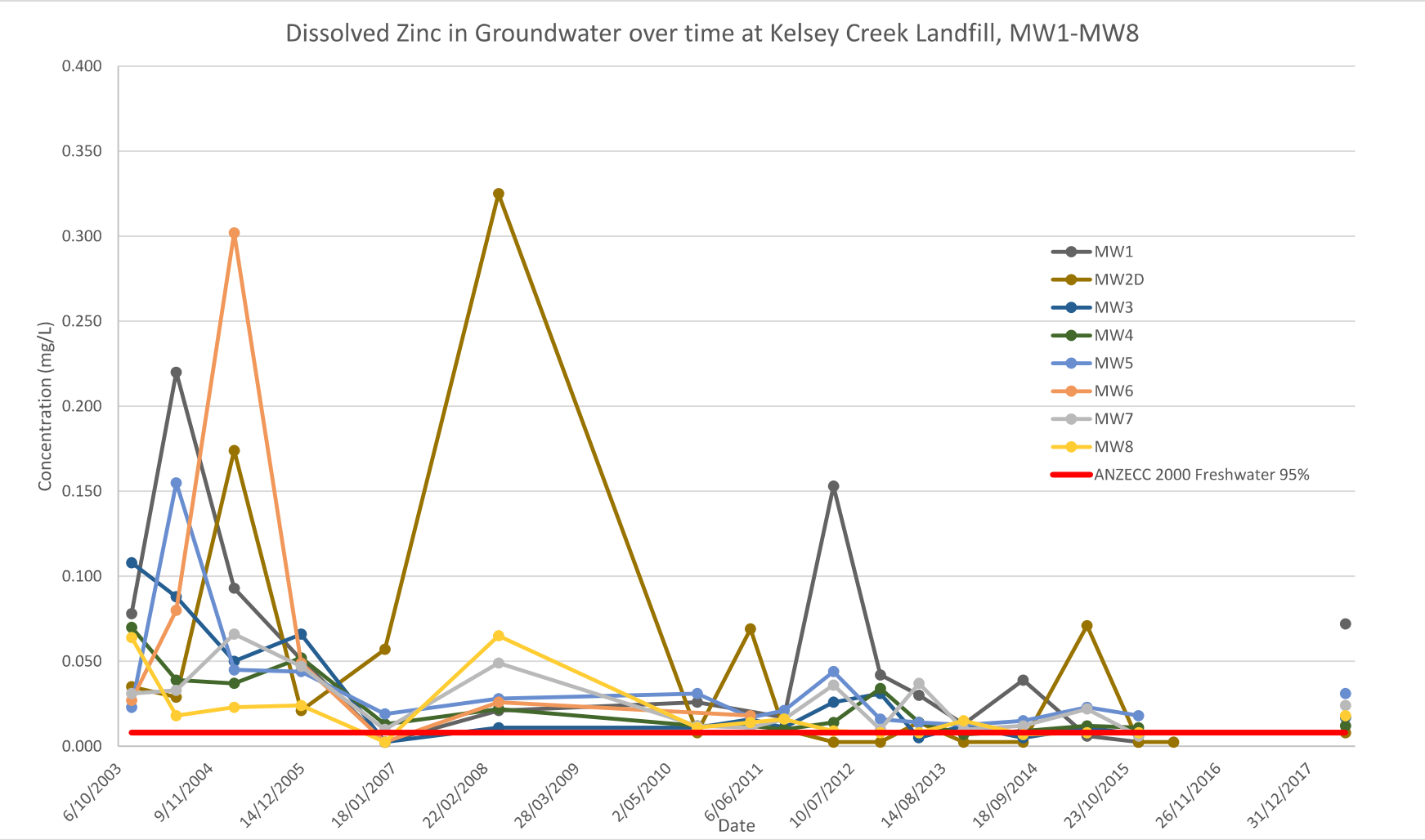

Total Mercury in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
Concentration (mg/L)
3/09/2015
21/03/2016
7/10/2016
25/04/2017
11/11/2017
30/05/2018
16/12/2018
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95%

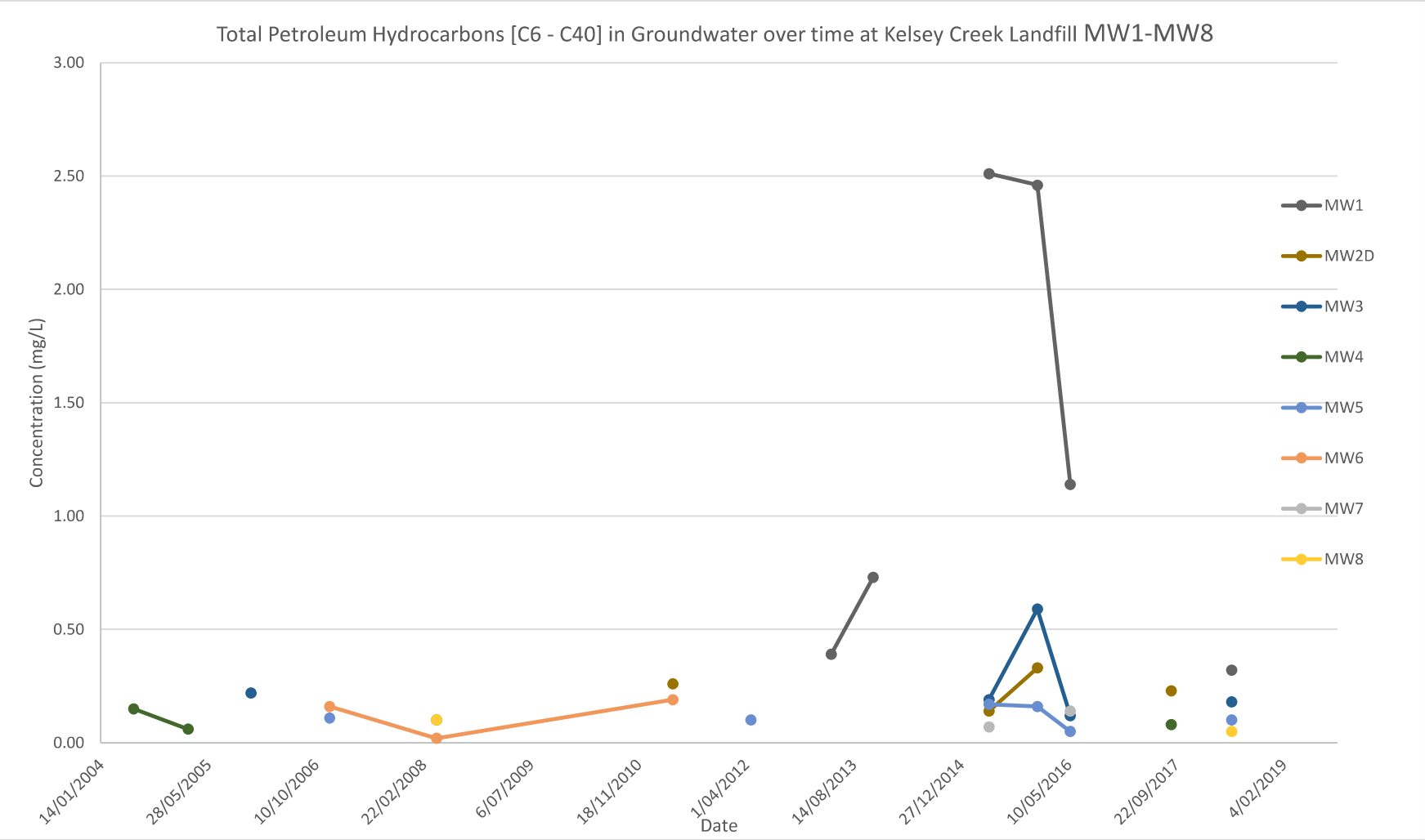

Dissolved Mercury in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
0.0006
0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
19/04/2001
14/01/2004
10/10/2006
6/07/2009
1/04/2012
27/12/2014
22/09/2017
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95%


Total Nickel in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
0.0500
0.0450
0.0400
0.0350
0.0300
0.0250
0.0200
0.0150
0.0100
0.0050
0.0000
3/09/2015
7/10/2016
11/11/2017
16/12/2018
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95%

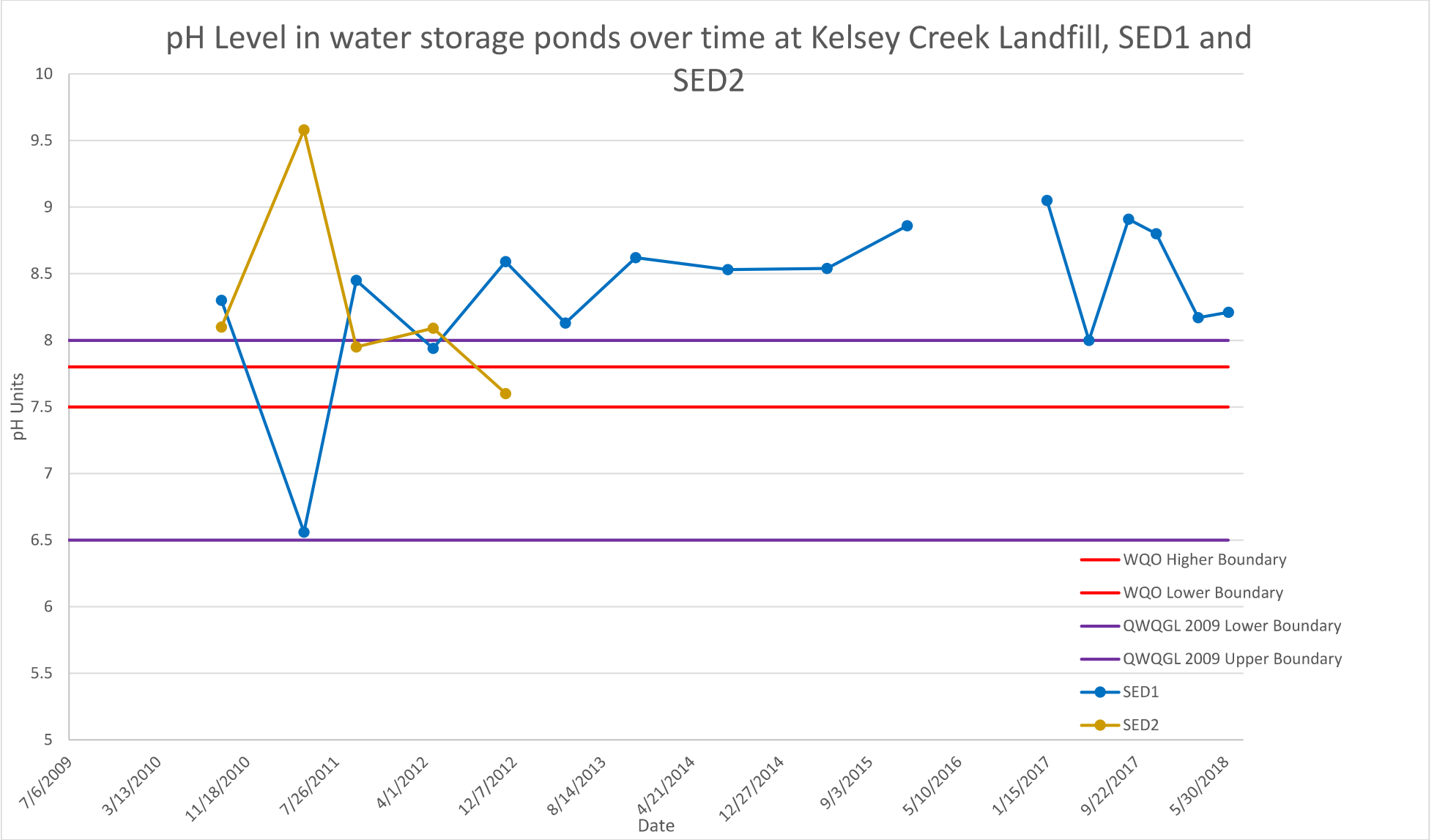

Dissolved Nickel in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
0.045
0.040
0.035
0.030
0.025
0.020
0.015
0.010
0.005
0.000
28/06/2003
1/08/2004
5/09/2005
10/10/2006
14/11/2007
18/12/2008
22/01/2010
26/02/2011
1/04/2012
6/05/2013
10/06/2014
15/07/2015
18/08/2016
22/09/2017
27/10/2018
1/12/2019
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95%


Total Zinc in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
0.150
0.100
0.050
0.000
Concentration (mg/L)
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95%
27/12/2014
15/07/2015
31/01/2016
18/08/2016
6/03/2017
22/09/2017
10/04/2018
Date

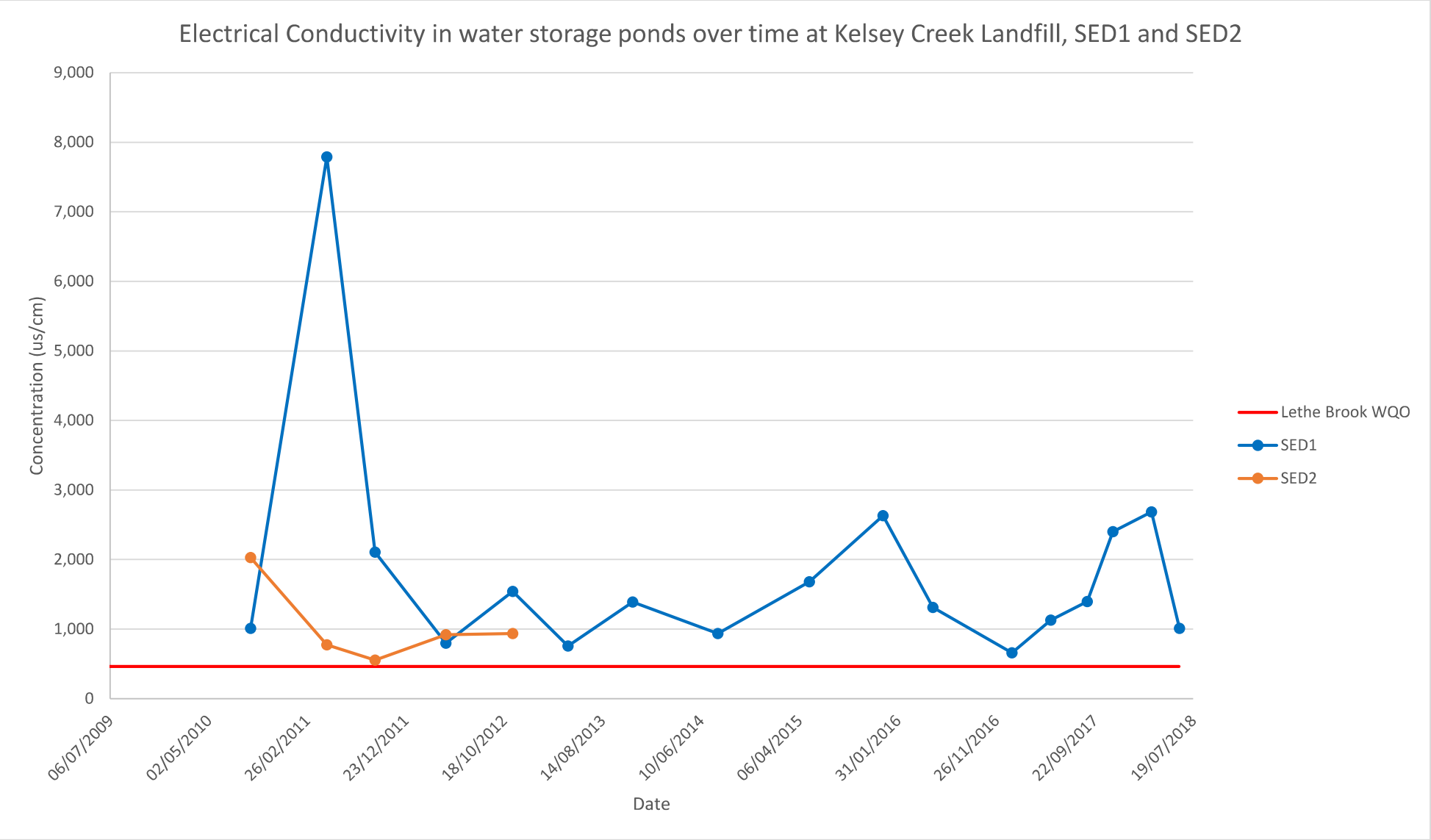

Dissolved Zinc in Groundwater over time at Kelsey Creek Landfill, MW1-MW8
Concentration (mg/L)
0.400
0.350
0.300
0.250
0.200
0.150
0.100
0.050
0.000
6/10/2003
9/11/2004
14/12/2005
18/01/2007
22/02/2008
28/03/2009
2/05/2010
6/06/2011
10/07/2012
14/08/2013
18/09/2014
23/10/2015
26/11/2016
31/12/2017
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8
ANZECC 2000 Freshwater 95%


Total Petroleum Hydrocarbons [C6 - C40] in Groundwater over time at Kelsey Creek Landfill MW1-MW8
Concentration (mg/L)
3.00
2.50
2.00
1.50
1.00
0.50
0.00
14/01/2004
28/05/2005
10/10/2006
22/02/2008
6/07/2009
18/11/2010
1/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
4/02/2019
Date
MW1
MW2D
MW3
MW4
MW5
MW6
MW7
MW8

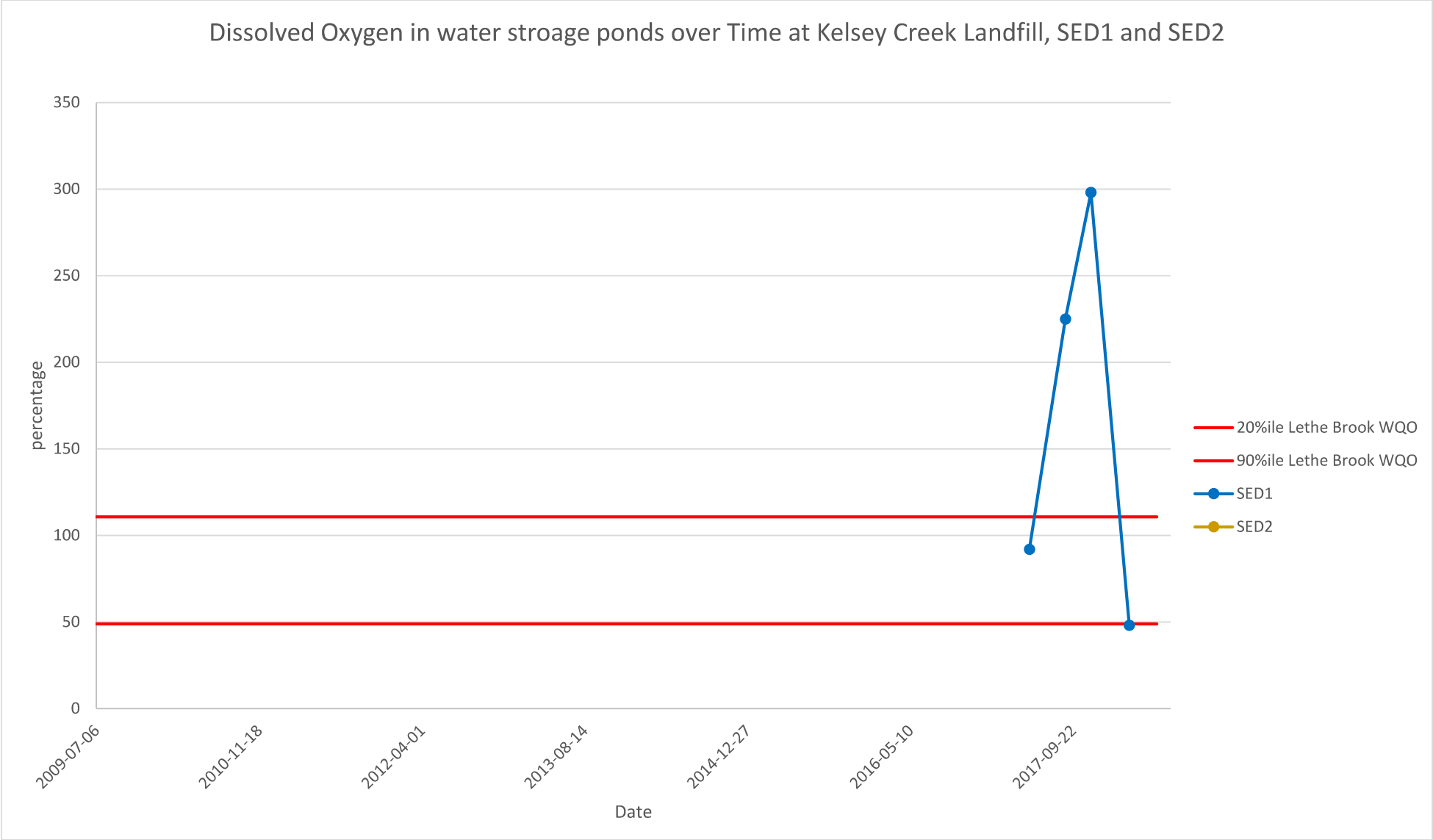
Appendix K Kelsey Creek Groundwater Graphs

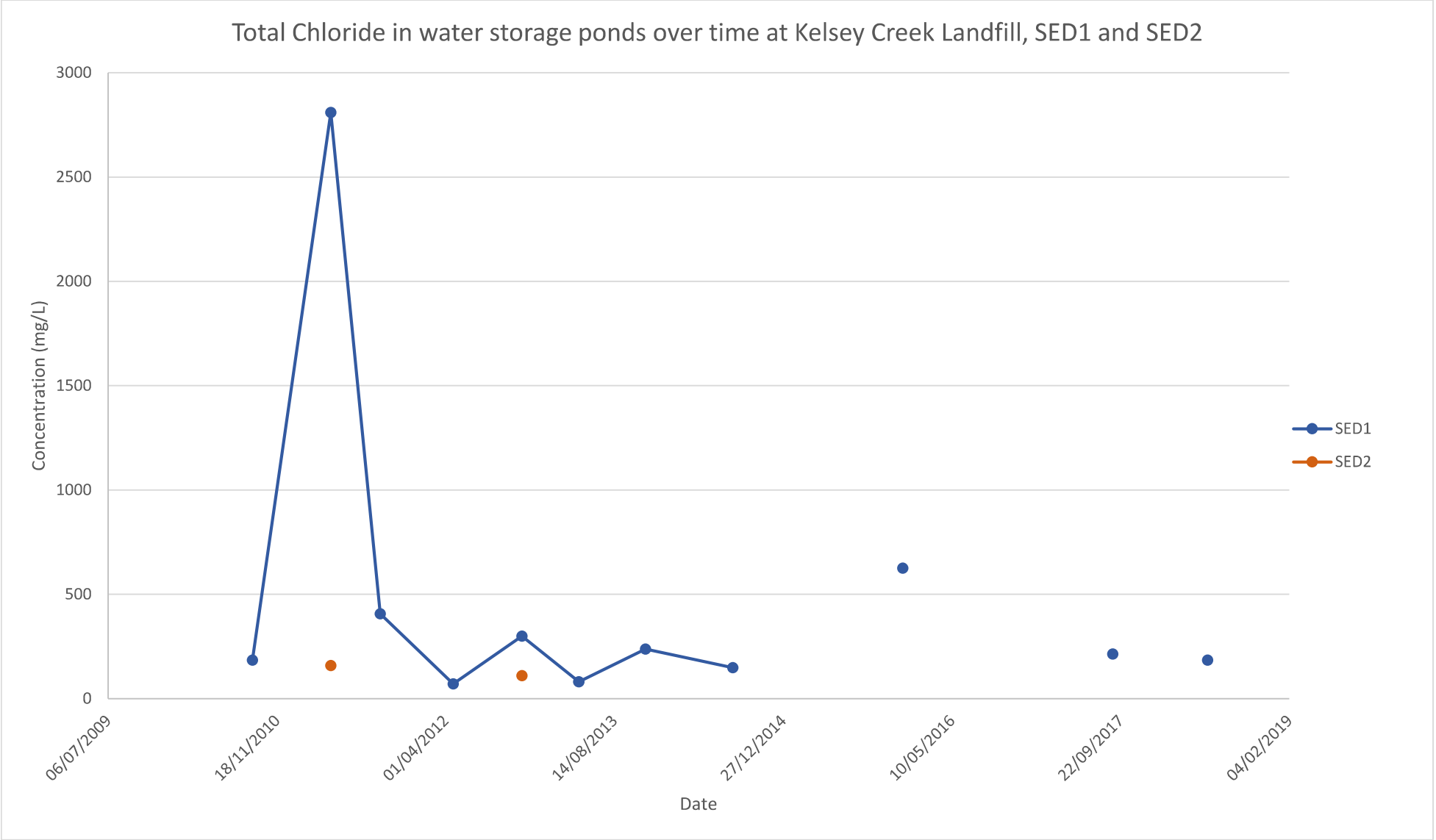


Appendix K Kelsey Creek Surface Water Graphs

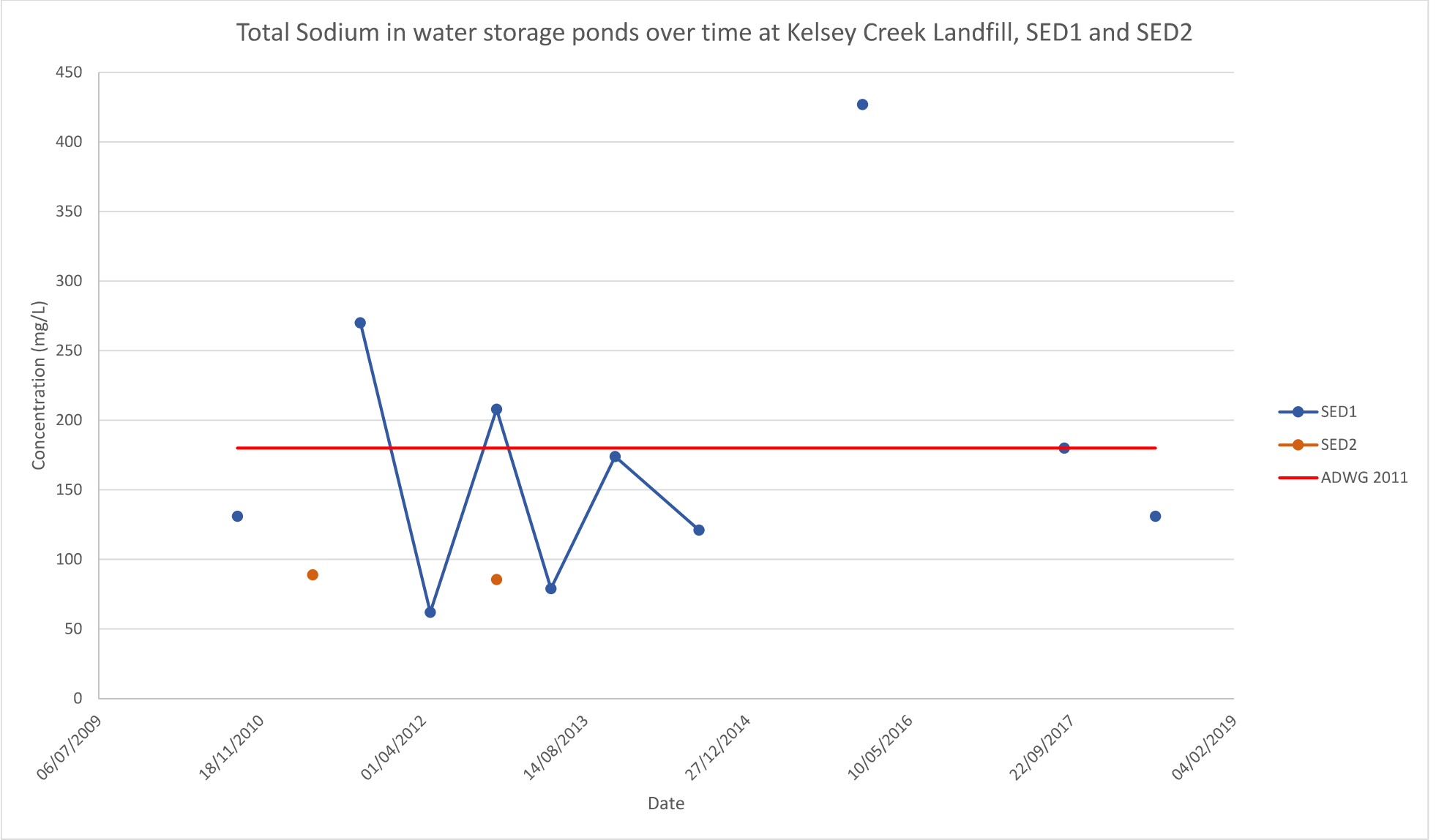


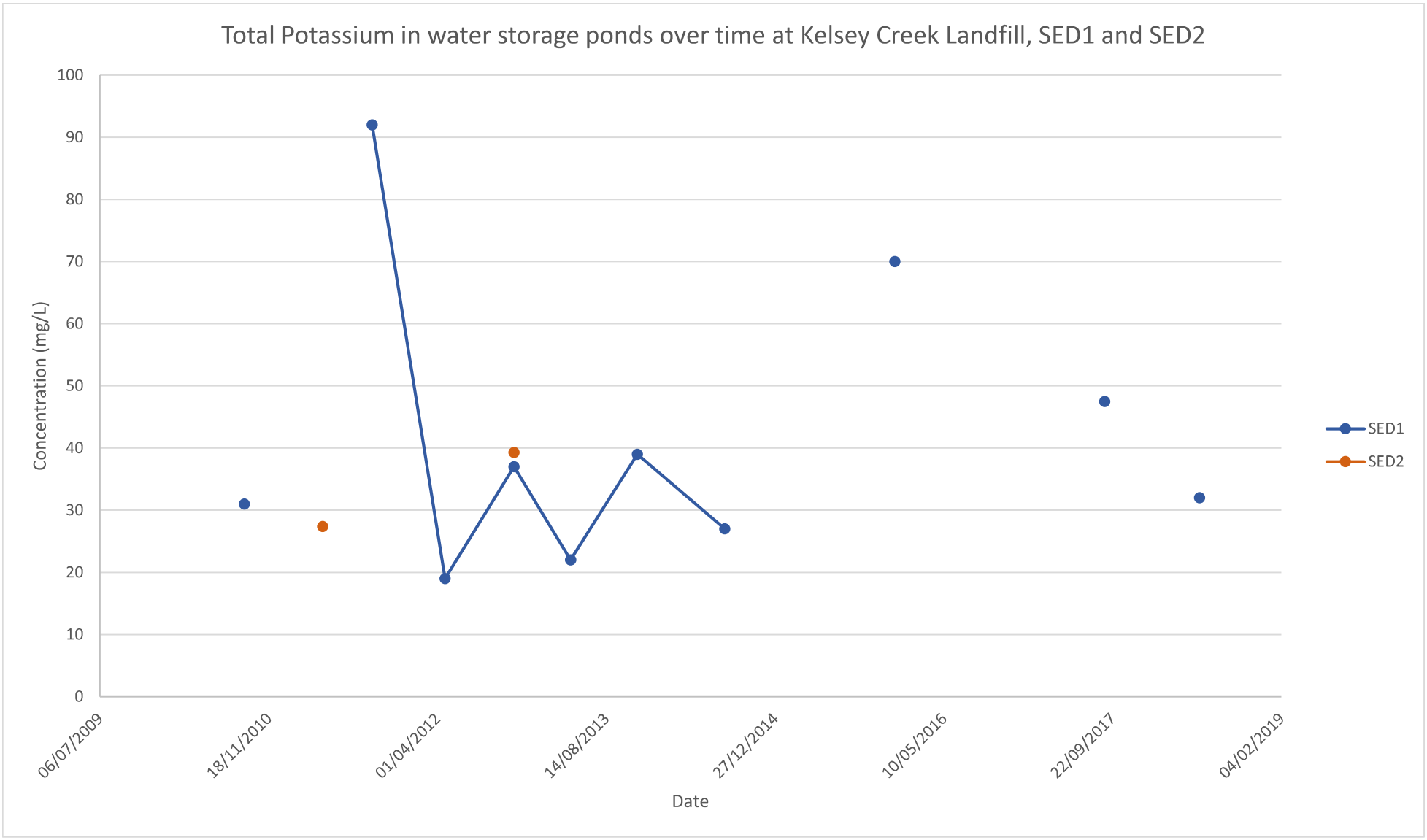
Appendix K Kelsey Creek Surface Water Graphs

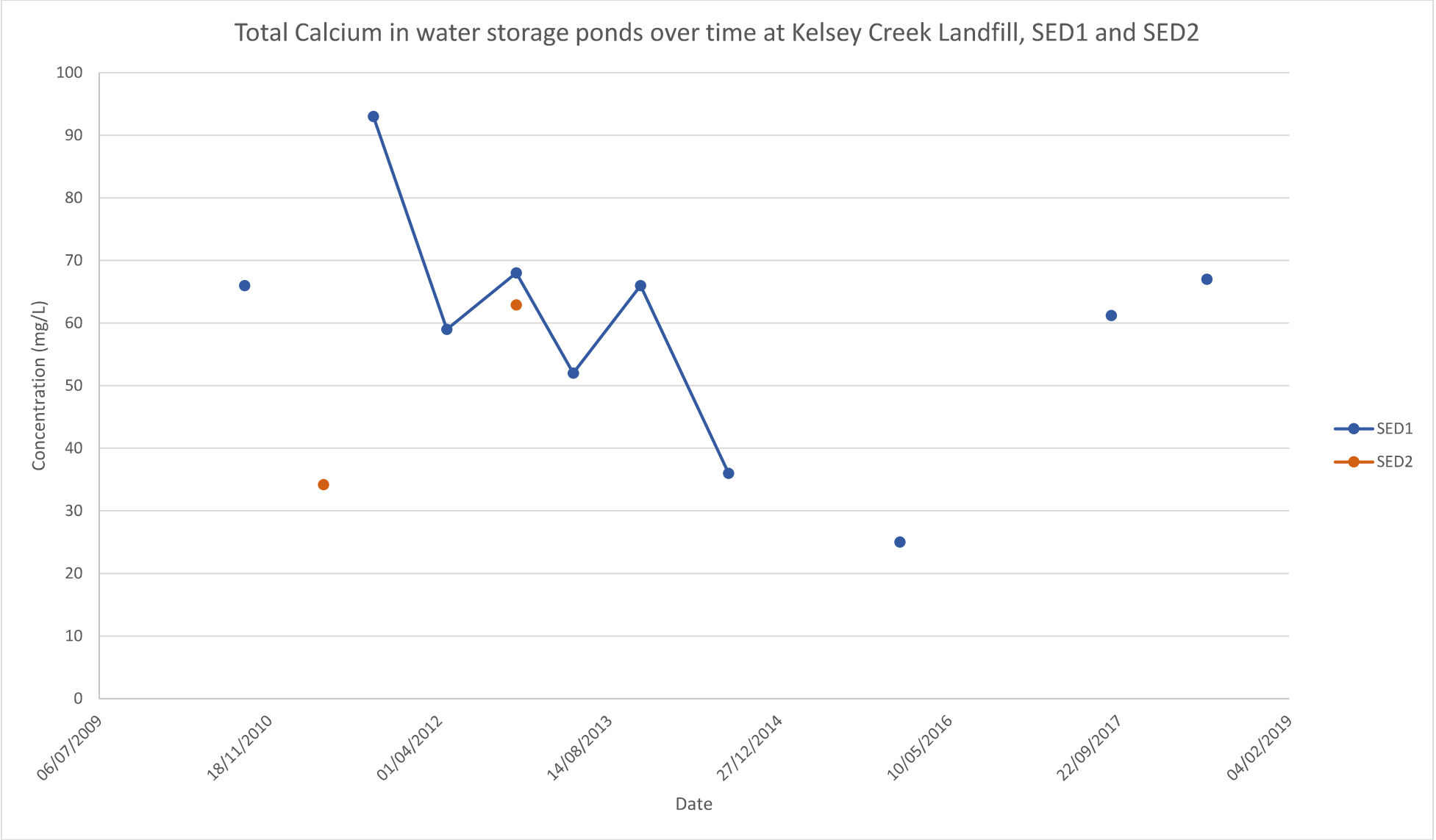


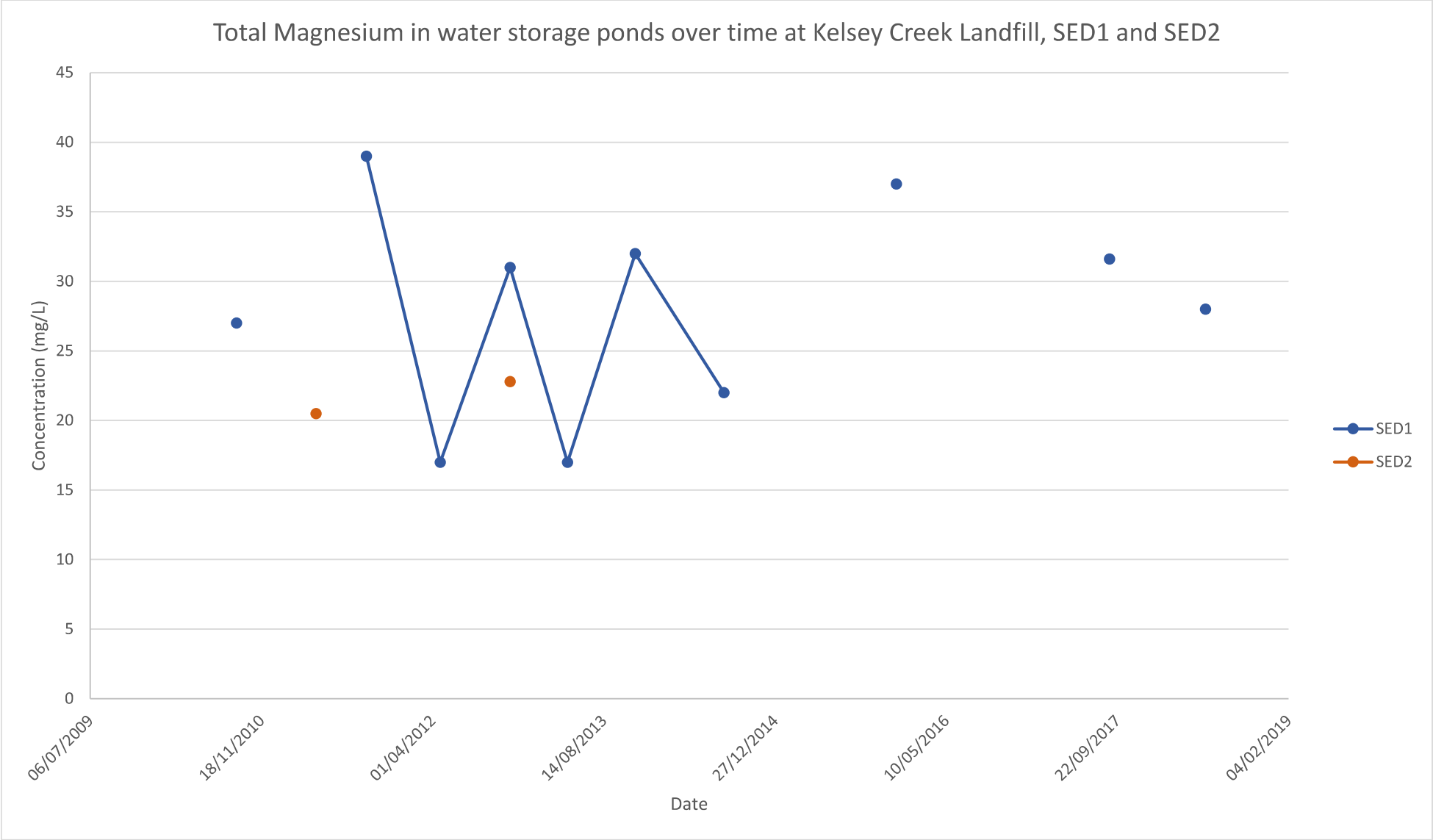

Total Chloride in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
3000
2500
2000
1500
1000
500
0
06/07/2009
18/11/2010
01/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
04/02/2019
Date
SED1
SED2

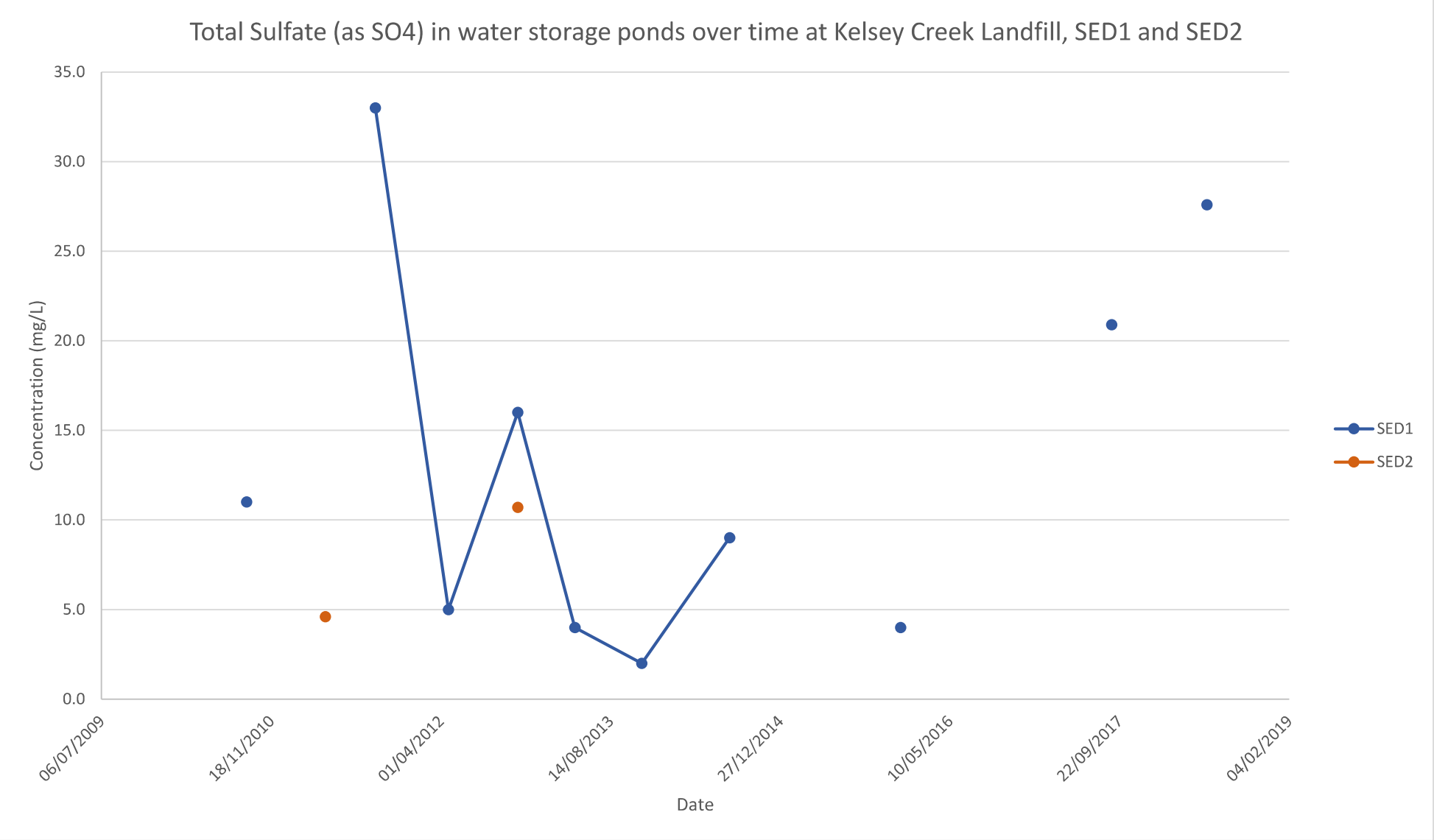
Appendix K Kelsey Creek Surface Water Graphs

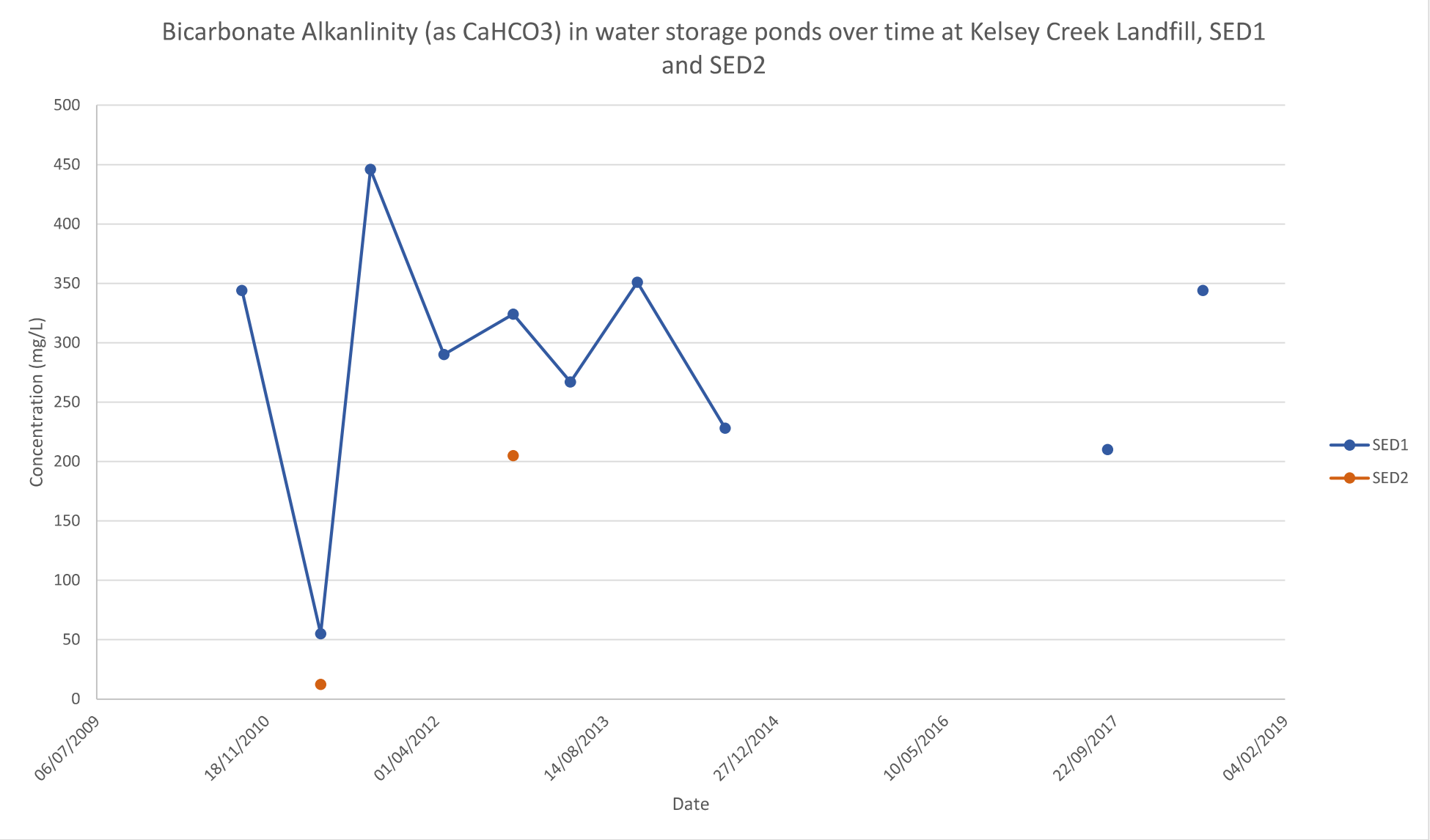


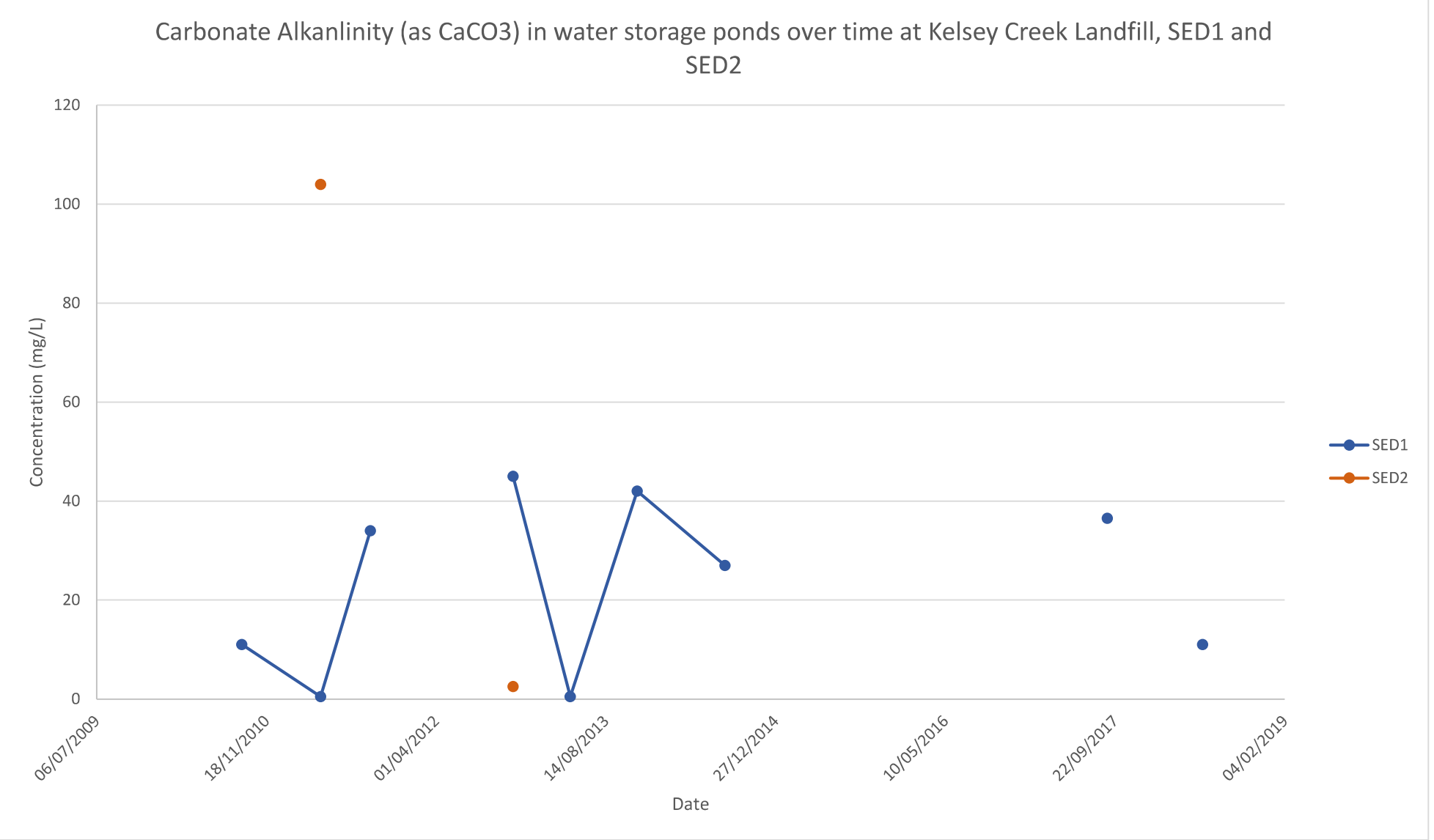

Total Potassium in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
100
90
80
70
60
50
40
30
20
10
0
06/07/2009
18/11/2010
01/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
04/02/2019
Date
SED1
SED2

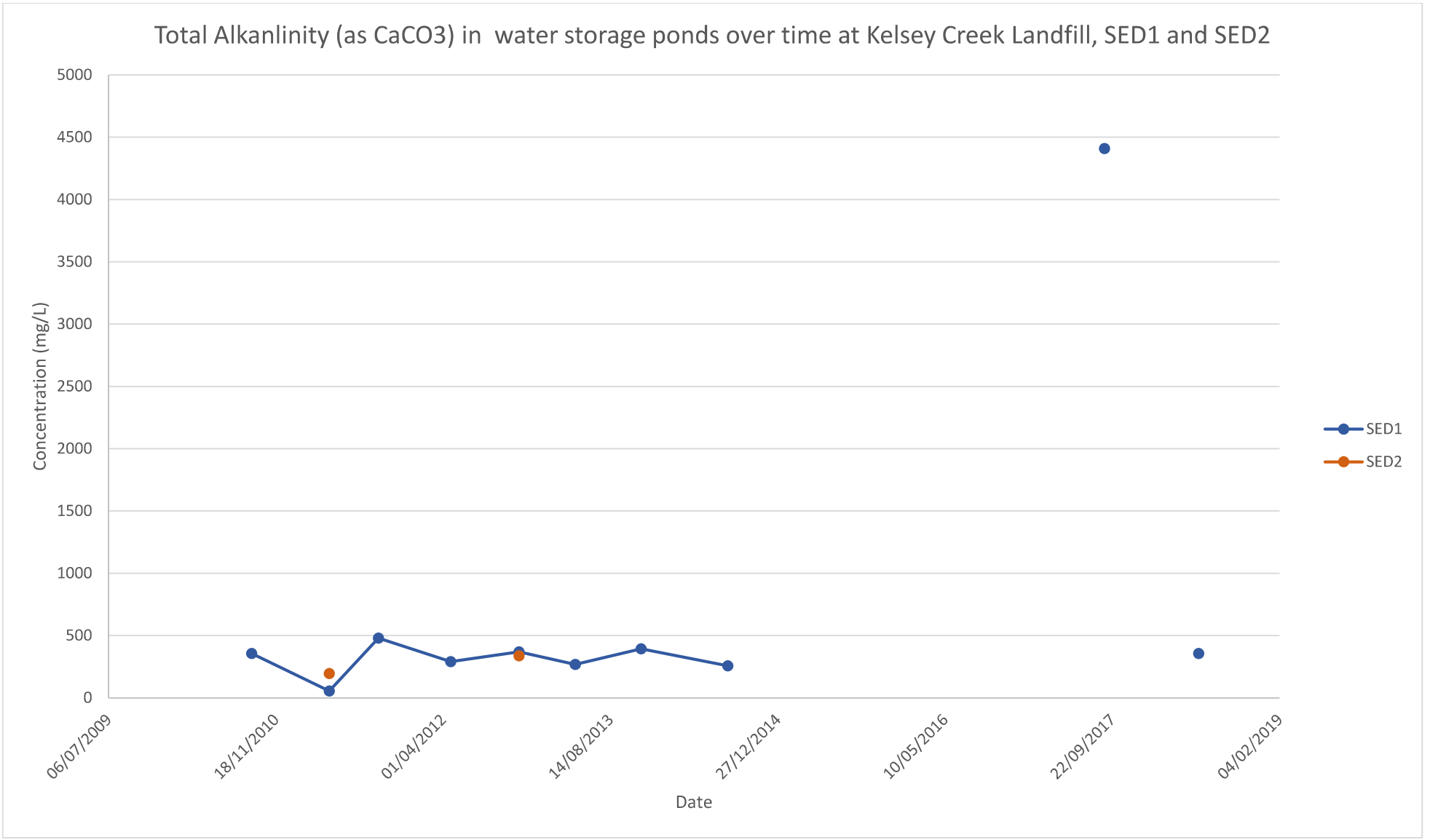

Total Calcium in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
100
90
80
70
60
50
40
30
20
10
0
06/07/2009
18/11/2010
01/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
04/02/2019
Date
SED1
SED2

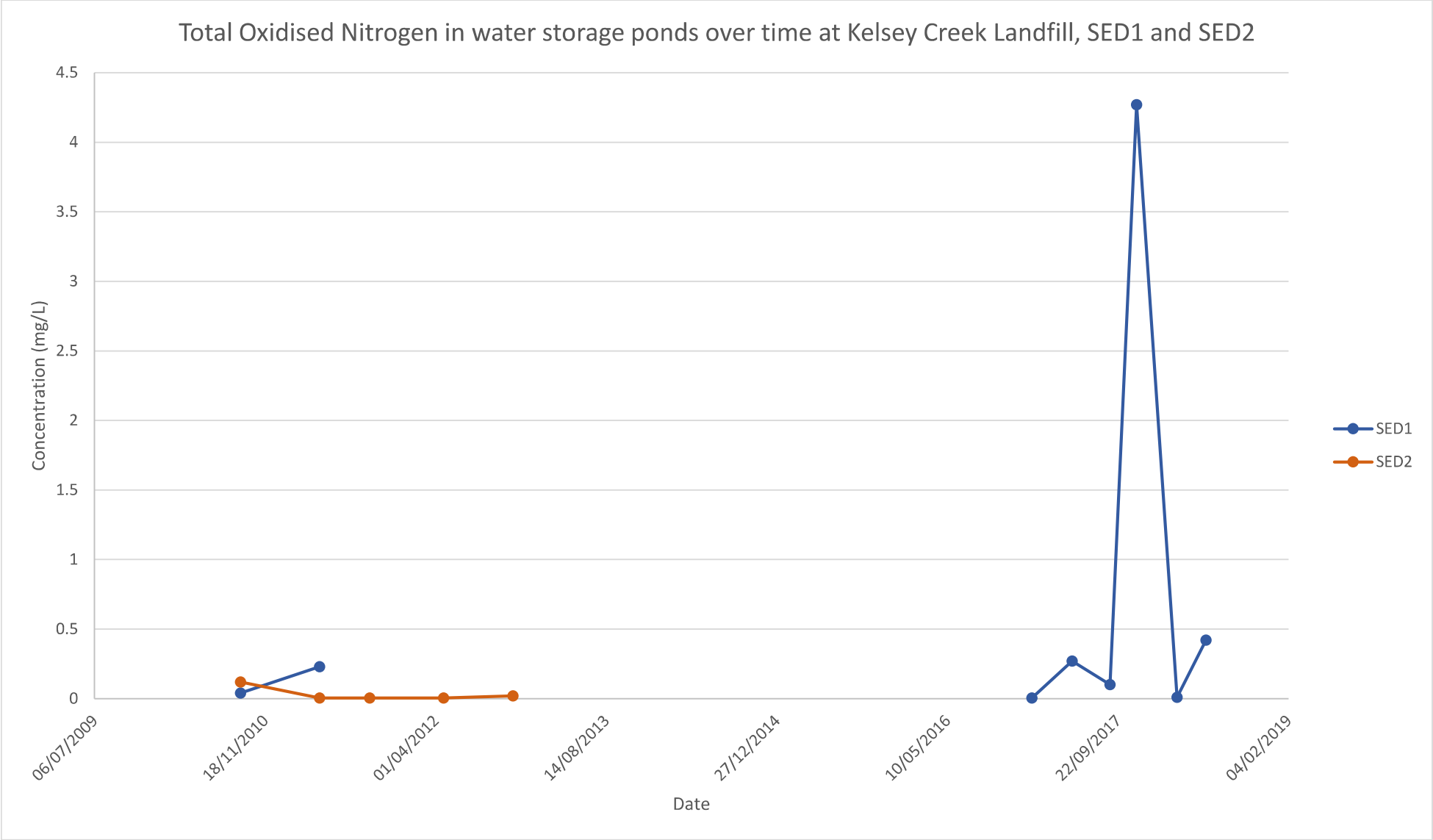

Total Magnesium in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
45
40
35
30
25
20
15
10
5
0
06/07/2009
18/11/2010
01/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
04/02/2019
Date
SED1
SED2

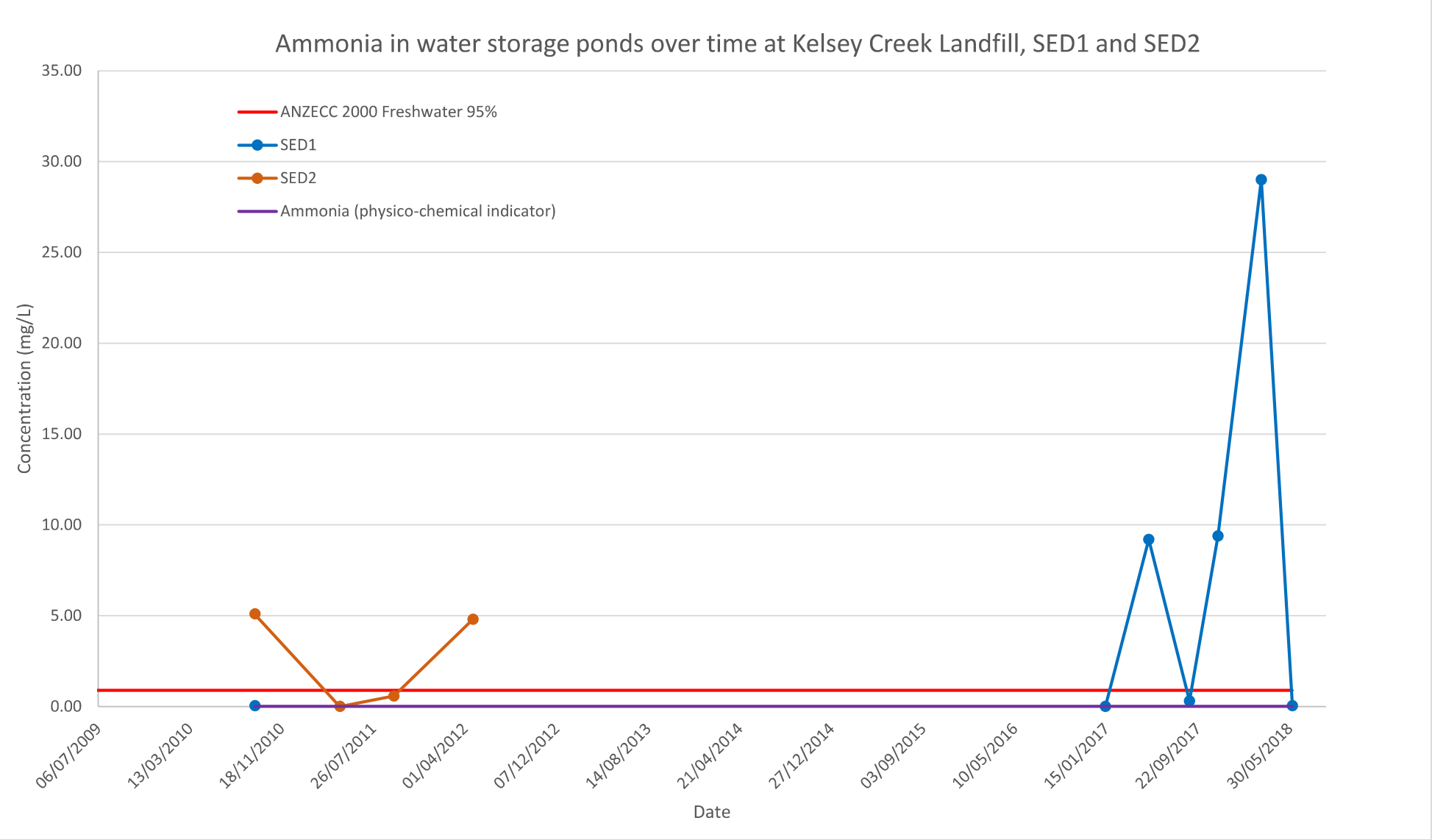

Total Sulfate (as SO4) in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Concentration (mg/L)
06/07/2009
18/11/2010
01/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
04/02/2019
Date
SED1
SED2

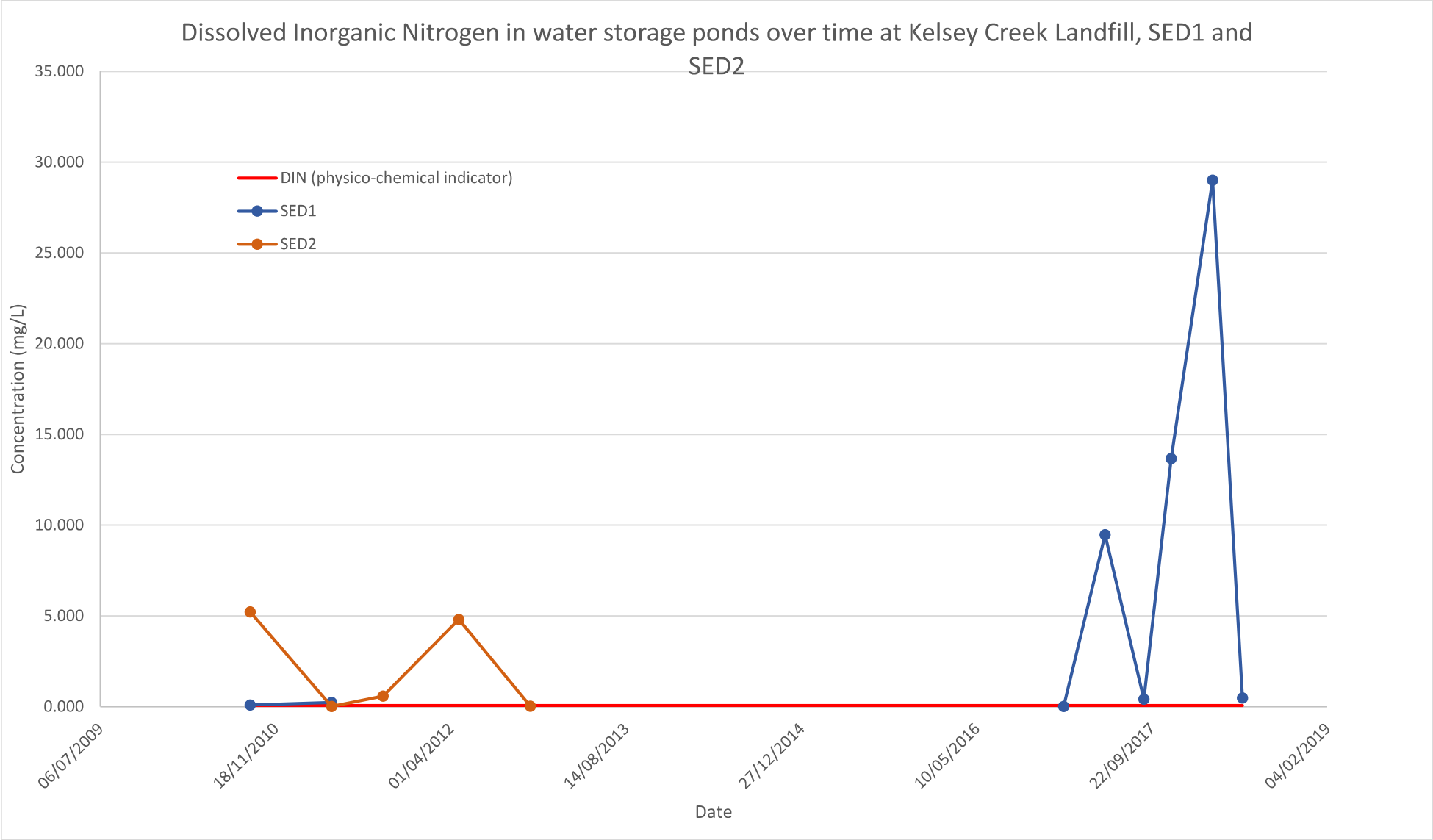

Bicarbonate Alkanlinity (as CaHCO3) in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
500
450
400
350
300
250
200
150
100
50
0
06/07/2009
18/11/2010
01/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
04/02/2019
Date
SED1
SED2

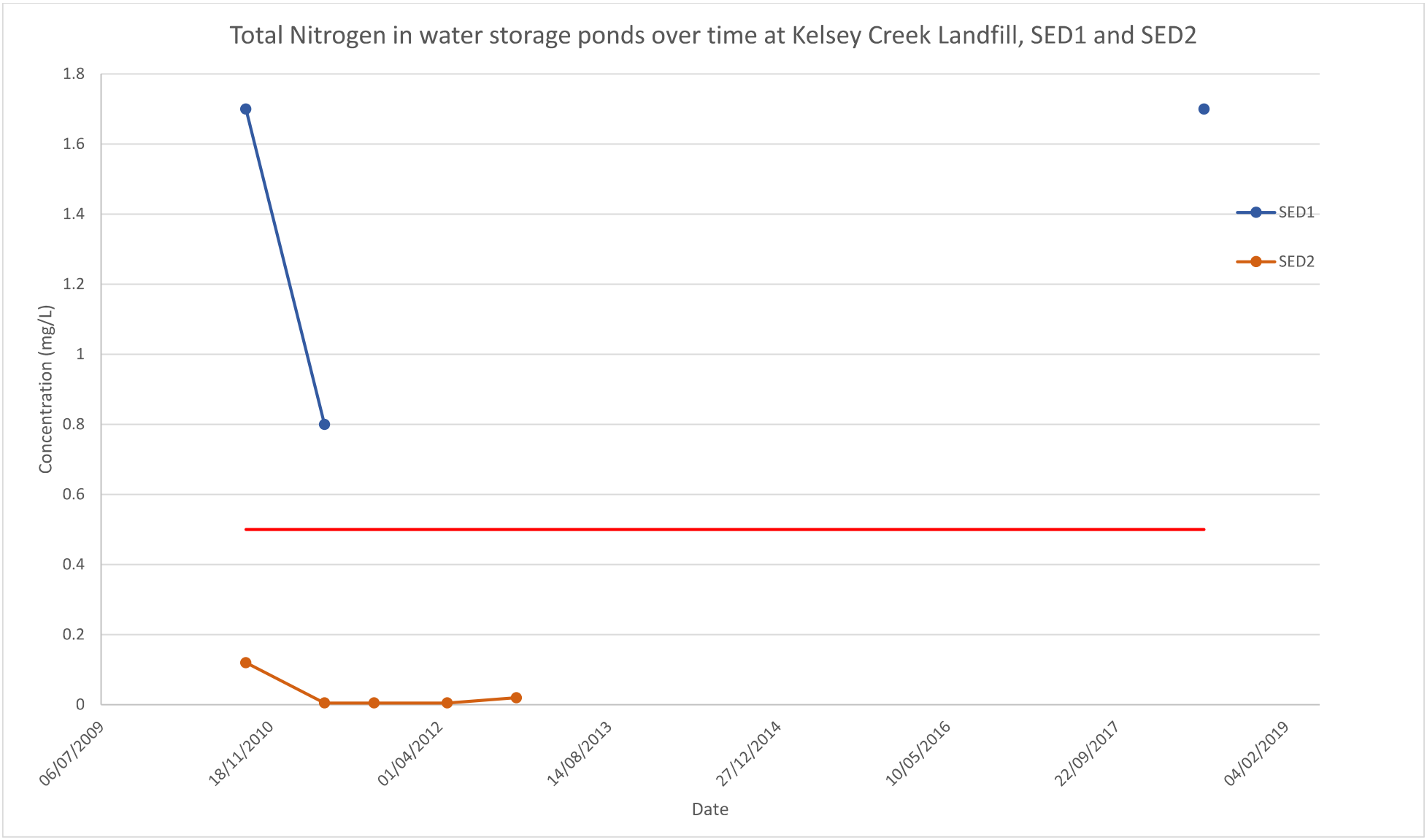

Carbonate Alkanlinity (as CaCO3) in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
120
100
80
60
40
20
0
Concentration (mg/L)
06/07/2009
18/11/2010
01/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
04/02/2019
Date
SED1
SED2

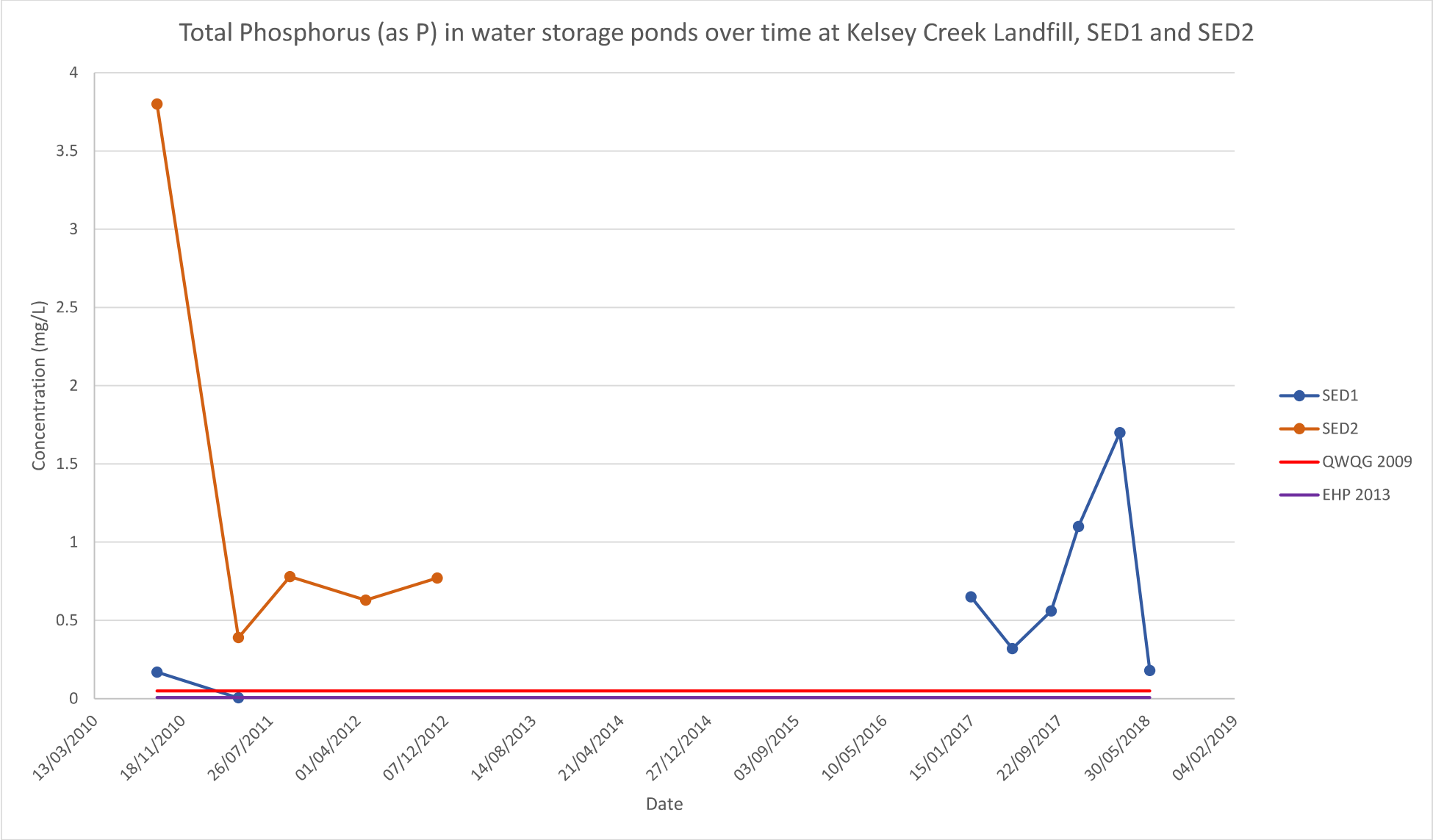

Total Alkanlinity (as CaCO3) in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
06/07/2009
18/11/2010
01/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
04/02/2019
Date
SED1
SED2

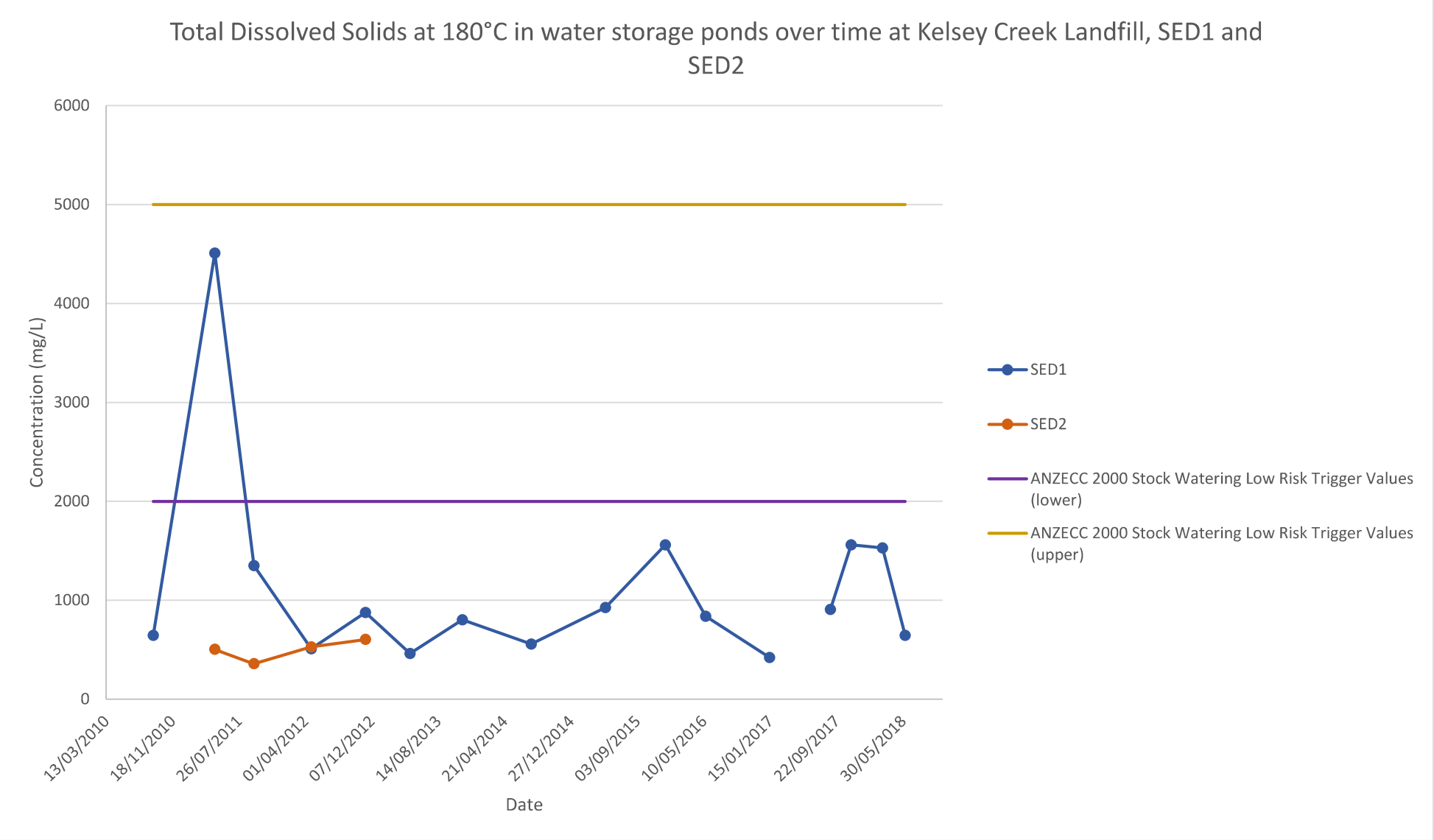

Total Oxidised Nitrogen in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
06/07/2009
18/11/2010
01/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
04/02/2019
Date
SED1
SED2

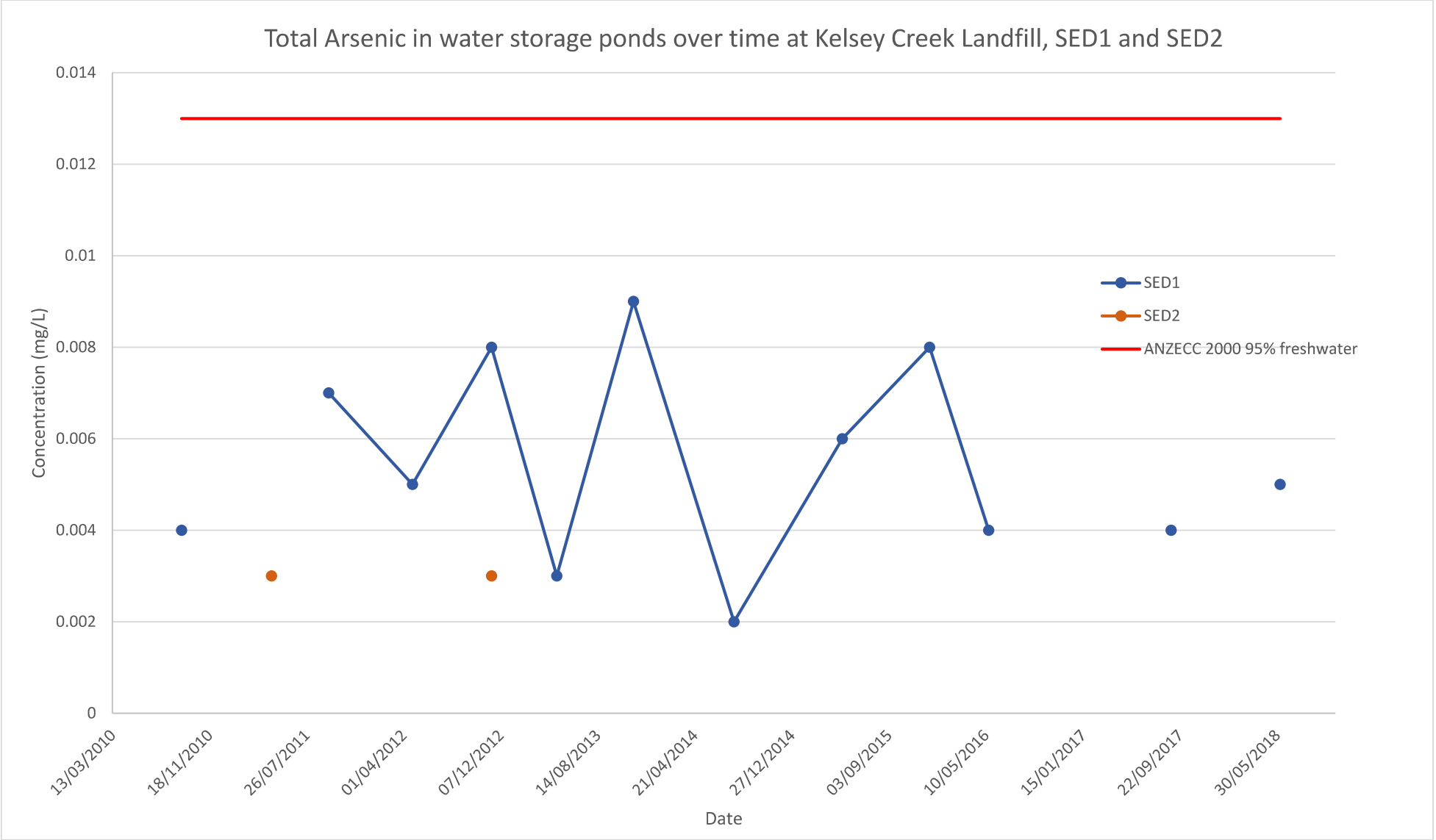

Ammonia in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
ANZECC 2000 Freshwater 95%
SED1
SED2
Ammonia (physico-chemical indicator)
Concentration (mg/L)
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
06/07/2009
13/03/2010
18/11/2010
26/07/2011
01/04/2012
07/12/2012
14/08/2013
21/04/2014
27/12/2014
03/09/2015
10/05/2016
15/01/2017
22/09/2017
30/05/2018
Date

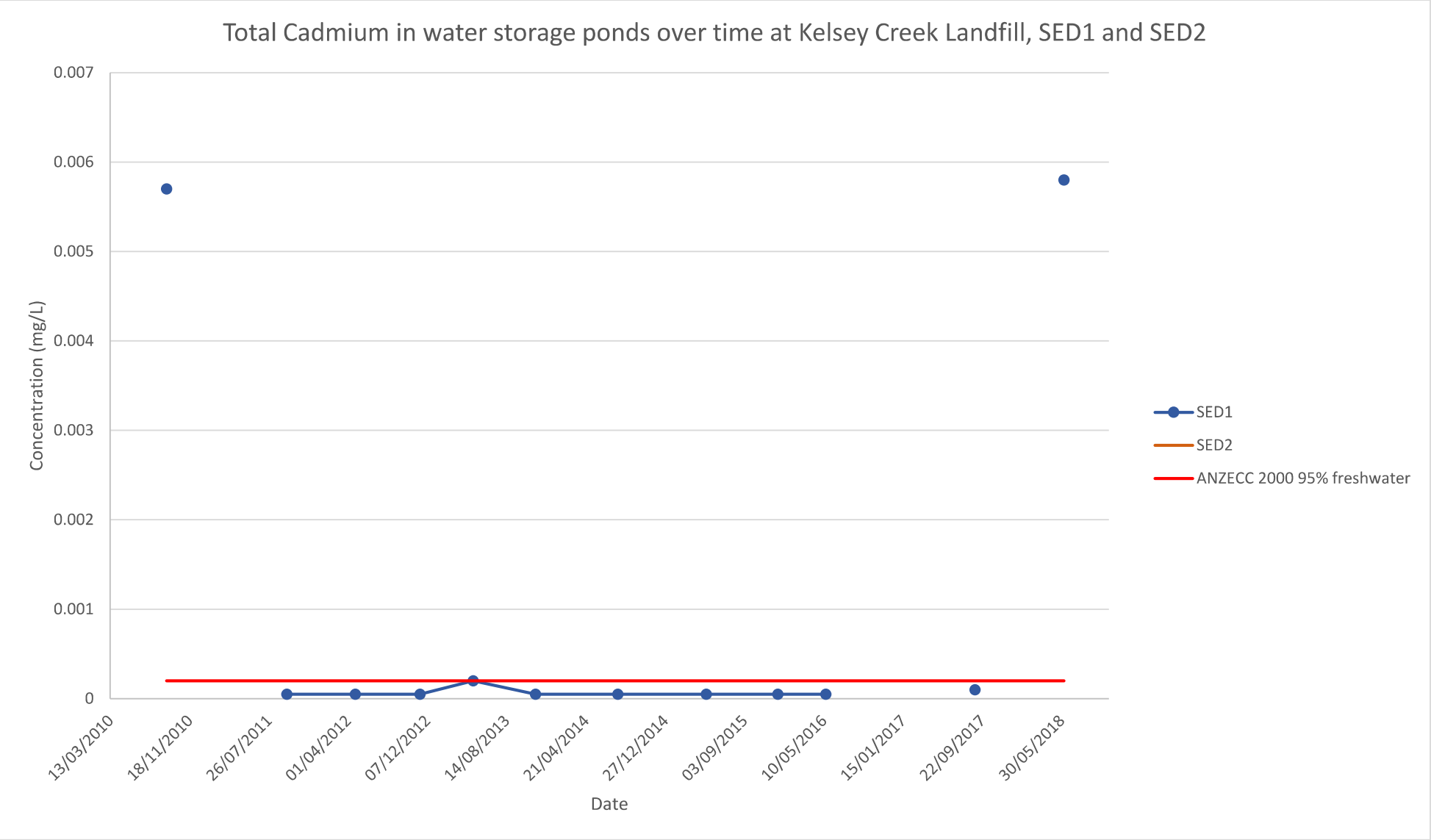

Dissolved Inorganic Nitrogen in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
35.000
30.000
25.000
20.000
15.000
10.000
5.000
0.000
Concentration (mg/L)
DIN (physico-chemical indicator)
SED1
SED2
06/07/2009
18/11/2010
01/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
04/02/2019
Date

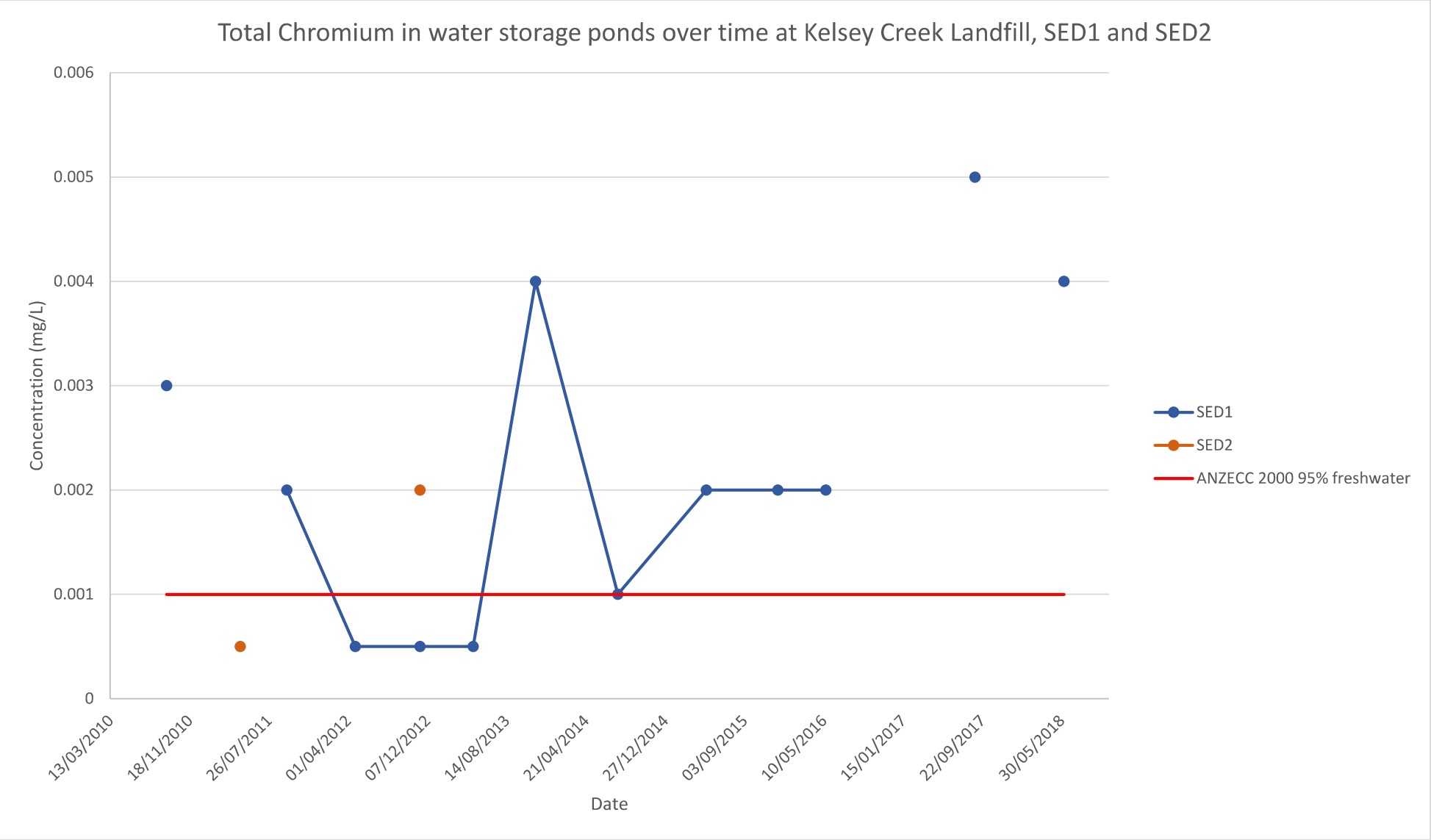

Total Nitrogen in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
SED1
SED2
06/07/2009
18/11/2010
01/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
04/02/2019
Date

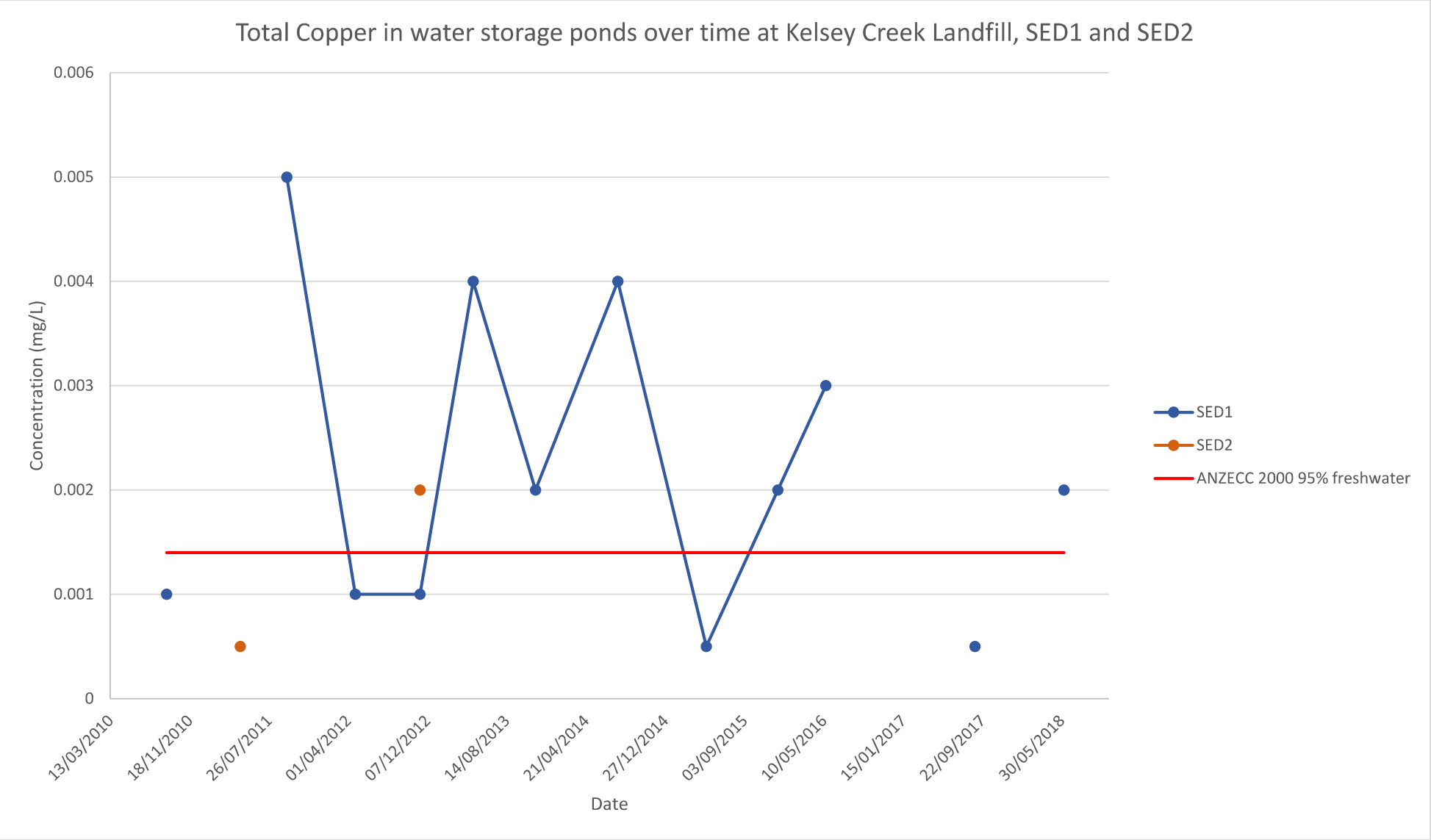

Total Phosphorus (as P) in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
4
3.5
3
2.5
2
1.5
1
0.5
0
13/03/2010
18/11/2010
26/07/2011
01/04/2012
07/12/2012
14/08/2013
21/04/2014
27/12/2014
03/09/2015
10/05/2016
15/01/2017
22/09/2017
30/05/2018
04/02/2019
Date
SED1
SED2
QWQG 2009
EHP 2013

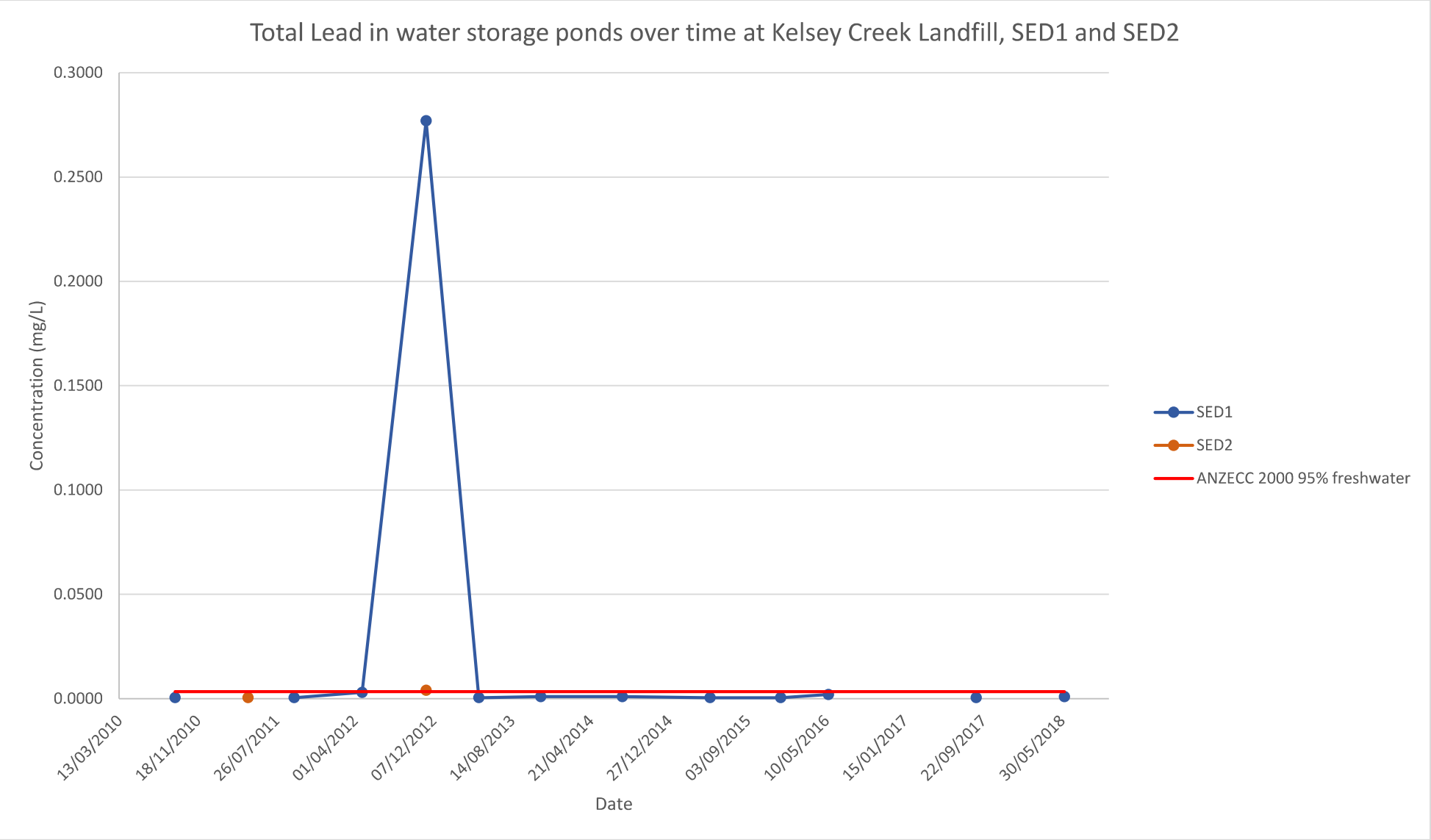

Total Dissolved Solids at 180°C in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
6000
5000
4000
3000
2000
1000
0
13/03/2010
18/11/2010
26/07/2011
01/04/2012
07/12/2012
14/08/2013
21/04/2014
27/12/2014
03/09/2015
10/05/2016
15/01/2017
22/09/2017
30/05/2018
Date
SED1
SED2
ANZECC 2000 Stock Watering Low Risk Trigger Values (lower)
ANZECC 2000 Stock Watering Low Risk Trigger Values (upper)

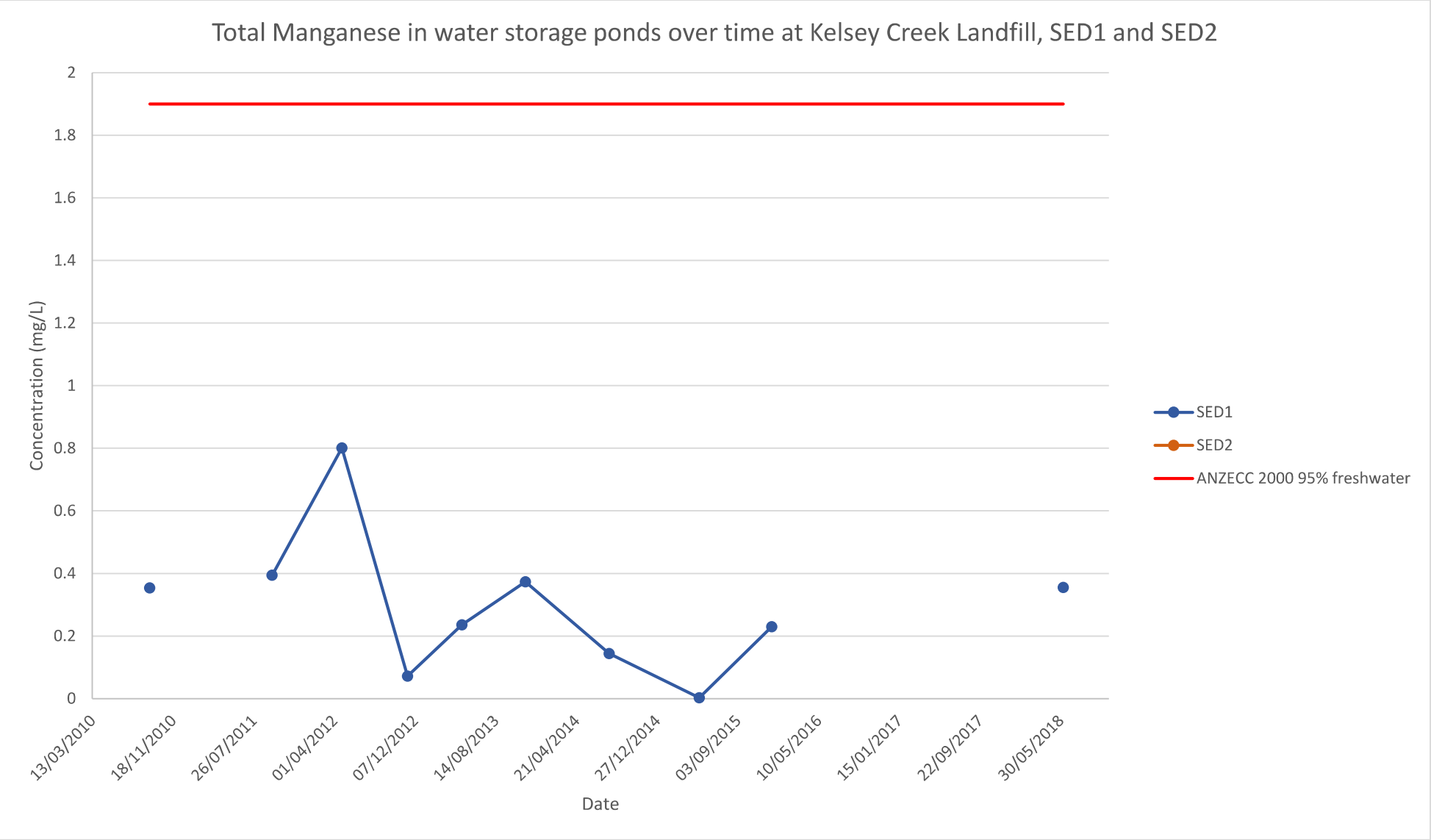

Total Arsenic in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Concentration (mg/L)
SED1
SED2
ANZECC 2000 95% freshwater
13/03/2010
18/11/2010
26/07/2011
01/04/2012
07/12/2012
14/08/2013
21/04/2014
27/12/2014
03/09/2015
10/05/2016
15/01/2017
22/09/2017
30/05/2018
Date

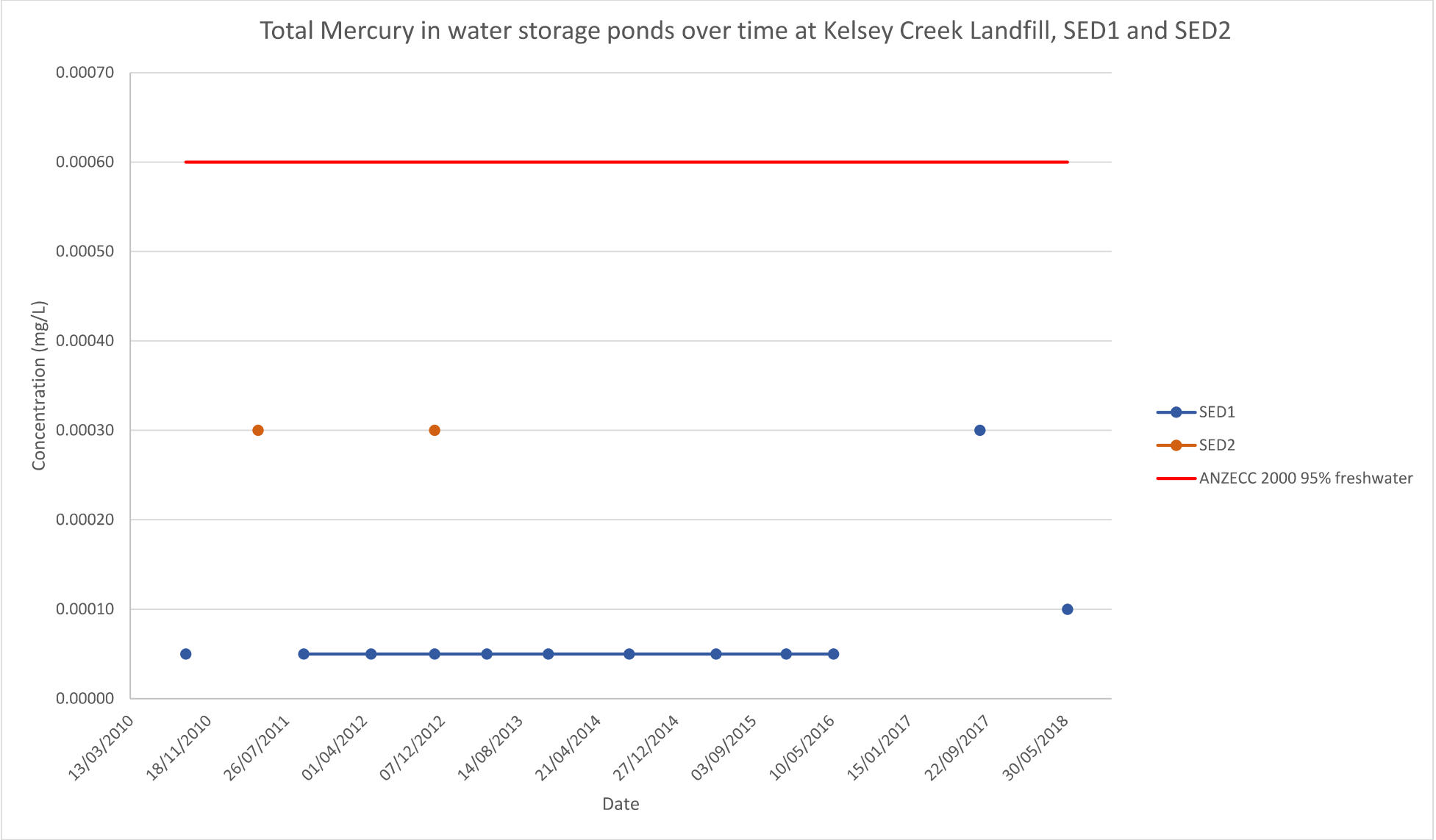

Total Cadmium in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0
13/03/2010
18/11/2010
26/07/2011
01/04/2012
07/12/2012
14/08/2013
21/04/2014
27/12/2014
03/09/2015
10/05/2016
15/01/2017
22/09/2017
30/05/2018
Date
SED1
SED2
ANZECC 2000 95% freshwater

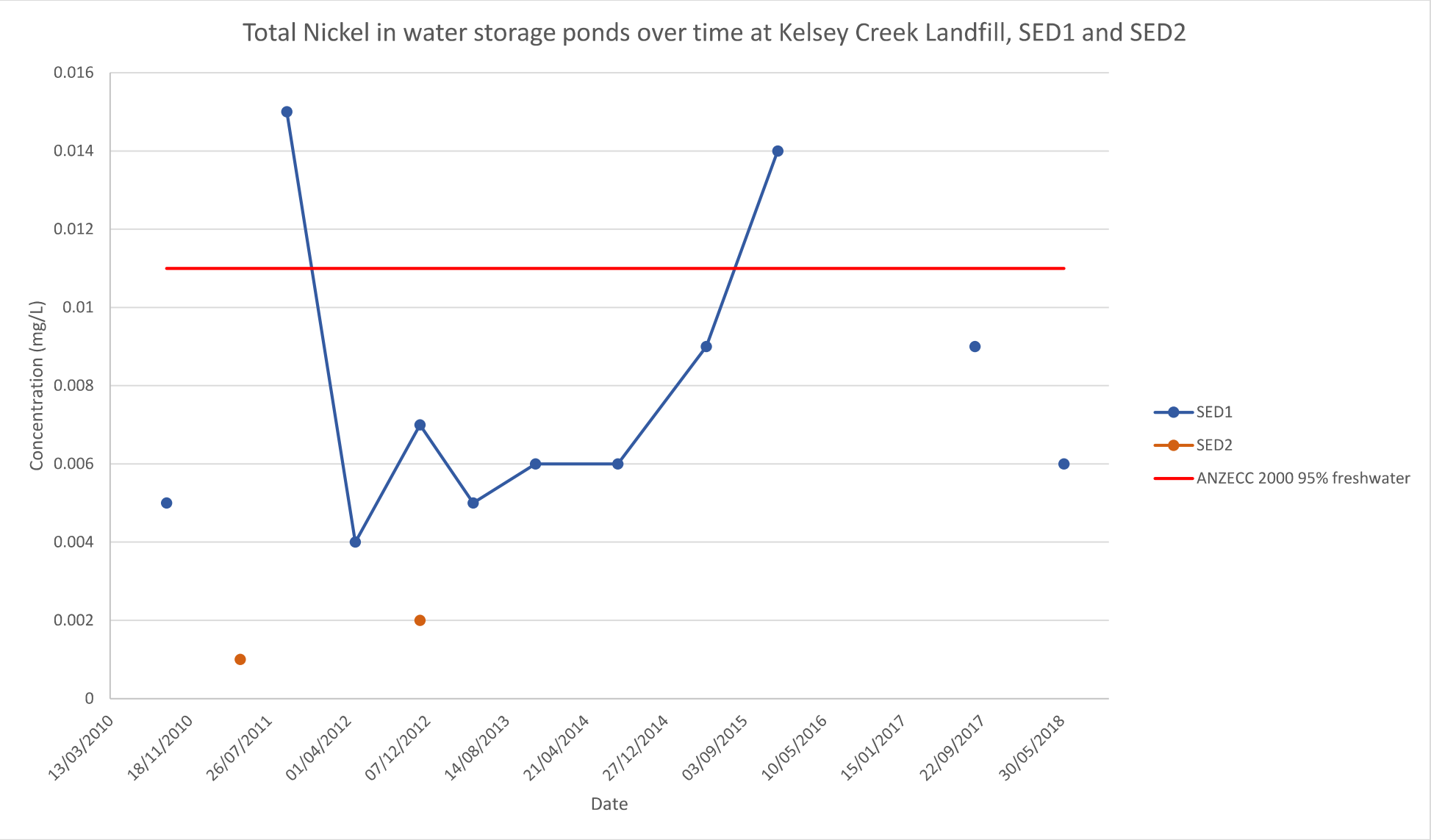

Total Chromium in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
0.006
0.005
0.004
0.003
0.002
0.001
0
13/03/2010
18/11/2010
26/07/2011
01/04/2012
07/12/2012
14/08/2013
21/04/2014
27/12/2014
03/09/2015
10/05/2016
15/01/2017
22/09/2017
30/05/2018
Date
SED1
SED2
ANZECC 2000 95% freshwater

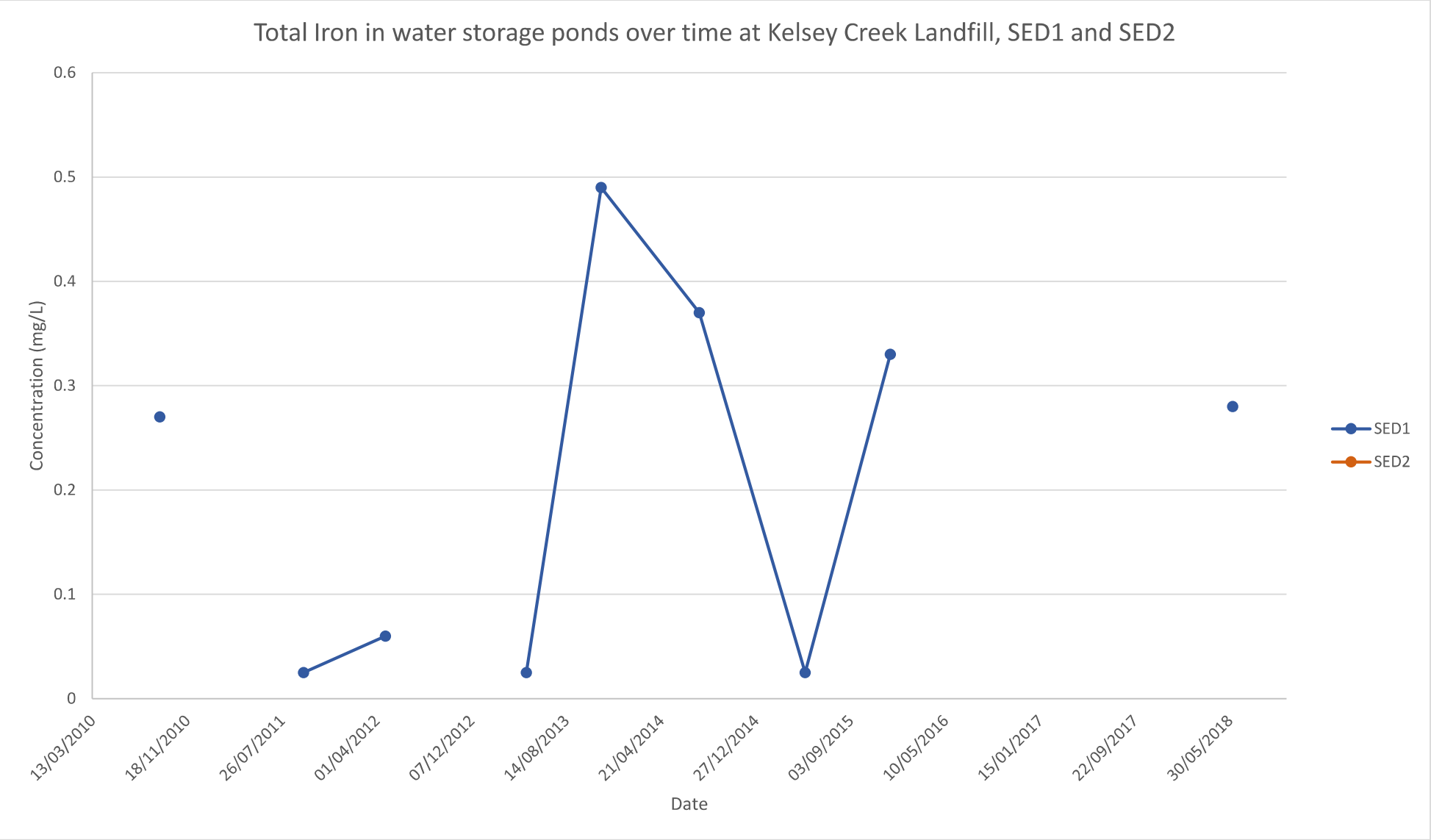

Total Copper in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
0.006
0.005
0.004
0.003
0.002
0.001
0
13/03/2010
18/11/2010
26/07/2011
01/04/2012
07/12/2012
14/08/2013
21/04/2014
27/12/2014
03/09/2015
10/05/2016
15/01/2017
22/09/2017
30/05/2018
Date
SED1
SED2
ANZECC 2000 95% freshwater


Total Lead in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
Concentration (mg/L)
13/03/2010
18/11/2010
26/07/2011
01/04/2012
07/12/2012
14/08/2013
21/04/2014
27/12/2014
03/09/2015
10/05/2016
15/01/2017
22/09/2017
30/05/2018
Date
SED1
SED2
ANZECC 2000 95% freshwater

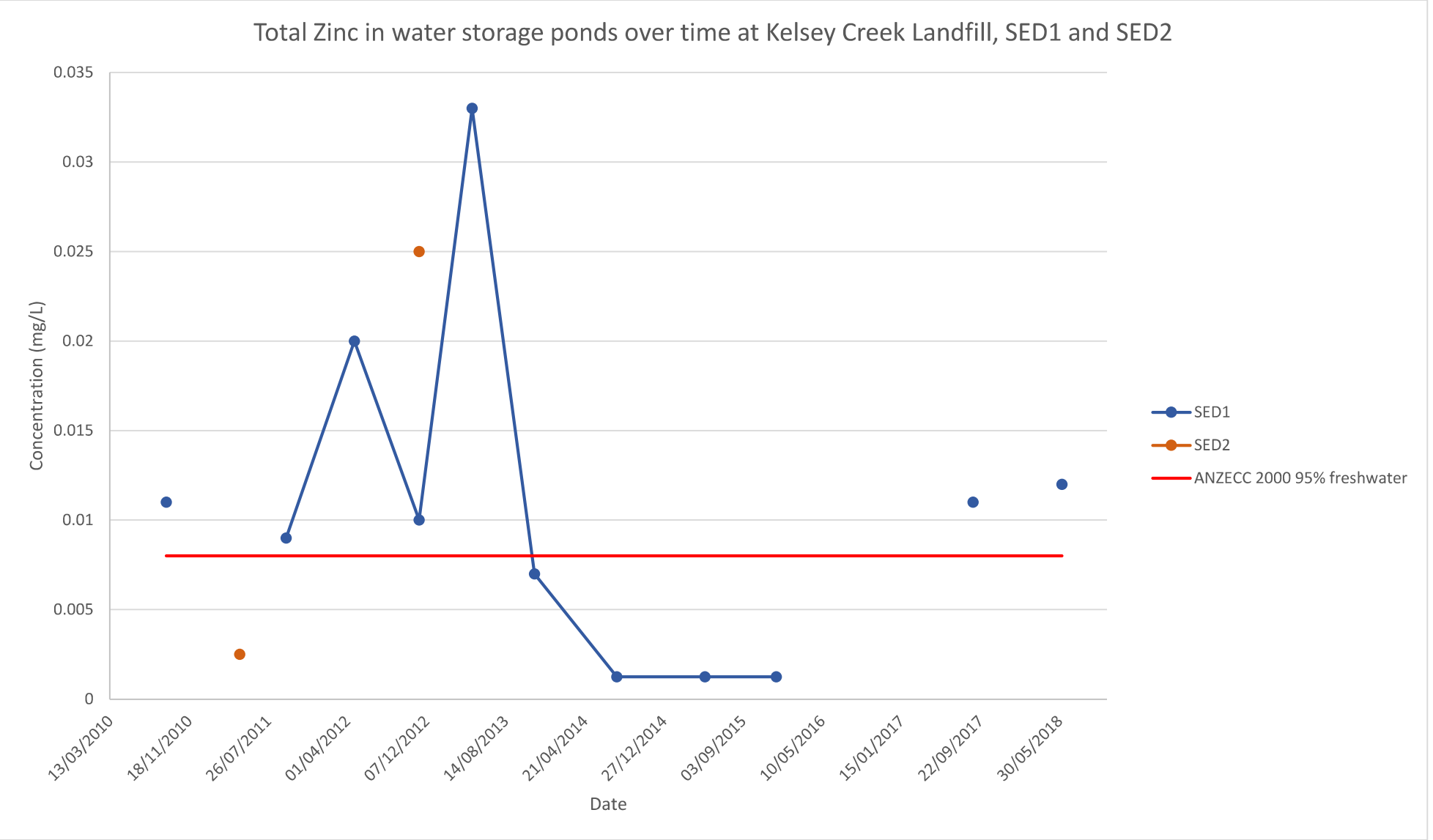

Total Manganese in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
13/03/2010
18/11/2010
26/07/2011
01/04/2012
07/12/2012
14/08/2013
21/04/2014
27/12/2014
03/09/2015
10/05/2016
15/01/2017
22/09/2017
30/05/2018
Date
SED1
SED2
ANZECC 2000 95% freshwater


Total Mercury in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
0.00070
0.00060
0.00050
0.00040
0.00030
0.00020
0.00010
0.00000
Concentration (mg/L)
13/03/2010
18/11/2010
26/07/2011
01/04/2012
07/12/2012
14/08/2013
21/04/2014
27/12/2014
03/09/2015
10/05/2016
15/01/2017
22/09/2017
30/05/2018
Date
SED1
SED2
ANZECC 2000 95% freshwater

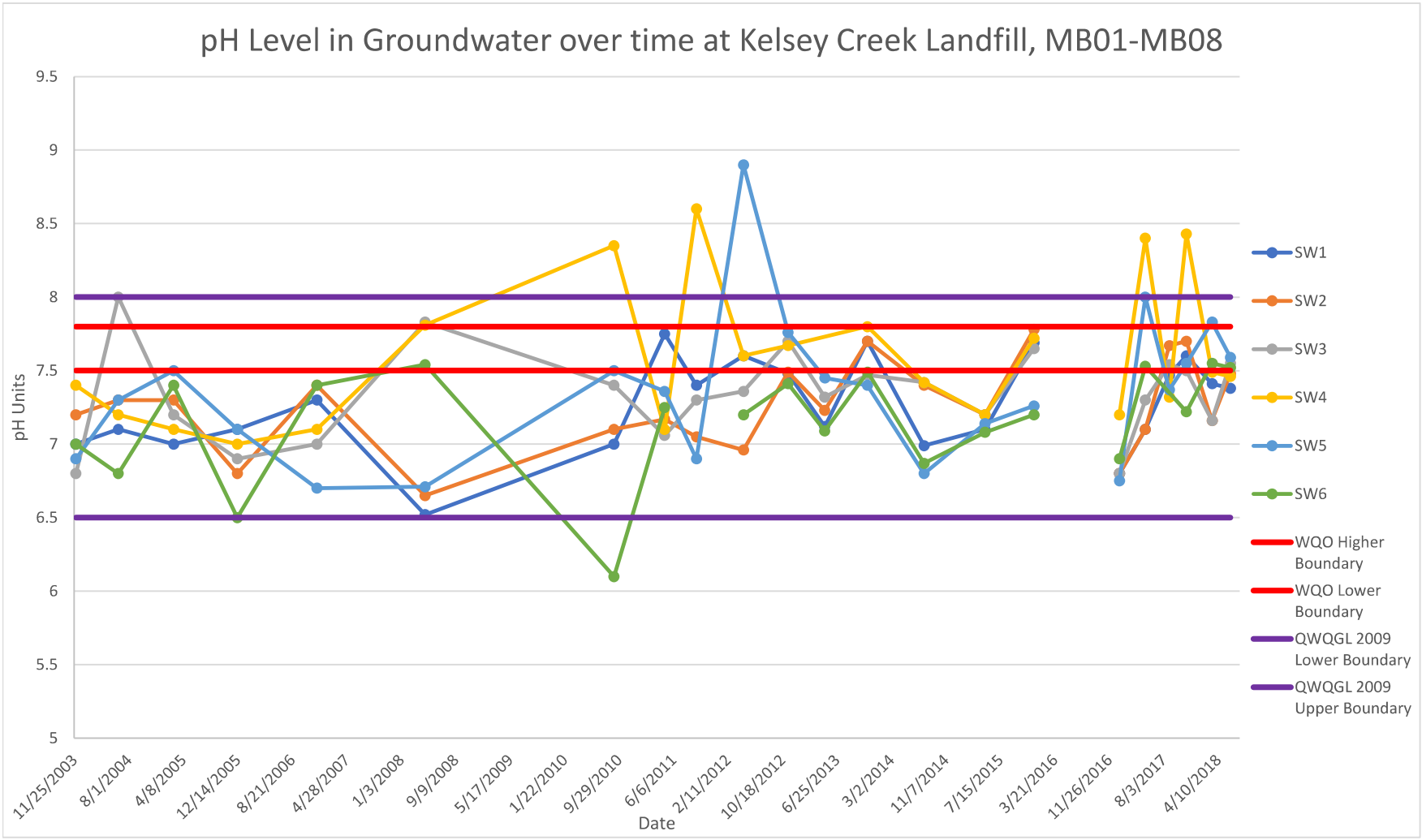

Total Nickel in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
13/03/2010
18/11/2010
26/07/2011
01/04/2012
07/12/2012
14/08/2013
21/04/2014
27/12/2014
03/09/2015
10/05/2016
15/01/2017
22/09/2017
30/05/2018
Date
SED1
SED2
ANZECC 2000 95% freshwater

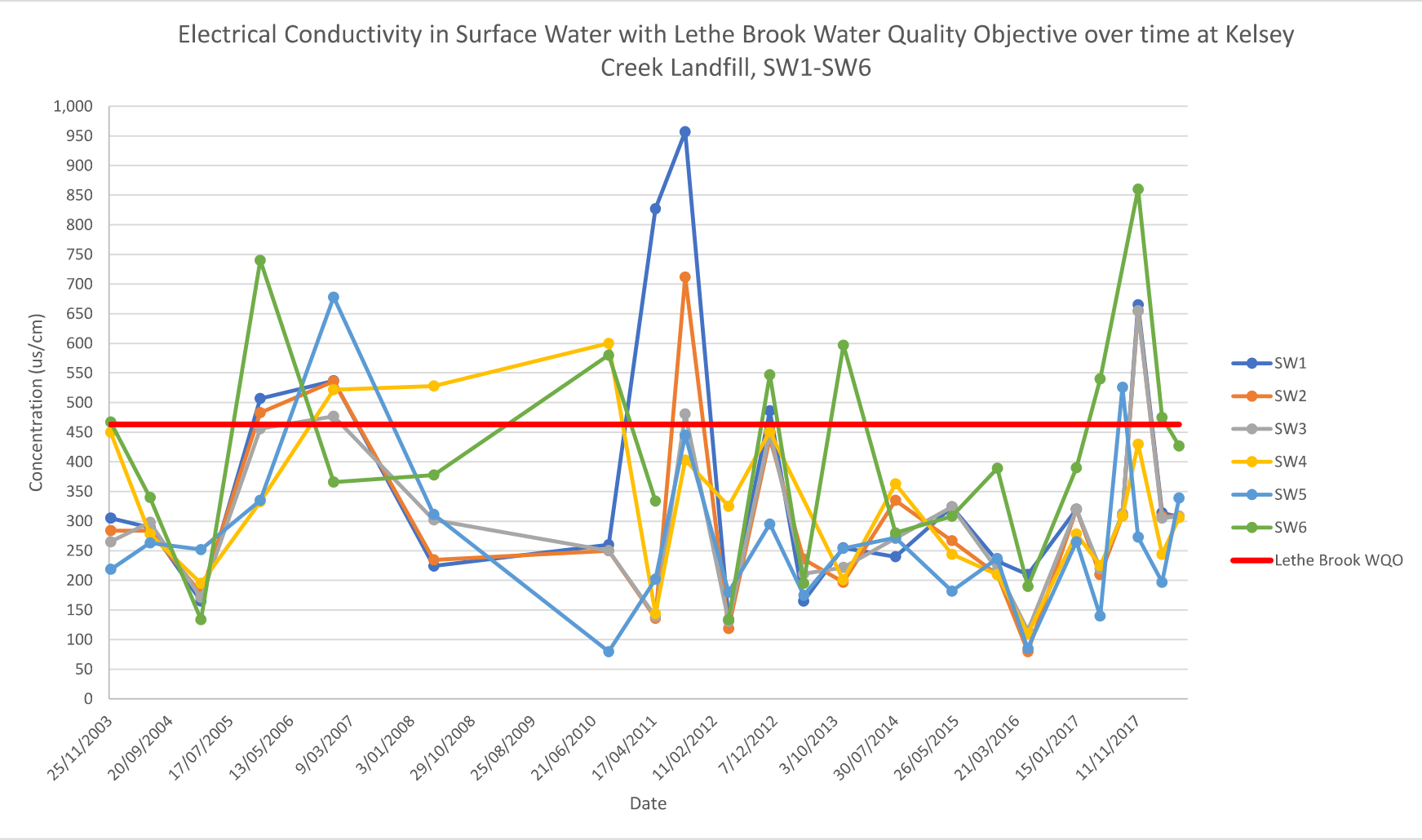

Total Iron in water storage ponds over time at Kelsey Creek Landfill, SED1 and SED2
Concentration (mg/L)
0.6
0.5
0.4
0.3
0.2
0.1
0
13/03/2010
18/11/2010
26/07/2011
01/04/2012
07/12/2012
14/08/2013
21/04/2014
27/12/2014
03/09/2015
10/05/2016
15/01/2017
22/09/2017
30/05/2018
Date
SED1
SED2

Appendix K Kelsey Creek Surface Water Graphs

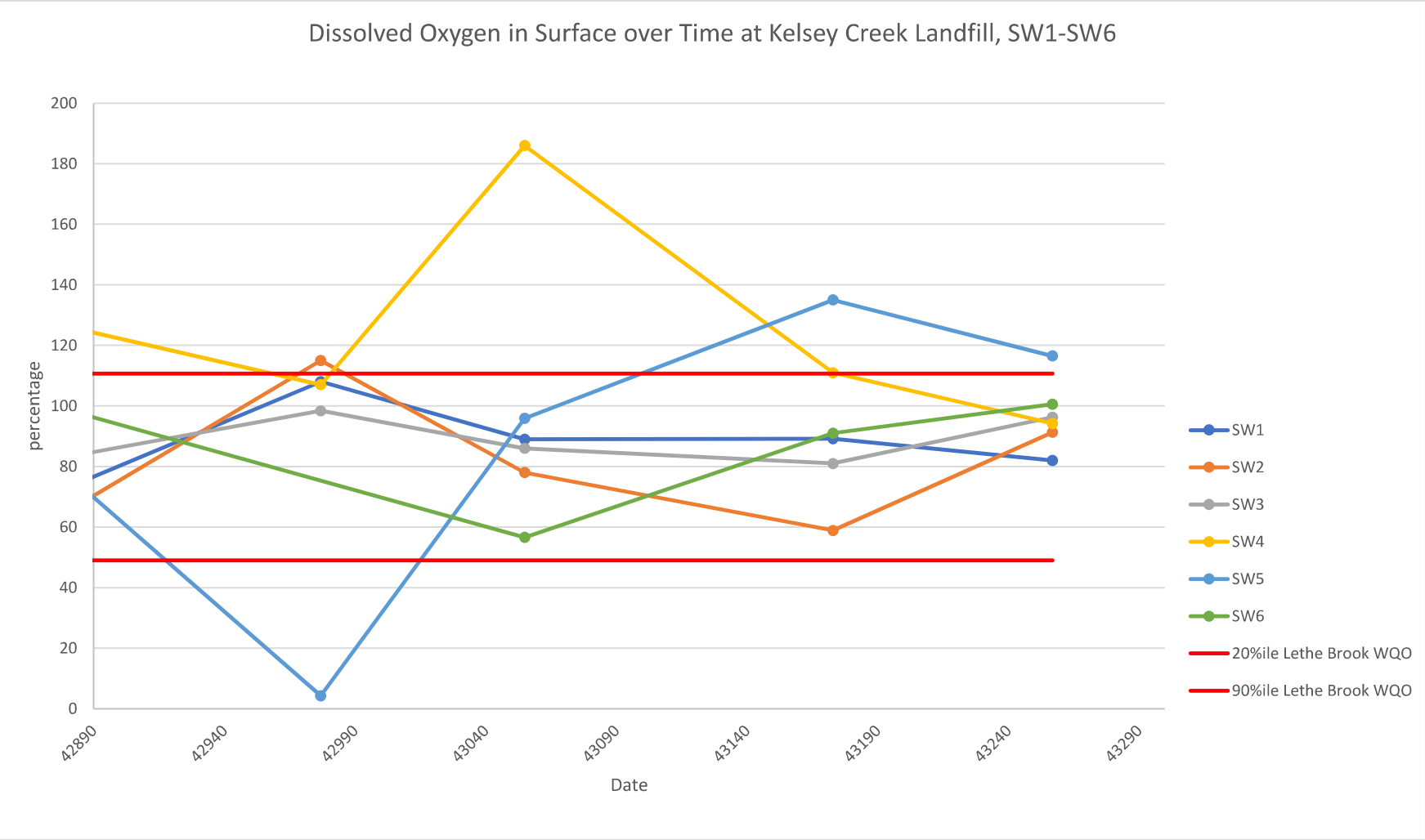


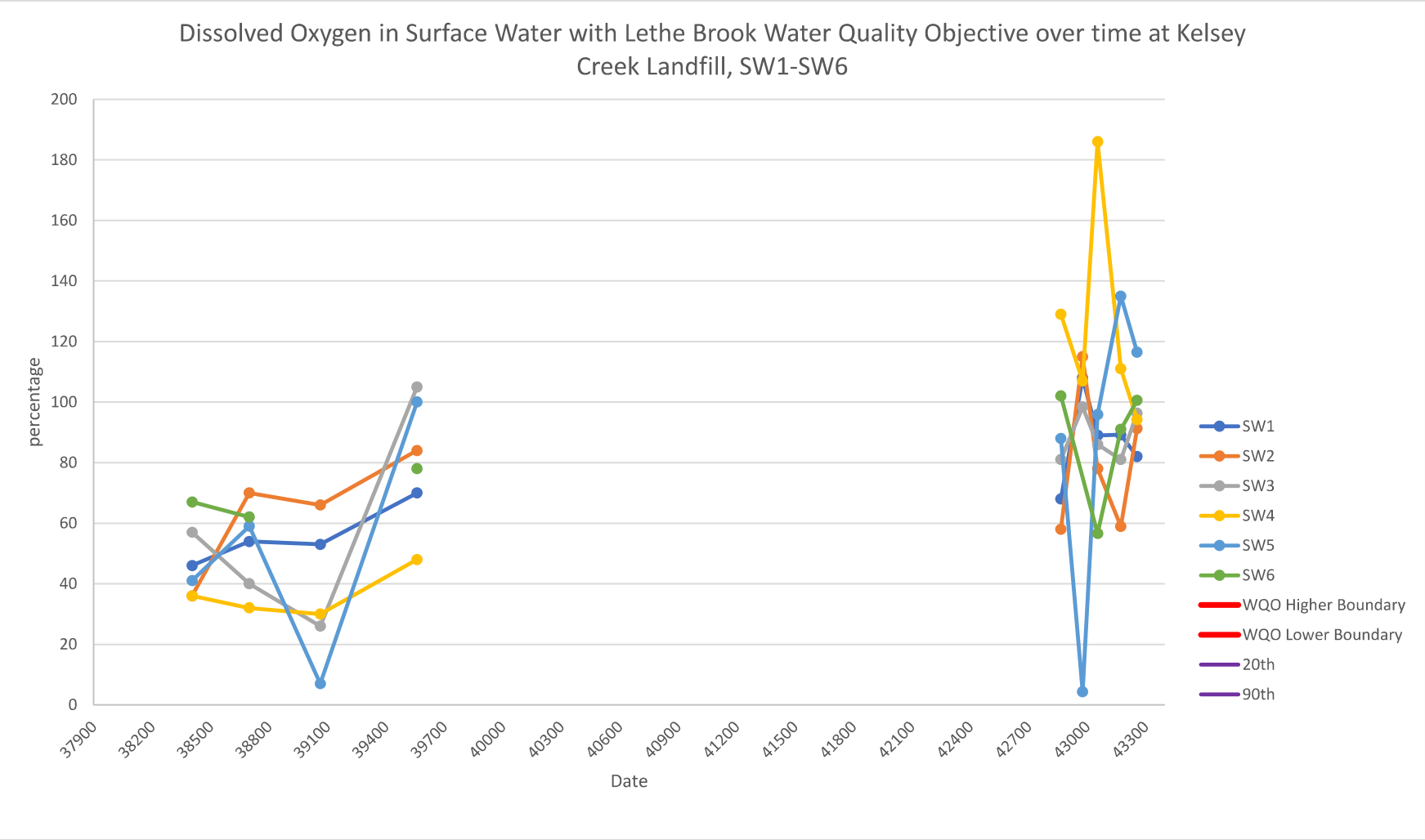
Appendix K Kelsey Creek Groundwater Graphs

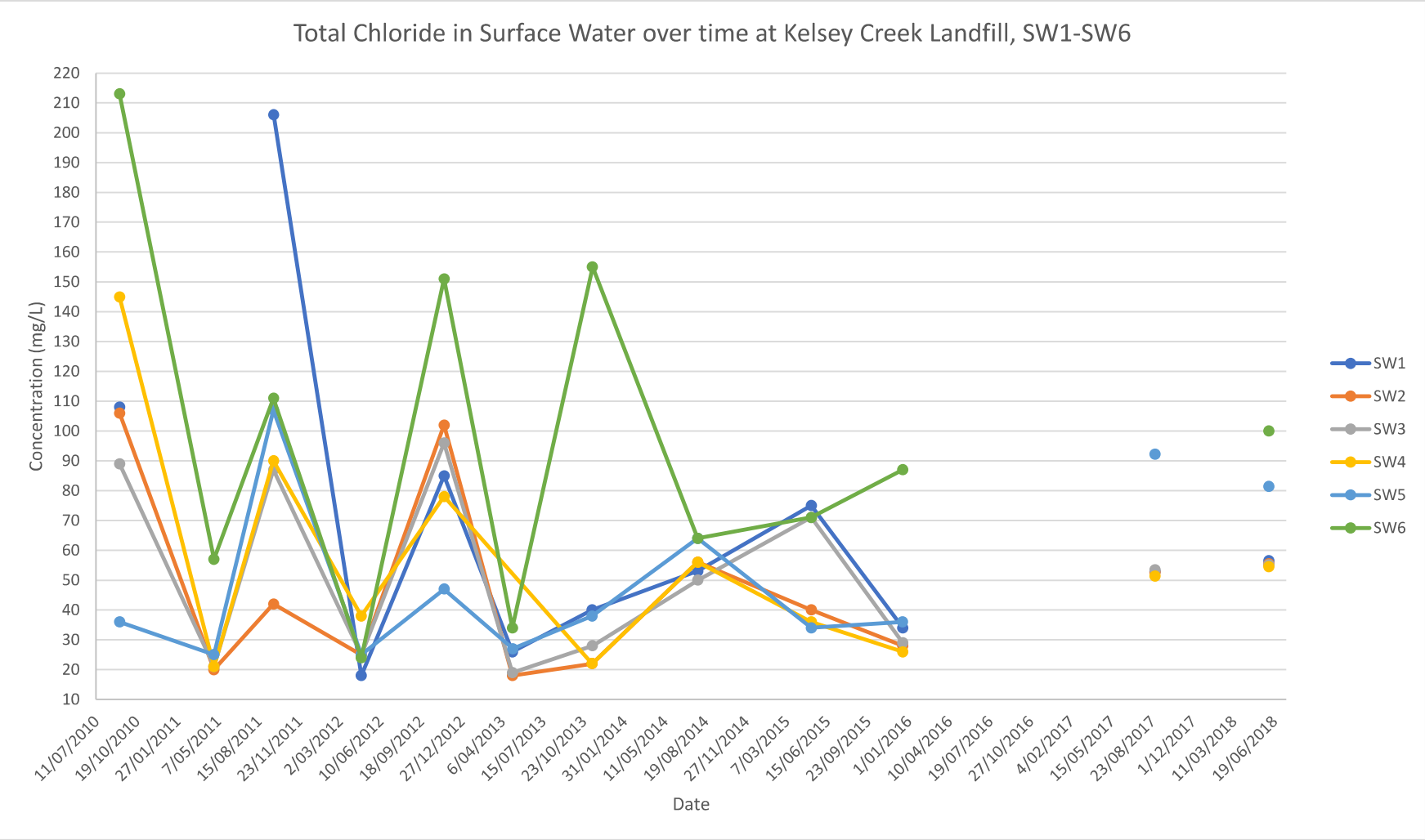


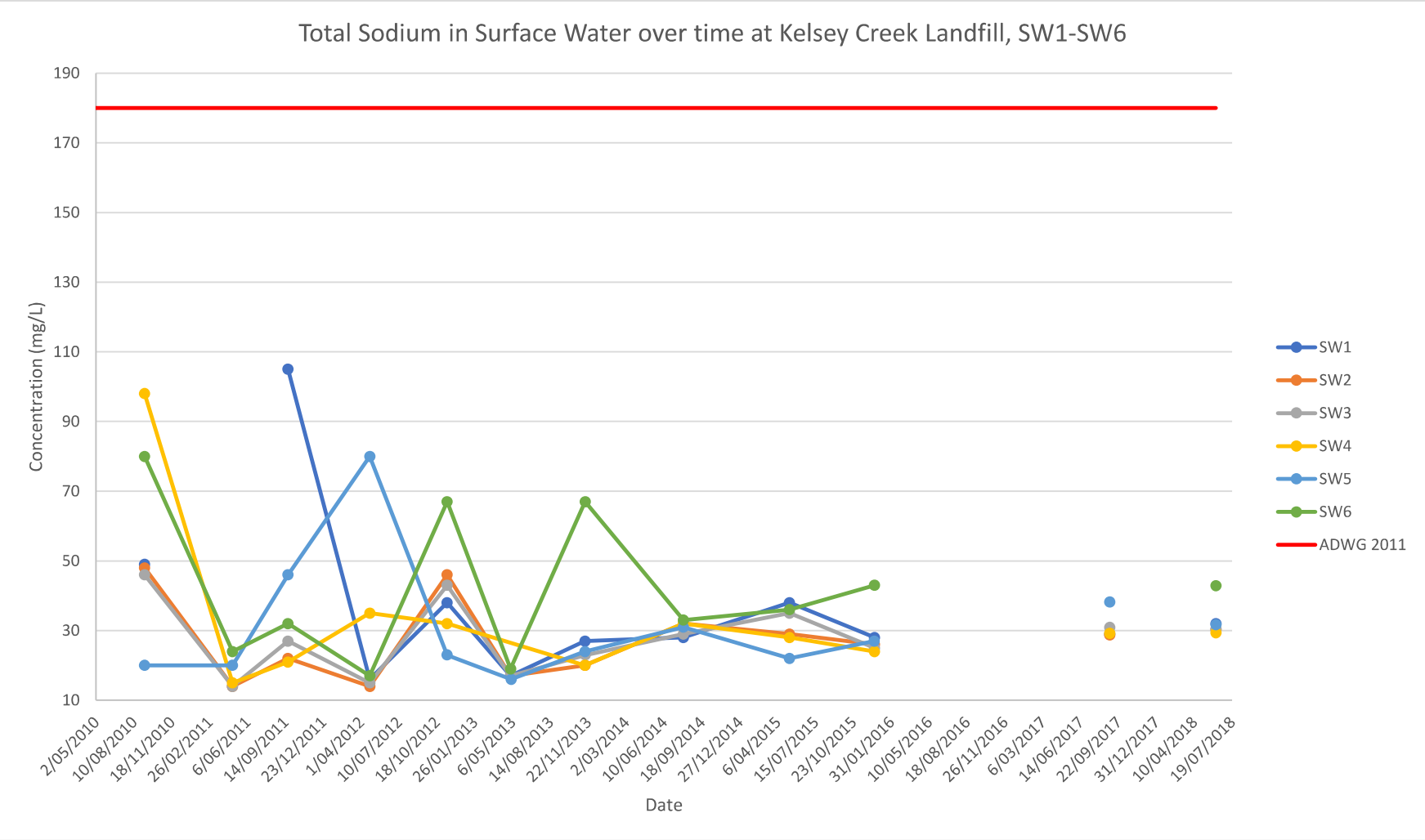

Electrical Conductivity in Surface Water with Lethe Brook Water Quality Objective over time at Kelsey Creek Landfill, SW1-SW6
Concentration (us/cm)
1,000
950
900
850
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
25/11/2003
20/09/2004
17/07/2005
13/05/2006
9/03/2007
3/01/2008
29/10/2008
25/08/2009
21/06/2010
17/04/2011
11/02/2012
7/12/2012
3/10/2013
30/07/2014
26/05/2015
21/03/2016
15/01/2017
11/11/2017
Date
SW1
SW2
SW3
SW4
SW5
SW6
Lethe Brook WQO

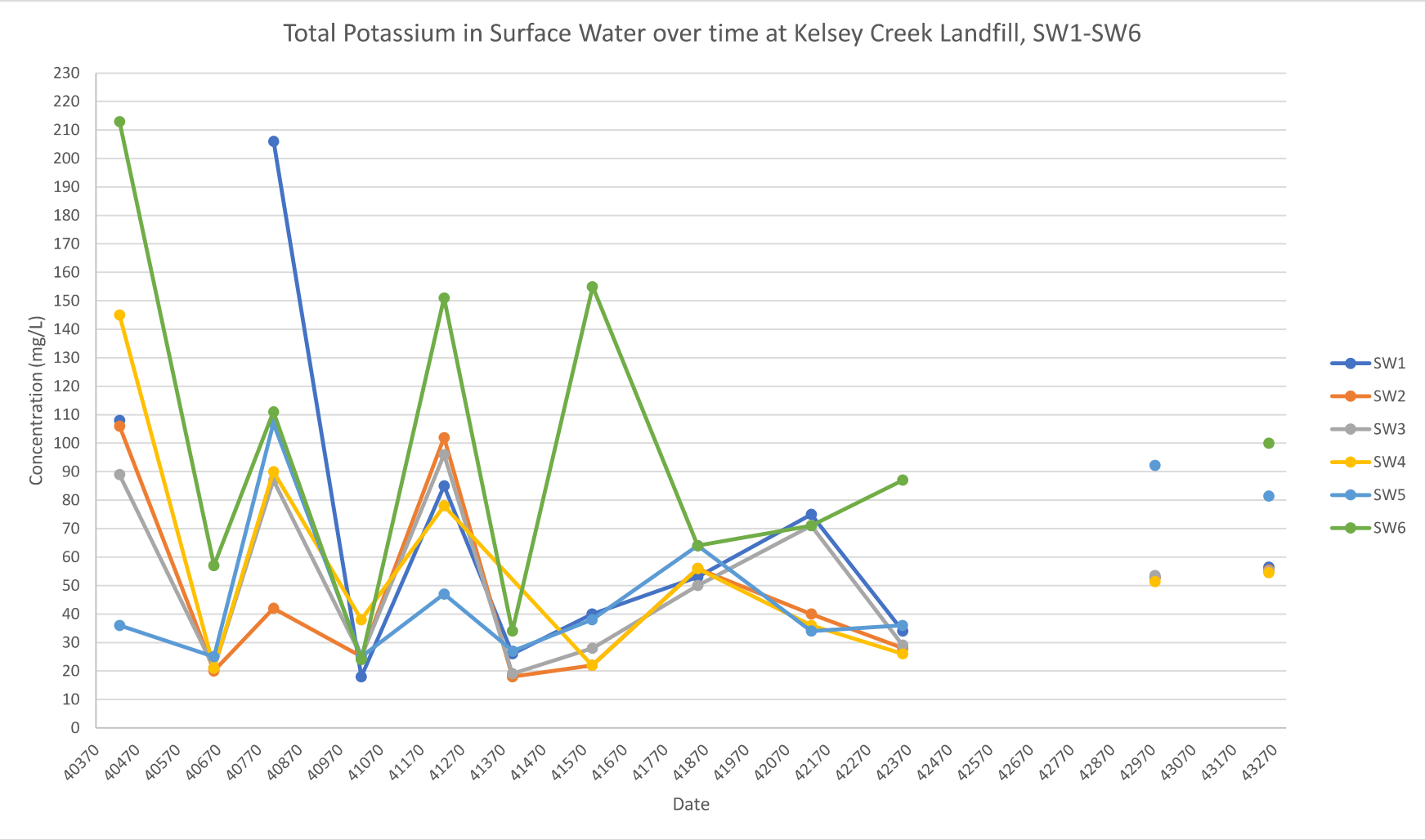
Appendix K Kelsey Creek Surface Water Graphs



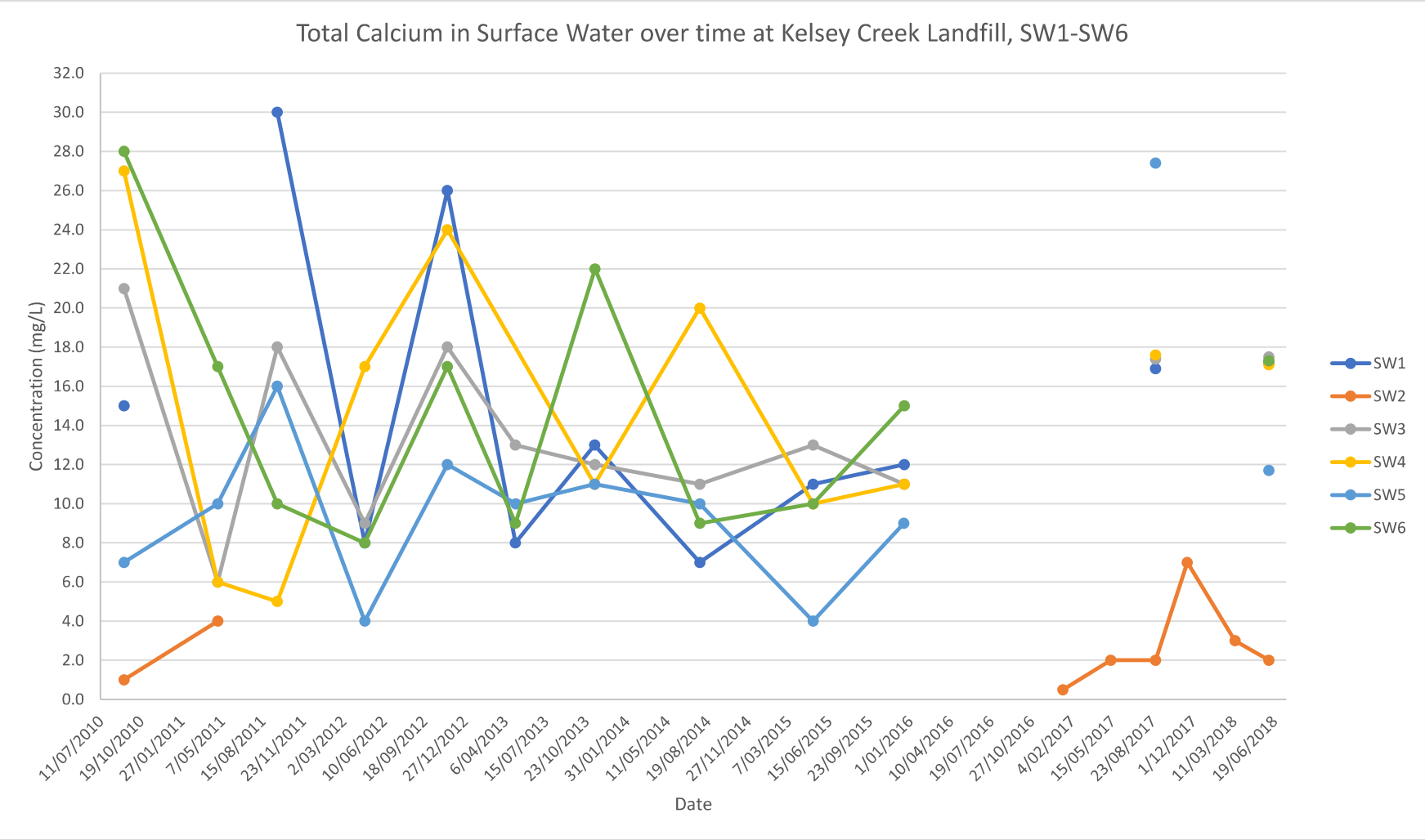

Dissolved Oxygen in Surface Water with Lethe Brook Water Quality Objective over time at Kelsey Creek Landfill, SW1-SW6
percentage
200
180
160
140
120
100
80
60
40
20
0
37900
38200
38500
38800
39100
39400
39700
40000
40300
40600
40900
41200
41500
41800
42100
42400
42700
43000
43300
Date
SW1
SW2
SW3
SW4
SW5
SW6
WQO Higher Boundary
WQO Lower Boundary
20th
90th


Total Chloride in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
11/07/2010
19/10/2010
27/01/2011
7/05/2011
15/08/2011
23/11/2011
2/03/2012
10/06/2012
18/09/2012
27/12/2012
6/04/2013
15/07/2013
23/10/2013
31/01/2014
11/05/2014
19/08/2014
27/11/2014
7/03/2015
15/06/2015
23/09/2015
1/01/2016
10/04/2016
19/07/2016
27/10/2016
4/02/2017
15/05/2017
23/08/2017
1/12/2017
11/03/2018
19/06/2018
Date
SW1
SW2
SW3
SW4
SW5
SW6

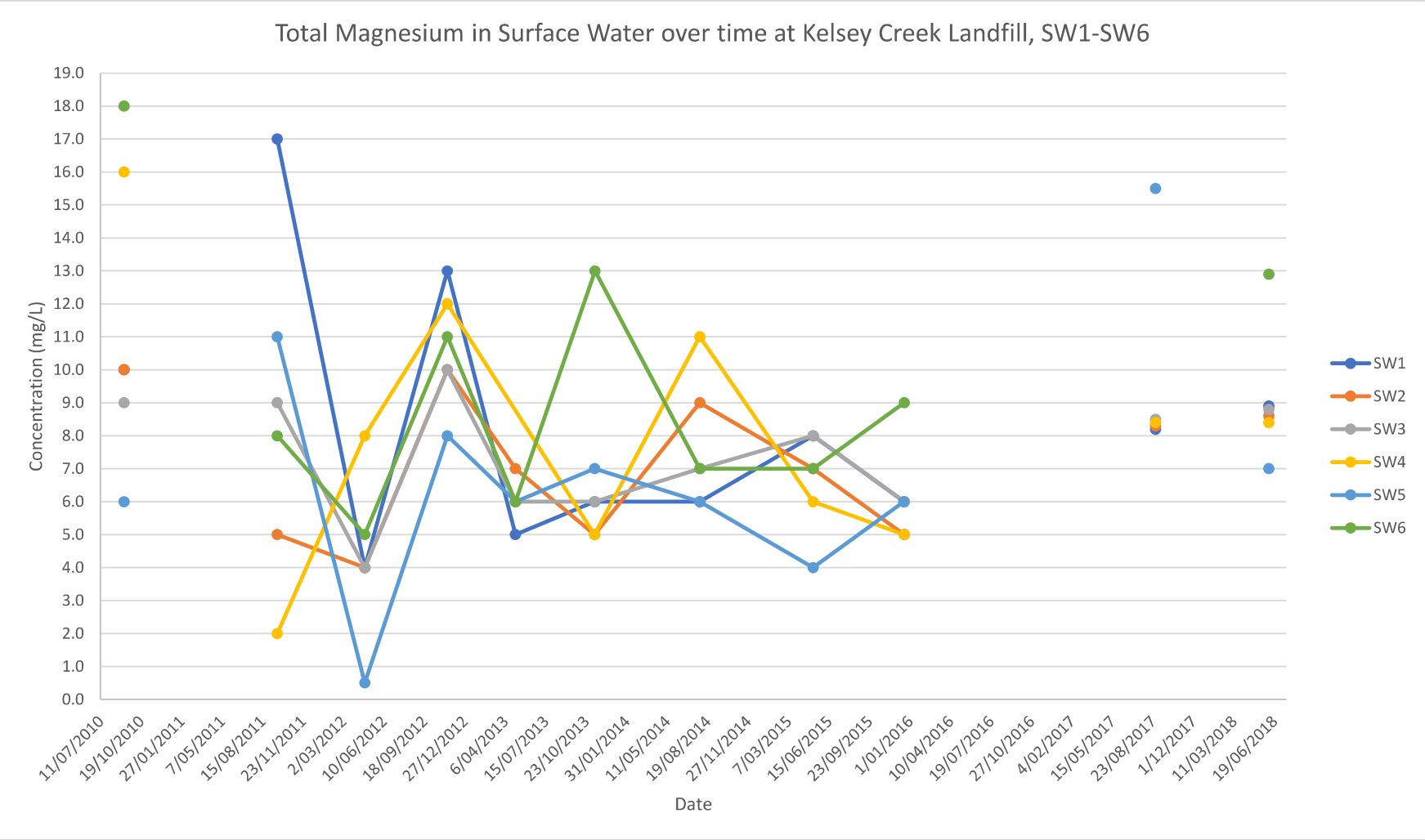

Total Sodium in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
190
170
150
130
110
90
70
50
30
10
2/05/2010
10/08/2010
18/11/2010
26/02/2011
6/06/2011
14/09/2011
23/12/2011
1/04/2012
10/07/2012
18/10/2012
26/01/2013
6/05/2013
14/08/2013
22/11/2013
2/03/2014
10/06/2014
18/09/2014
27/12/2014
6/04/2015
15/07/2015
23/10/2015
31/01/2016
10/05/2016
18/08/2016
26/11/2016
6/03/2017
14/06/2017
22/09/2017
31/12/2017
10/04/2018
19/07/2018
Date
SW1
SW2
SW3
SW4
SW5
SW6
ADWG 2011

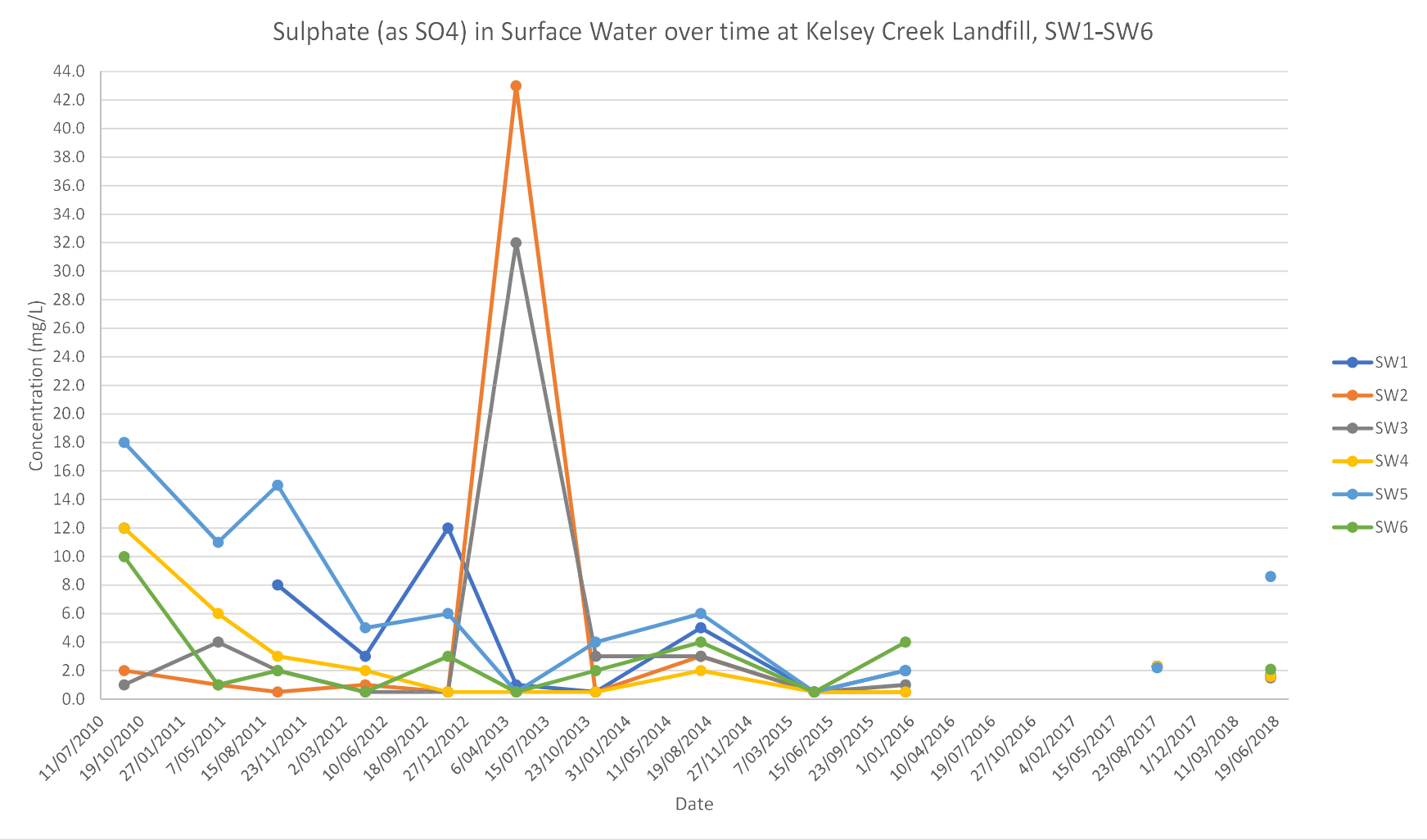

Total Potassium in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
Date
SW1
SW2
SW3
SW4
SW5
SW6

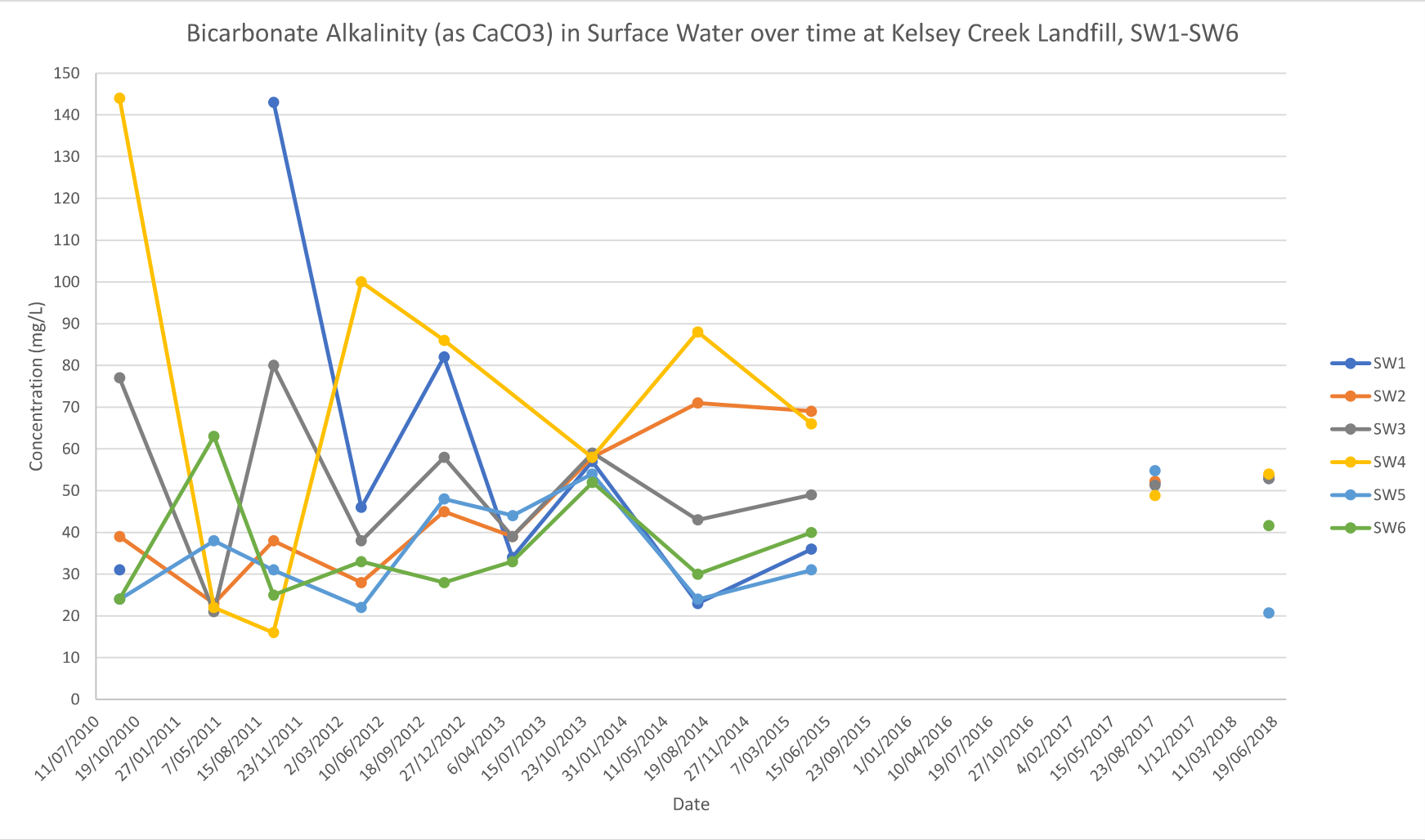
Appendix K Kelsey Creek Surface Water Graphs

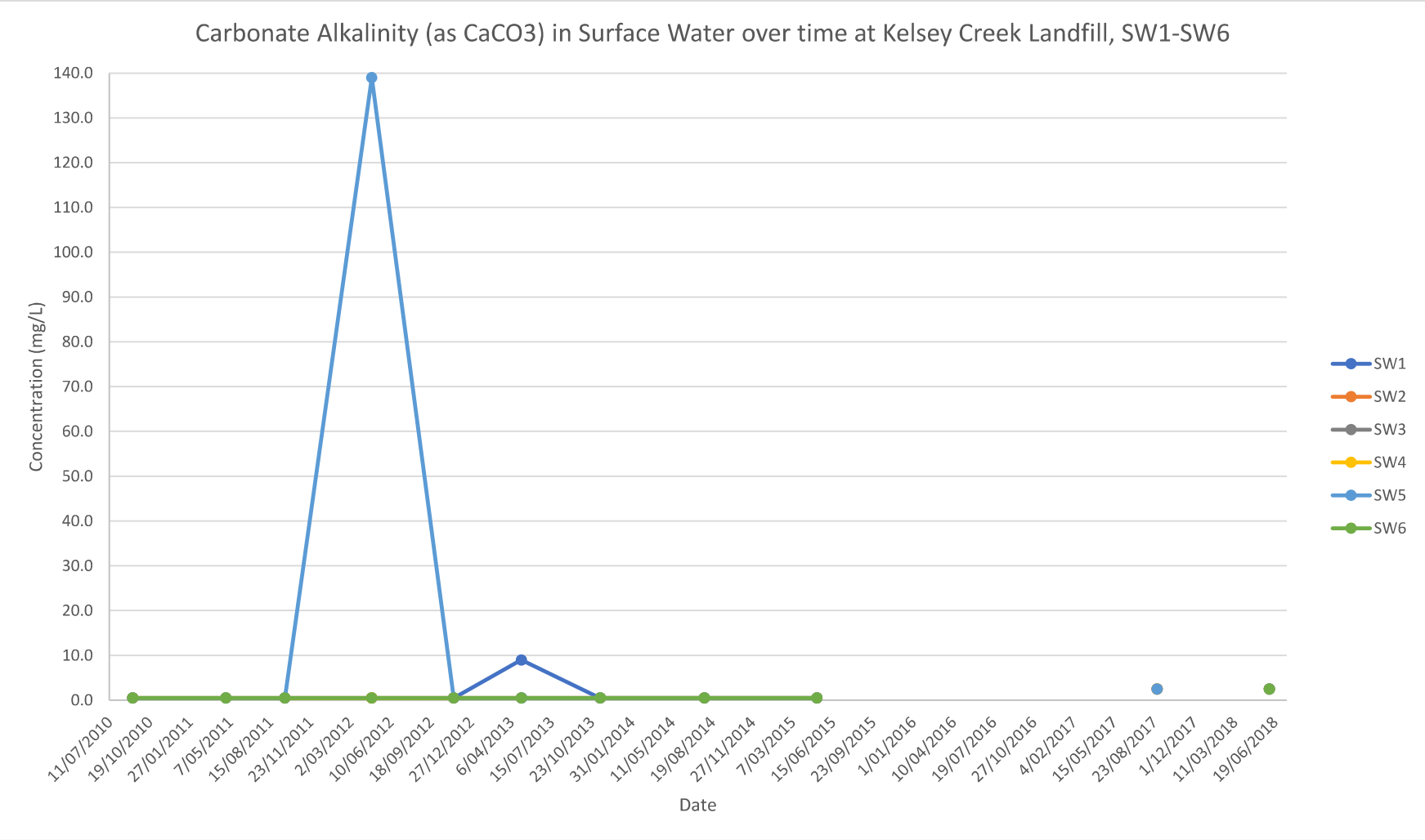


Appendix K Kelsey Creek Surface Water Graphs

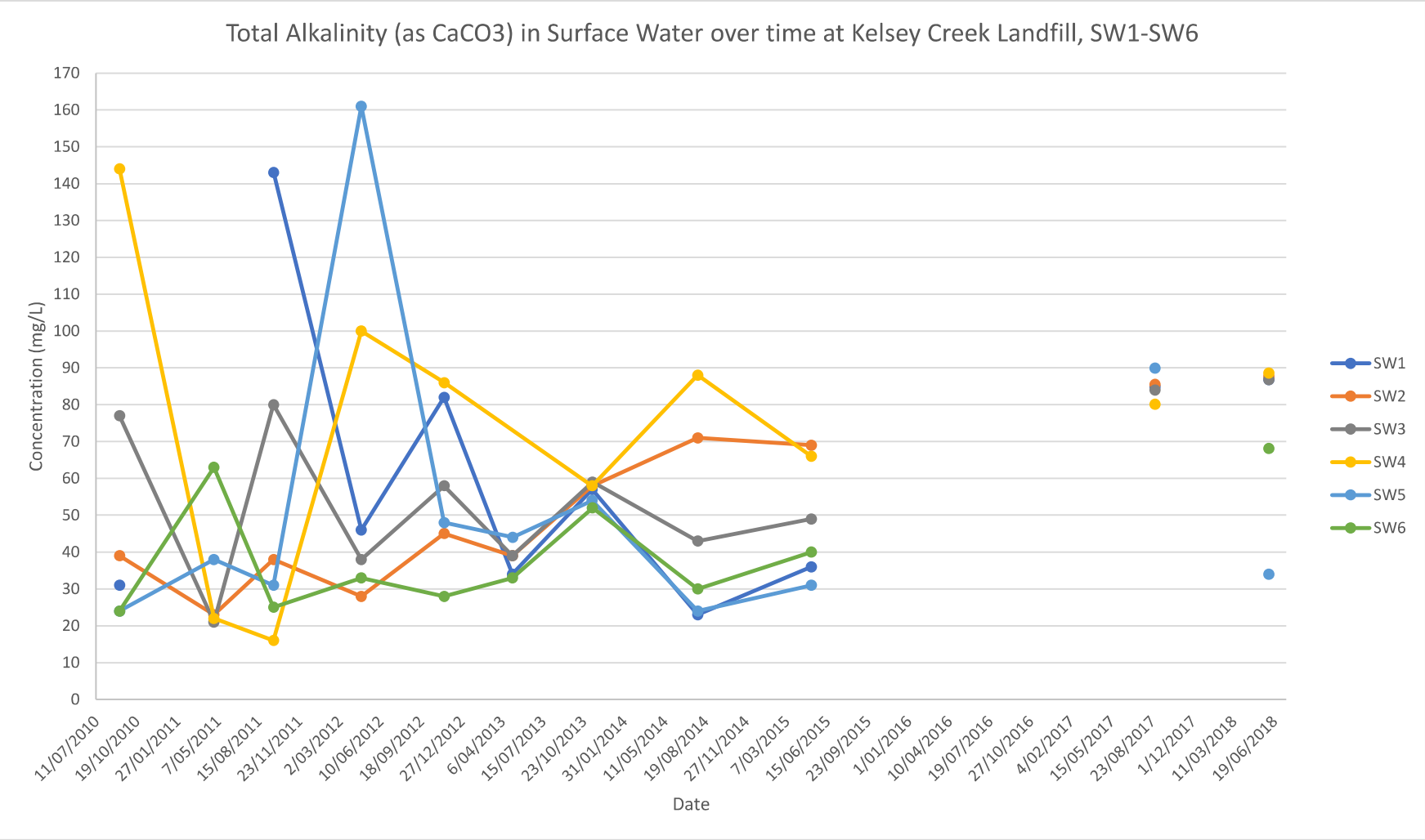



Sulphate (as SO4) in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
44.0
42.0
40.0
38.0
36.0
34.0
32.0
30.0
28.0
26.0
24.0
22.0
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
11/07/2010
19/10/2010
27/01/2011
7/05/2011
15/08/2011
23/11/2011
2/03/2012
10/06/2012
18/09/2012
27/12/2012
6/04/2013
15/07/2013
23/10/2013
31/01/2014
11/05/2014
19/08/2014
27/11/2014
7/03/2015
15/06/2015
23/09/2015
1/01/2016
10/04/2016
19/07/2016
27/10/2016
4/02/2017
15/05/2017
23/08/2017
1/12/2017
11/03/2018
19/06/2018
Date
SW1
SW2
SW3
SW4
SW5
SW6

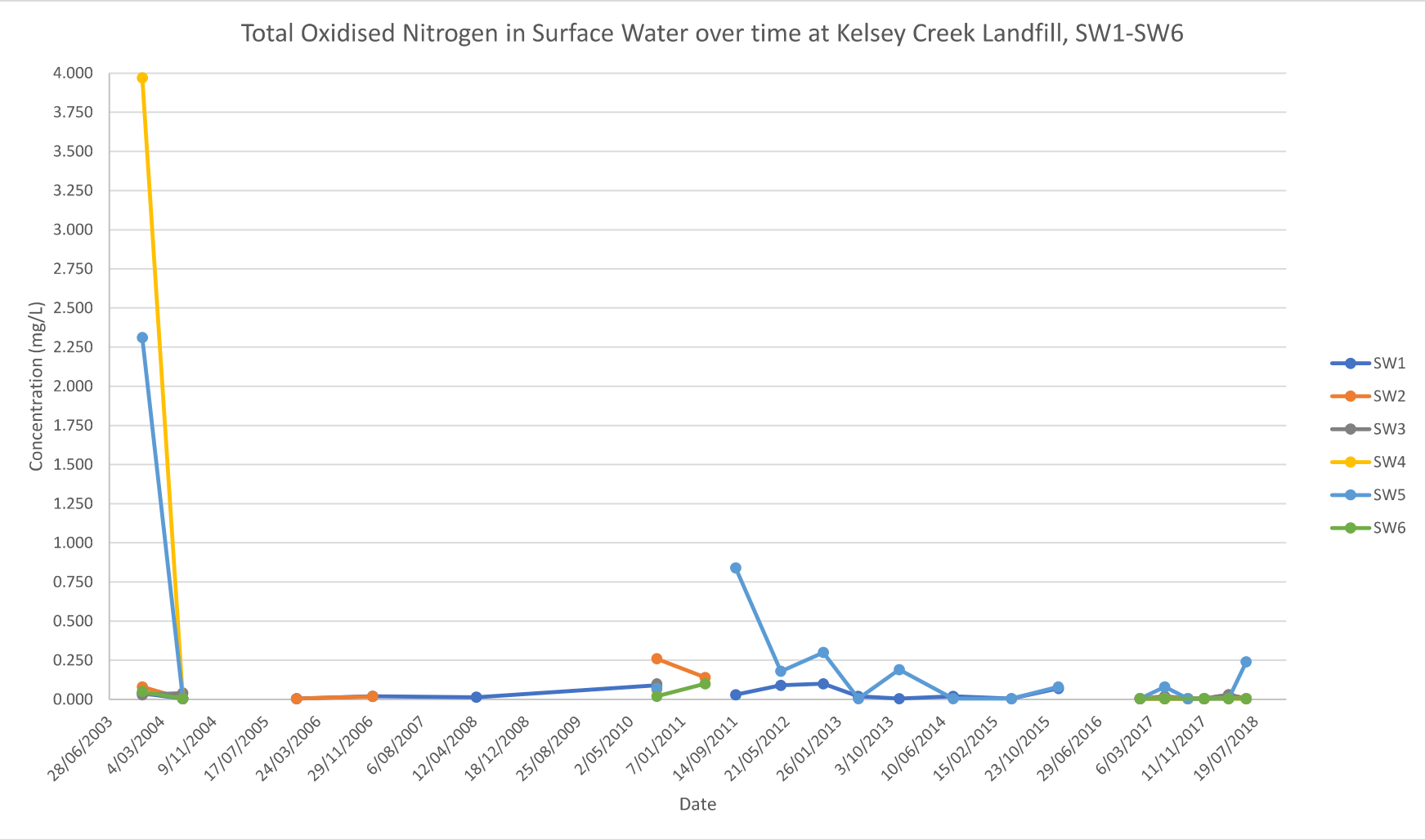

Bicarbonate Alkalinity (as CaCO3) in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
11/07/2010
19/10/2010
27/01/2011
7/05/2011
15/08/2011
23/11/2011
2/03/2012
10/06/2012
18/09/2012
27/12/2012
6/04/2013
15/07/2013
23/10/2013
31/01/2014
11/05/2014
19/08/2014
27/11/2014
7/03/2015
15/06/2015
23/09/2015
1/01/2016
10/04/2016
19/07/2016
27/10/2016
4/02/2017
15/05/2017
23/08/2017
1/12/2017
11/03/2018
19/06/2018
Date
SW1
SW2
SW3
SW4
SW5
SW6

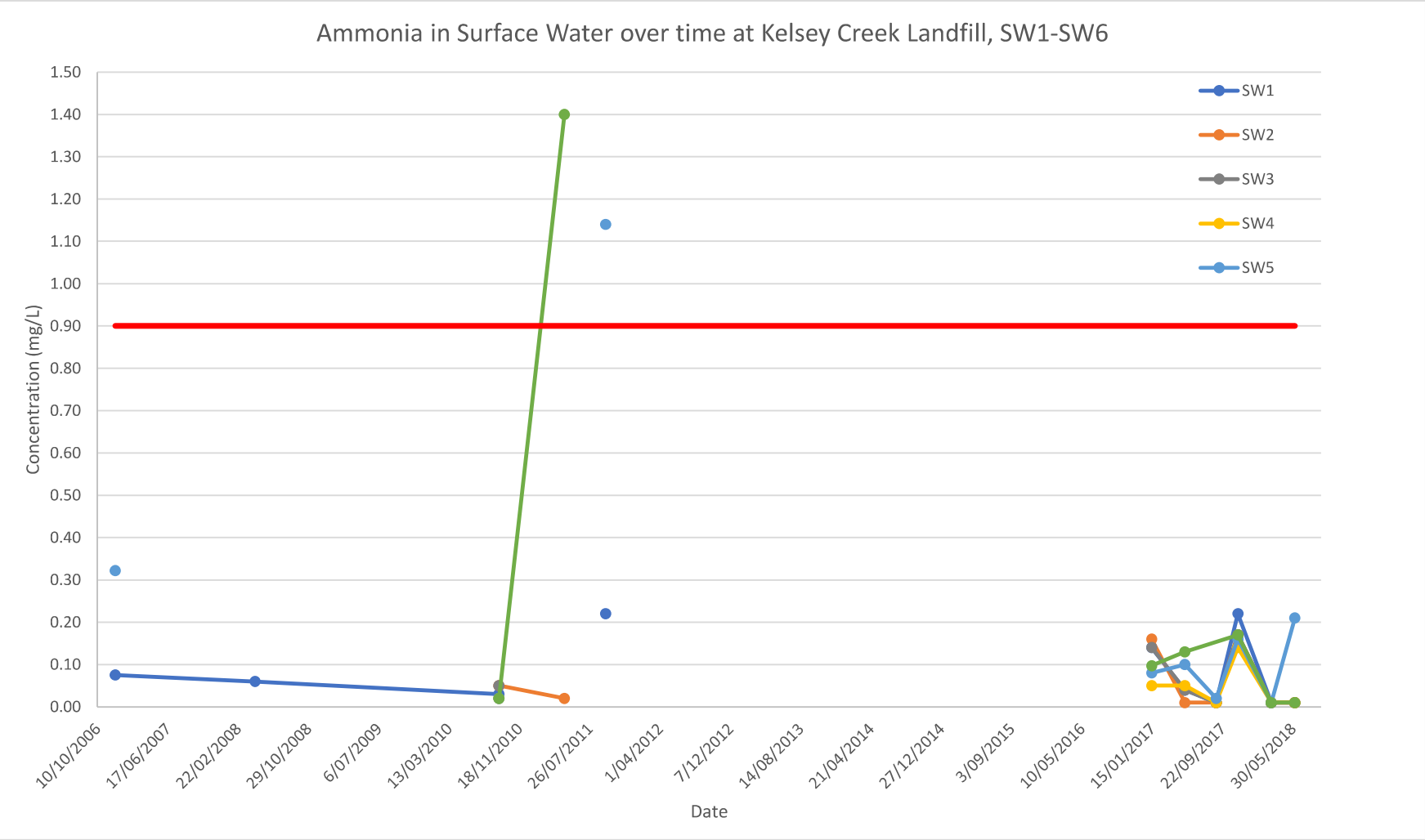

Carbonate Alkalinity (as CaCO3) in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
140.0
130.0
120.0
110.0
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
11/07/2010
19/10/2010
27/01/2011
7/05/2011
15/08/2011
23/11/2011
2/03/2012
10/06/2012
18/09/2012
27/12/2012
6/04/2013
15/07/2013
23/10/2013
31/01/2014
11/05/2014
19/08/2014
27/11/2014
7/03/2015
15/06/2015
23/09/2015
1/01/2016
10/04/2016
19/07/2016
27/10/2016
4/02/2017
15/05/2017
23/08/2017
1/12/2017
11/03/2018
19/06/2018
Date
SW1
SW2
SW3
SW4
SW5
SW6

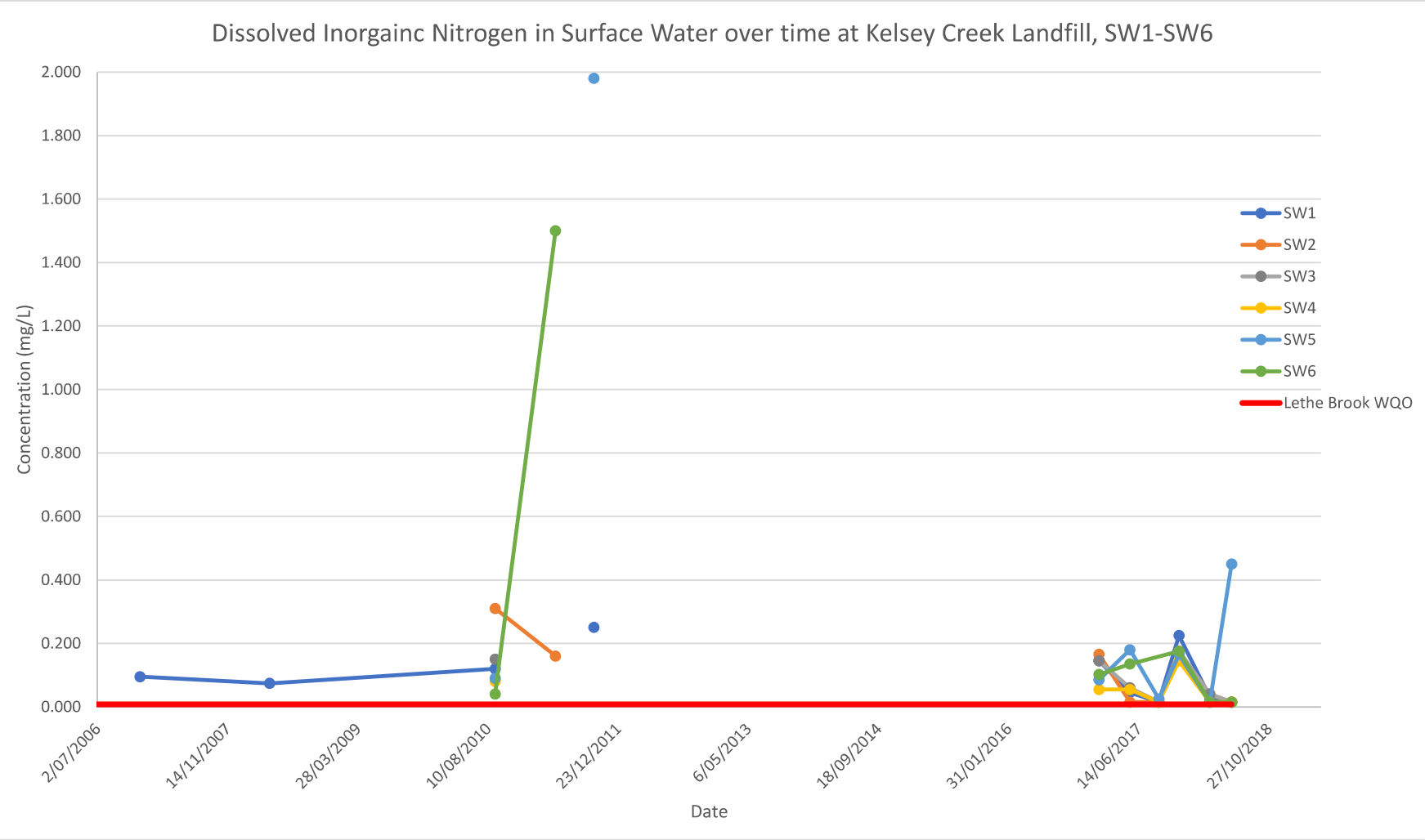
Appendix K Kelsey Creek Surface Water Graphs

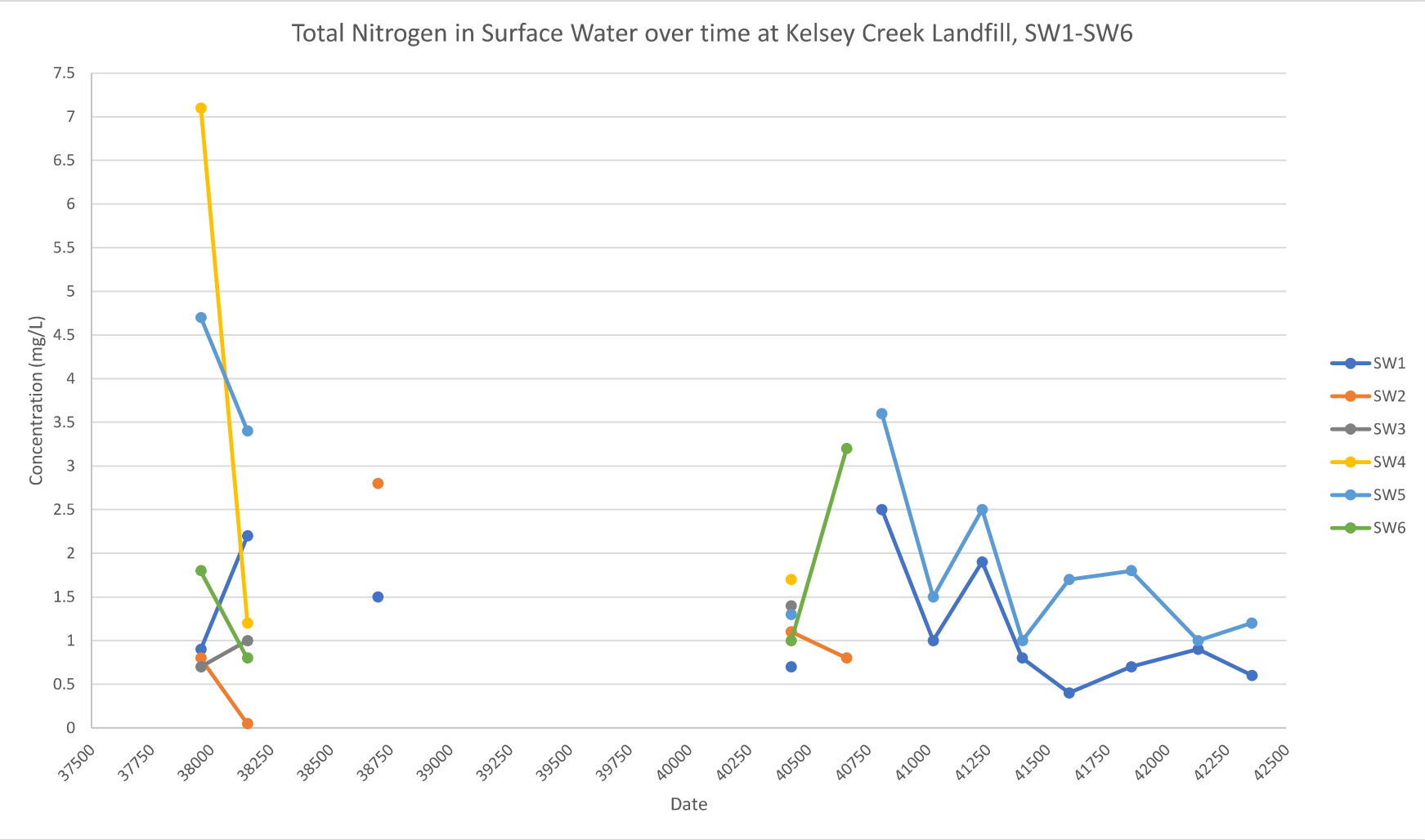


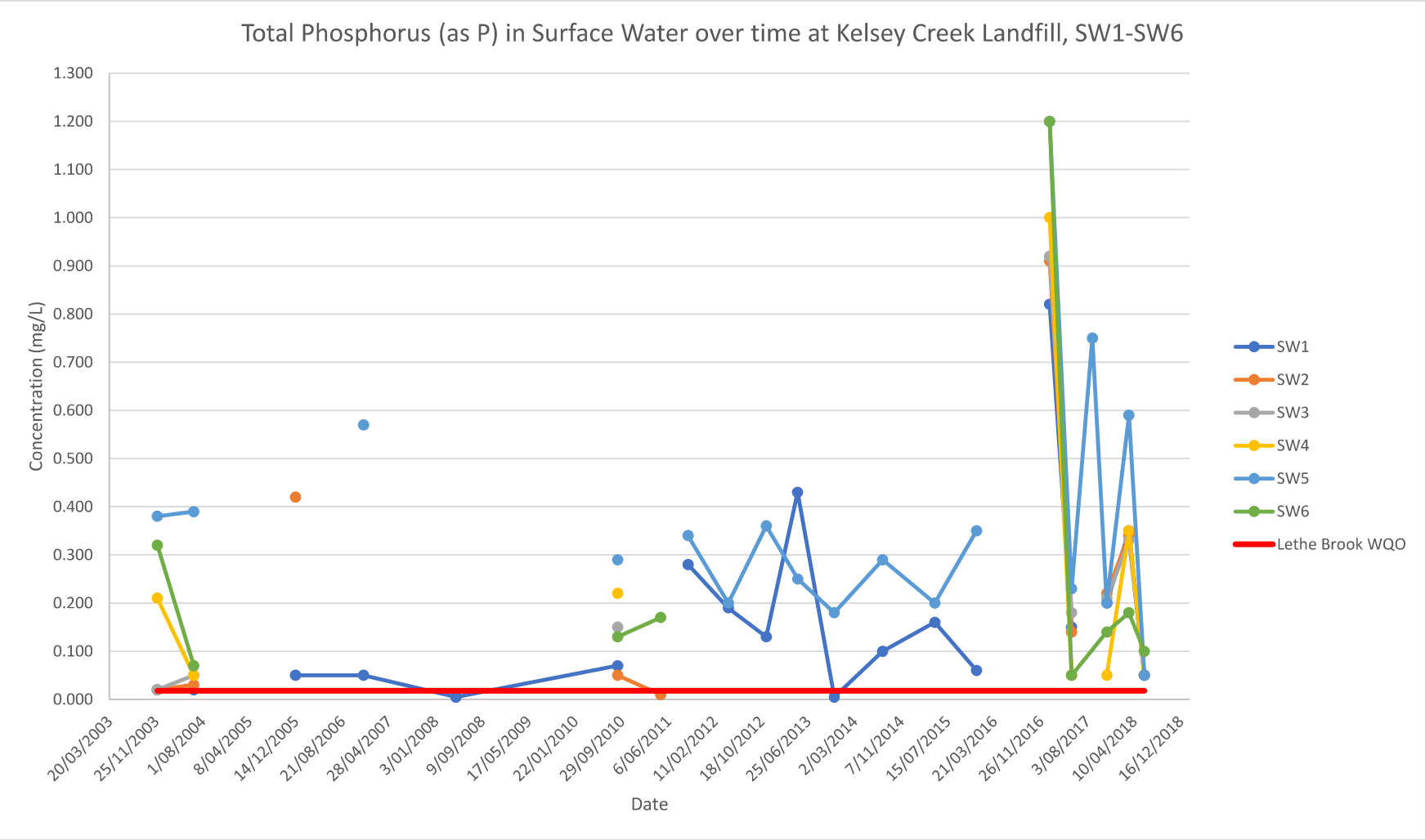
Appendix K Kelsey Creek Surface Water Graphs



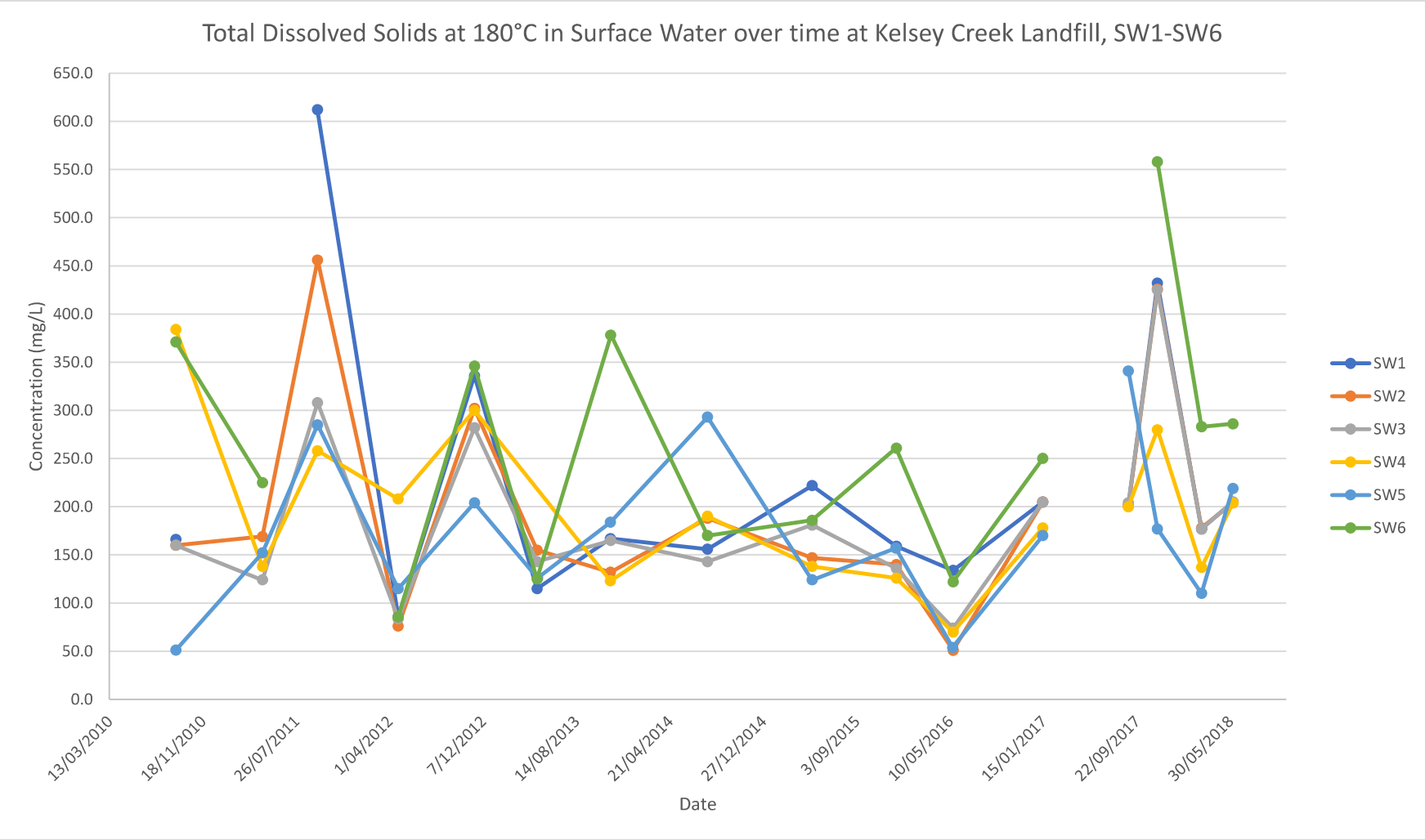

Ammonia in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
1.50
1.40
1.30
1.20
1.10
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
SW1
SW2
SW3
SW4
SW5
10/10/2006
17/06/2007
22/02/2008
29/10/2008
6/07/2009
13/03/2010
18/11/2010
26/07/2011
1/04/2012
7/12/2012
14/08/2013
21/04/2014
27/12/2014
3/09/2015
10/05/2016
15/01/2017
22/09/2017
30/05/2018
Date

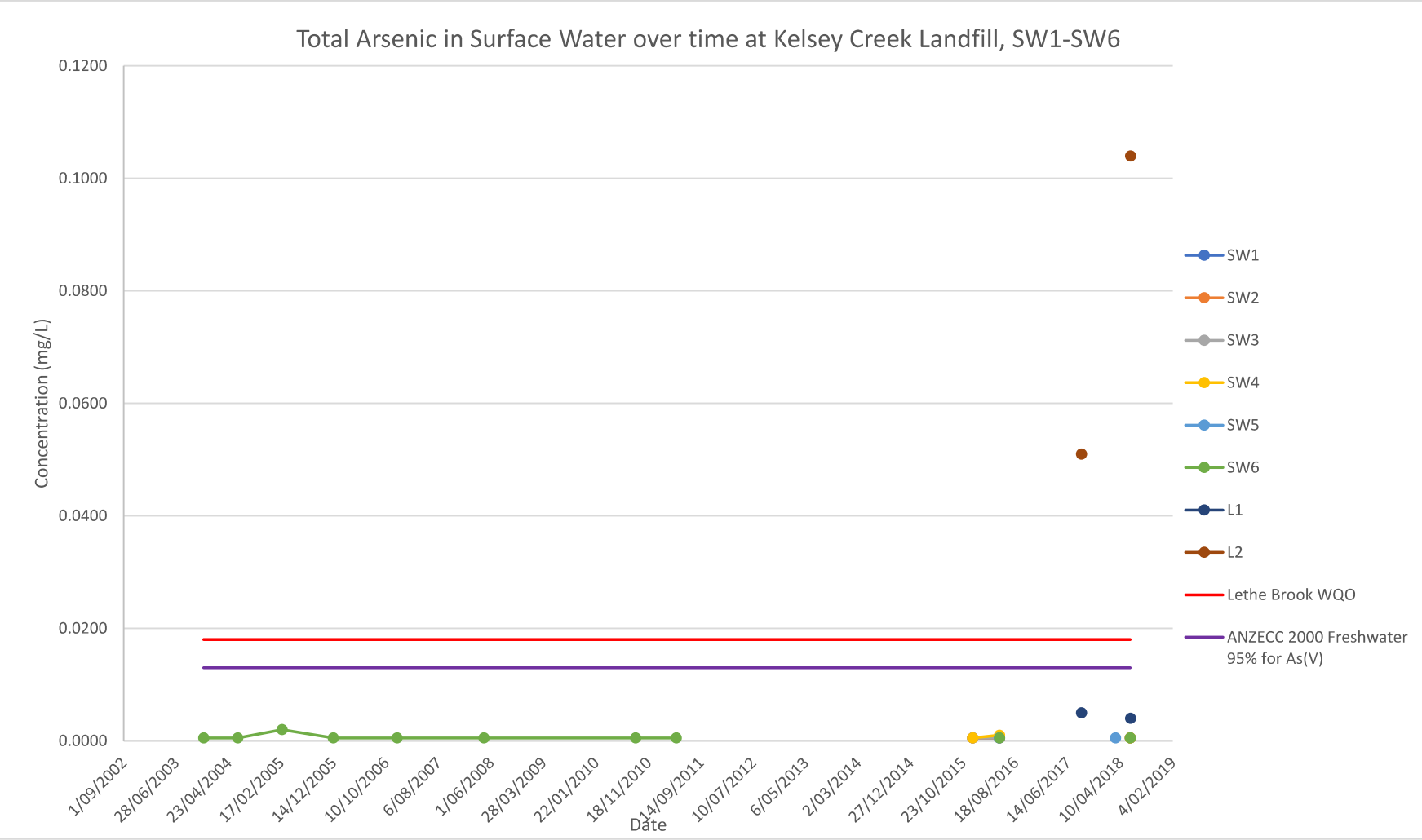

Dissolved Inorgainc Nitrogen in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
2.000
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
2/07/2006
14/11/2007
28/03/2009
10/08/2010
23/12/2011
6/05/2013
18/09/2014
31/01/2016
14/06/2017
27/10/2018
Date
SW1
SW2
SW3
SW4
SW5
SW6
Lethe Brook WQO

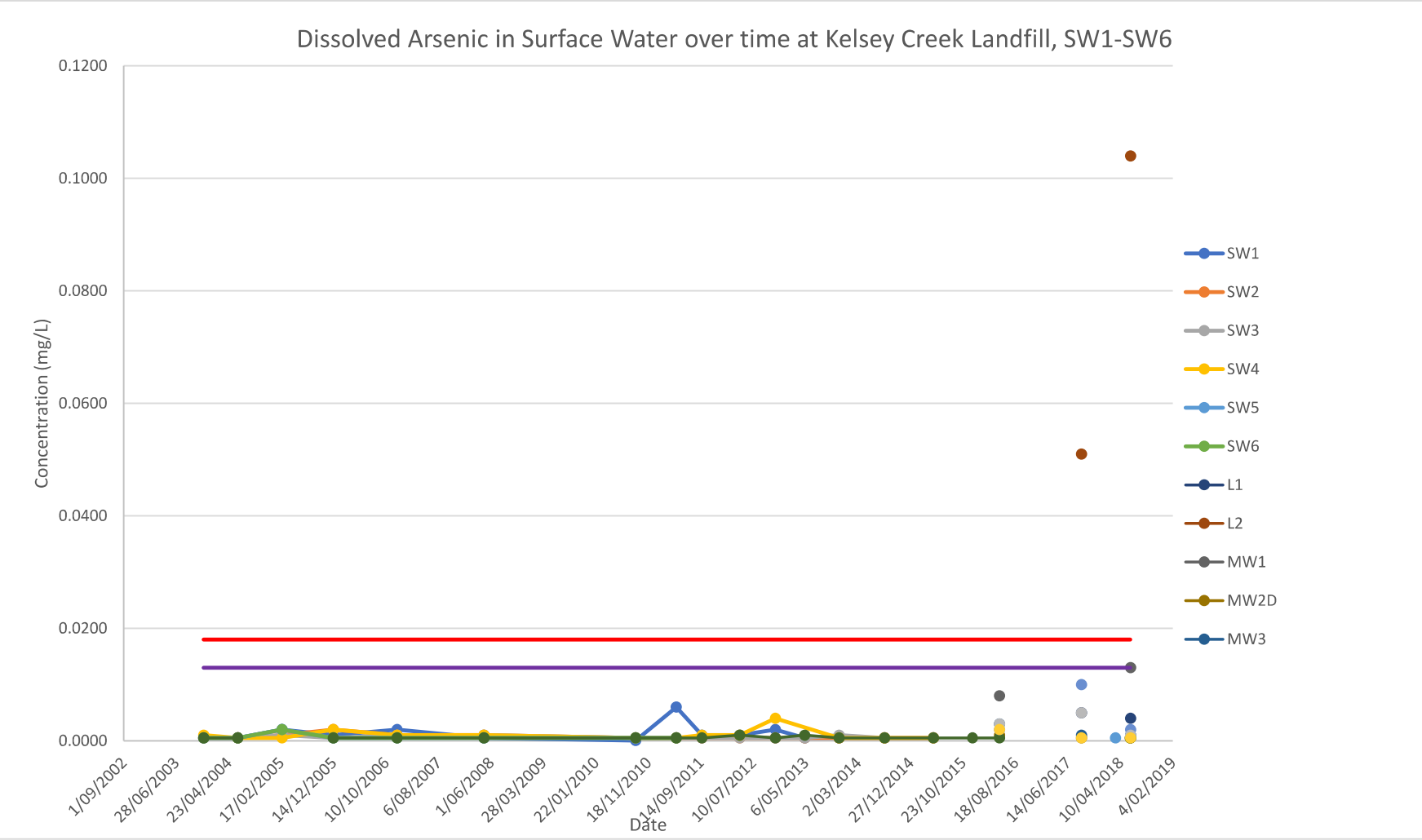

Total Nitrogen in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
37500
37750
38000
38250
38500
38750
39000
39250
39500
39750
40000
40250
40500
40750
41000
41250
41500
41750
42000
42250
42500
Date
SW1
SW2
SW3
SW4
SW5
SW6

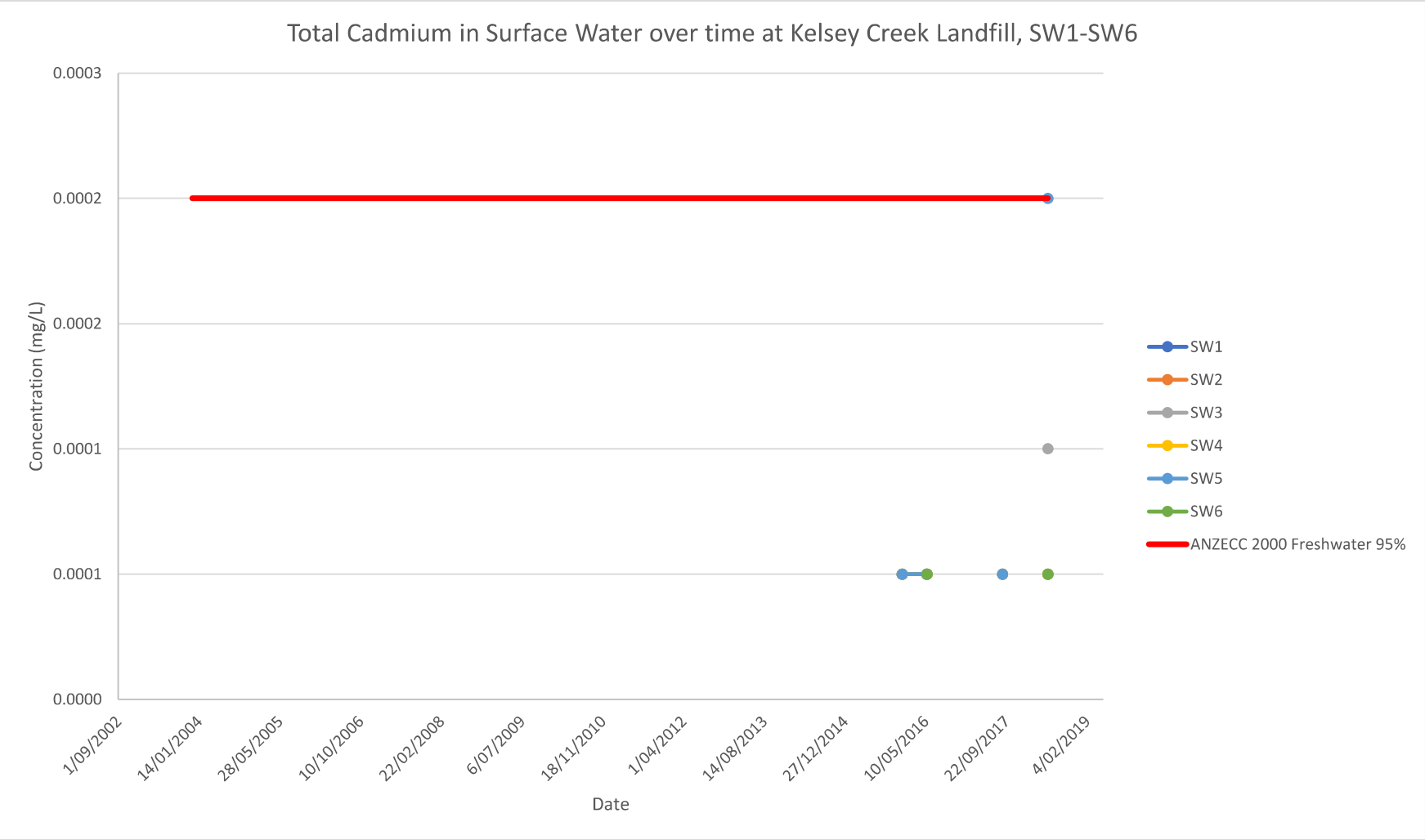

Total Phosphorus (as P) in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
1.300
1.200
1.100
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
20/03/2003
25/11/2003
1/08/2004
8/04/2005
14/12/2005
21/08/2006
28/04/2007
3/01/2008
9/09/2008
17/05/2009
22/01/2010
29/09/2010
6/06/2011
11/02/2012
18/10/2012
25/06/2013
2/03/2014
7/11/2014
15/07/2015
21/03/2016
26/11/2016
3/08/2017
10/04/2018
16/12/2018
Date
SW1
SW2
SW3
SW4
SW5
SW6
Lethe Brook WQO

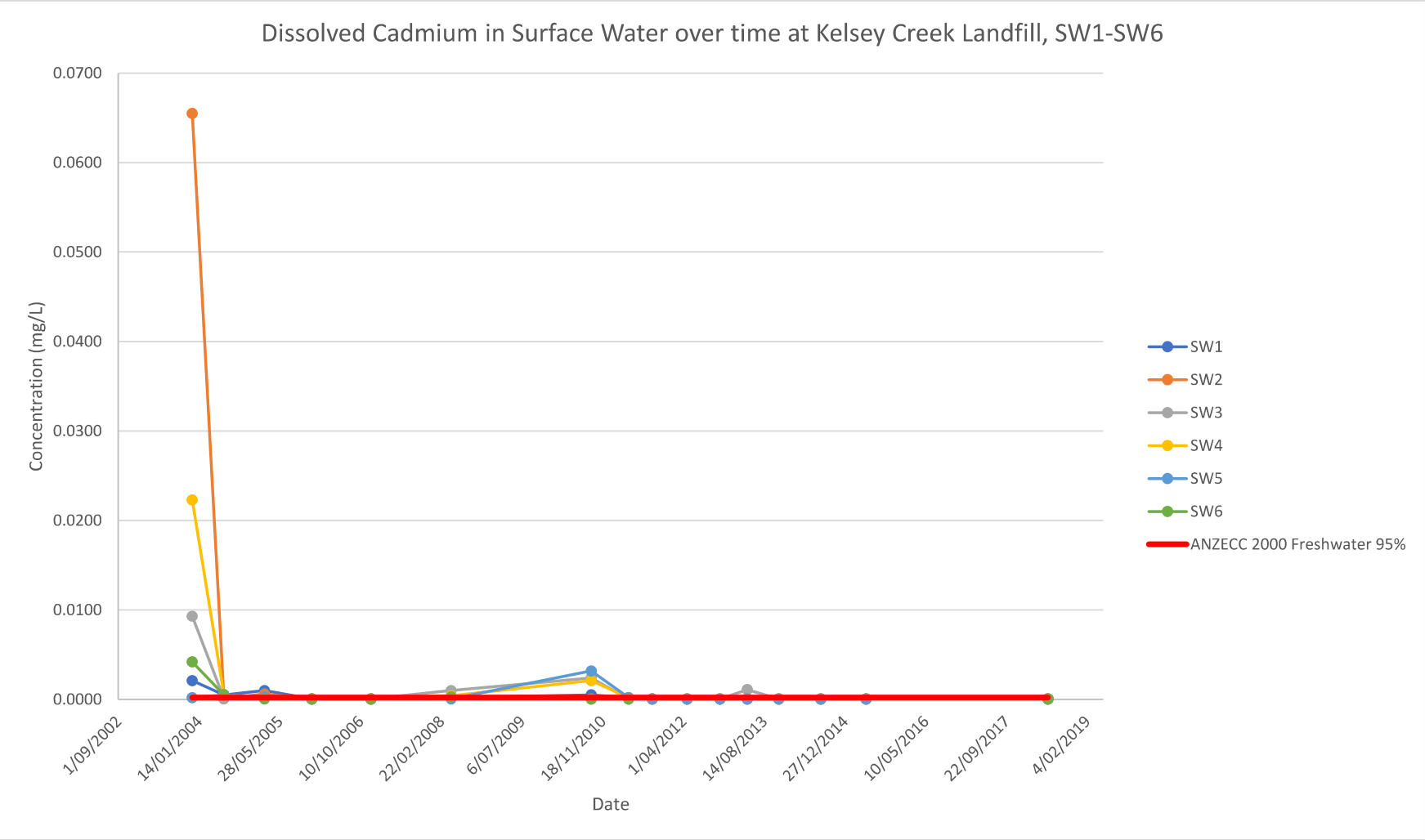
Appendix K Kelsey Creek Surface Water Graphs

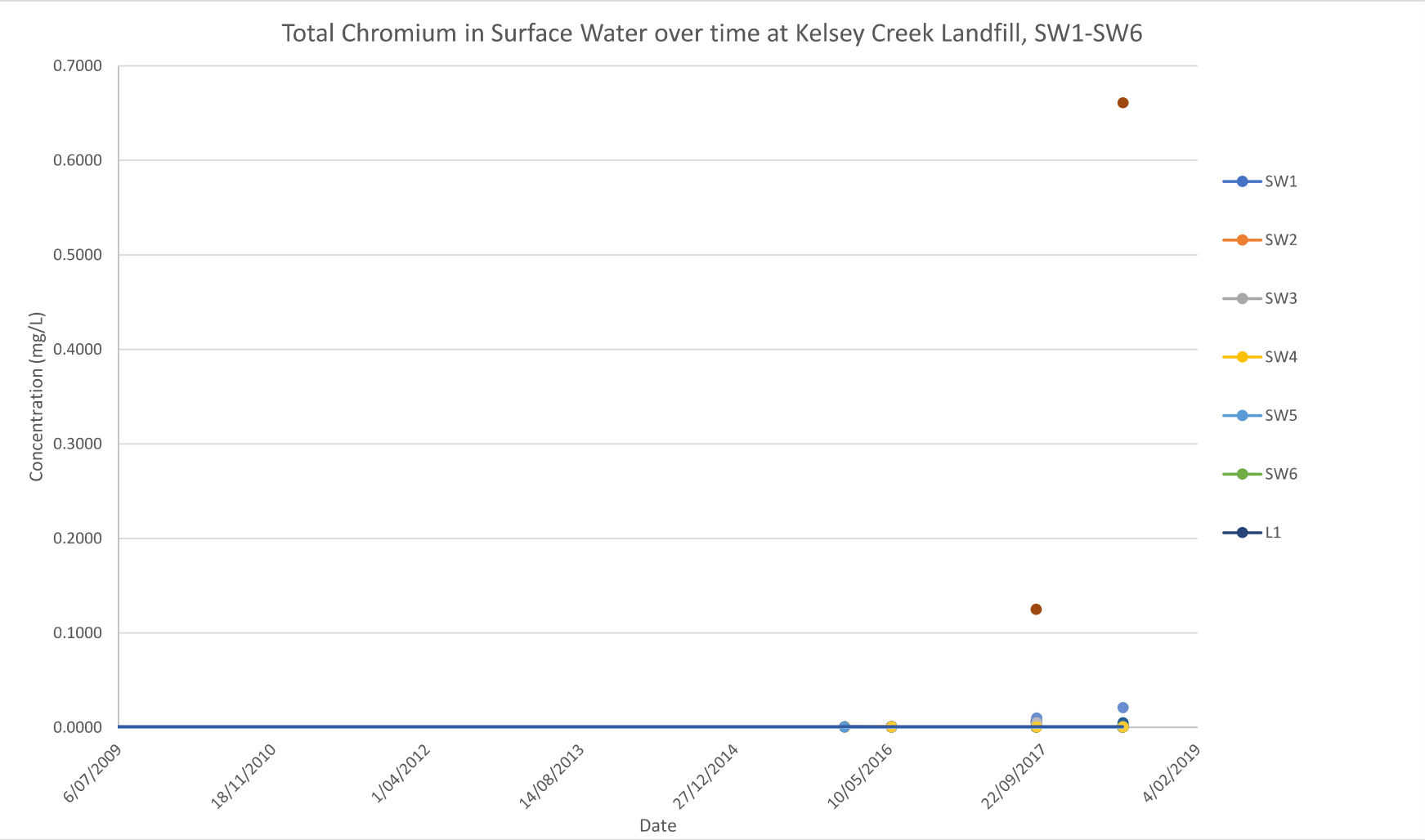


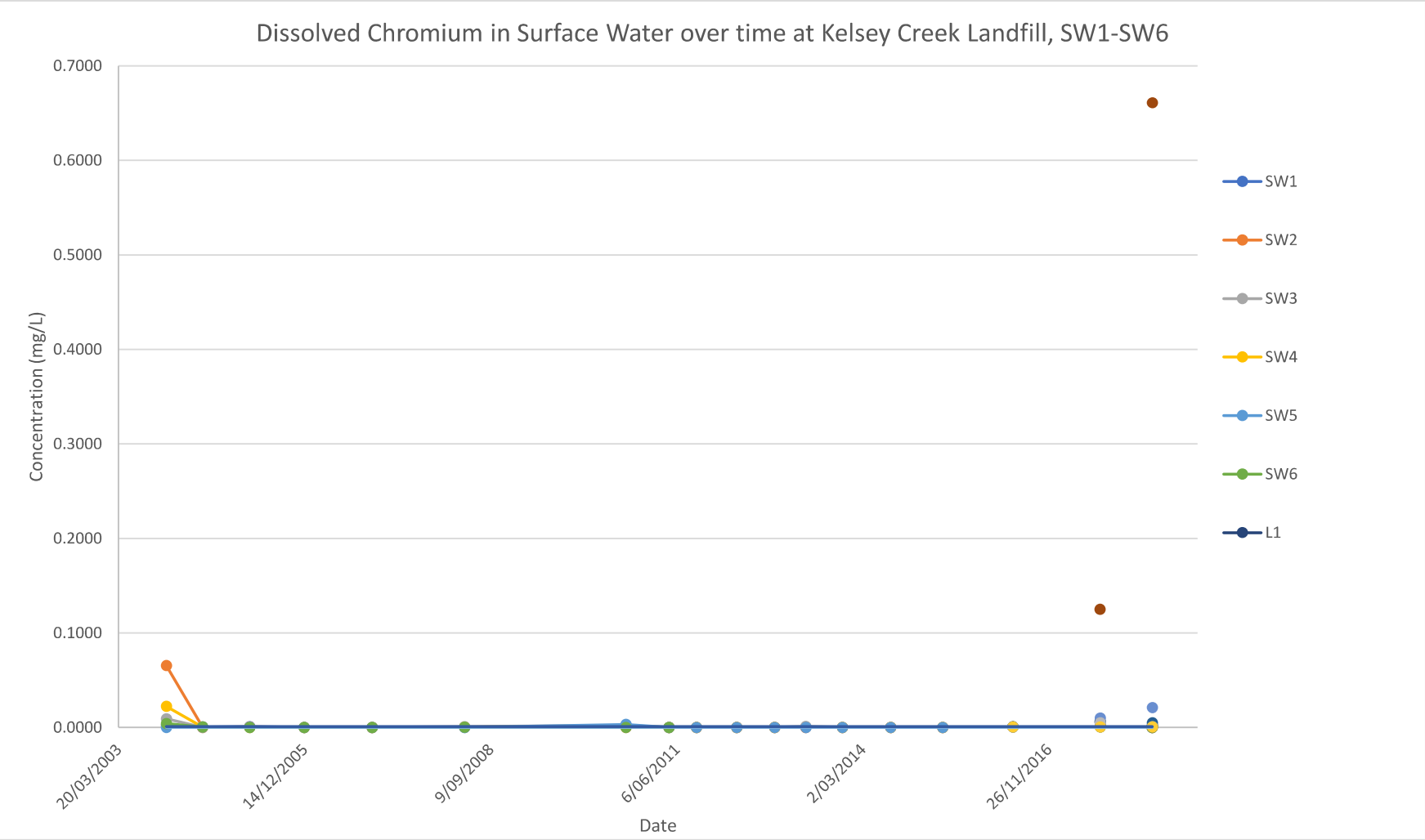

Total Arsenic in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
0.1200
0.1000
0.0800
0.0600
0.0400
0.0200
0.0000
1/09/2002
28/06/2003
23/04/2004
17/02/2005
14/12/2005
10/10/2006
6/08/2007
1/06/2008
28/03/2009
22/01/2010
18/11/2010
14/09/2011
10/07/2012
6/05/2013
2/03/2014
27/12/2014
23/10/2015
18/08/2016
14/06/2017
10/04/2018
4/02/2019
Date
SW1
SW2
SW3
SW4
SW5
SW6
L1
L2
Lethe Brook WQO
ANZECC 2000 Freshwater 95% for As(V)

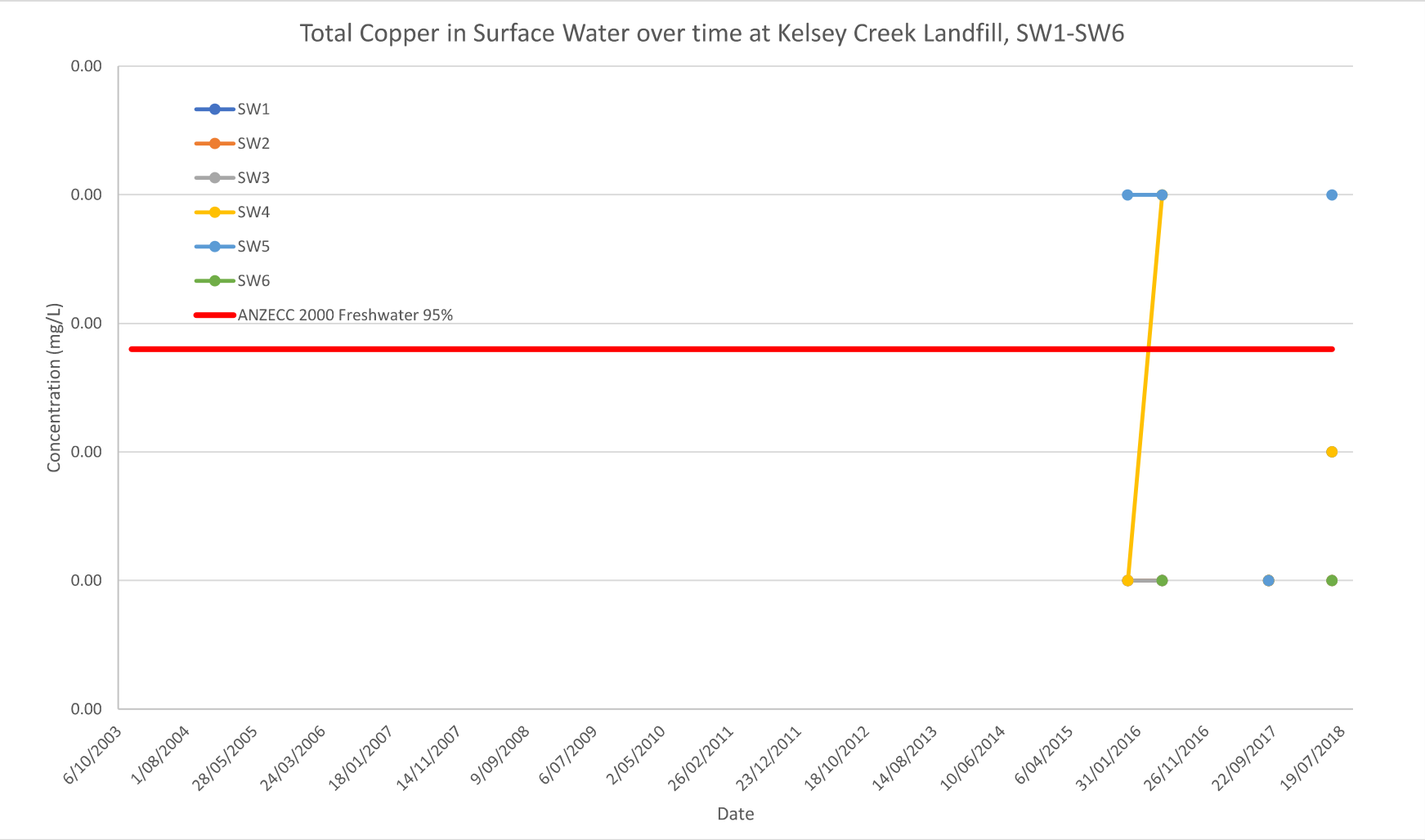

Dissolved Arsenic in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
0.1200
0.1000
0.0800
0.0600
0.0400
0.0200
0.0000
1/09/2002
28/06/2003
23/04/2004
17/02/2005
14/12/2005
10/10/2006
6/08/2007
1/06/2008
28/03/2009
22/01/2010
18/11/2010
14/09/2011
10/07/2012
6/05/2013
2/03/2014
27/12/2014
23/10/2015
18/08/2016
14/06/2017
10/04/2018
4/02/2019
Date
SW1
SW2
SW3
SW4
SW5
SW6
L1
L2
MW1
MW2D
MW3

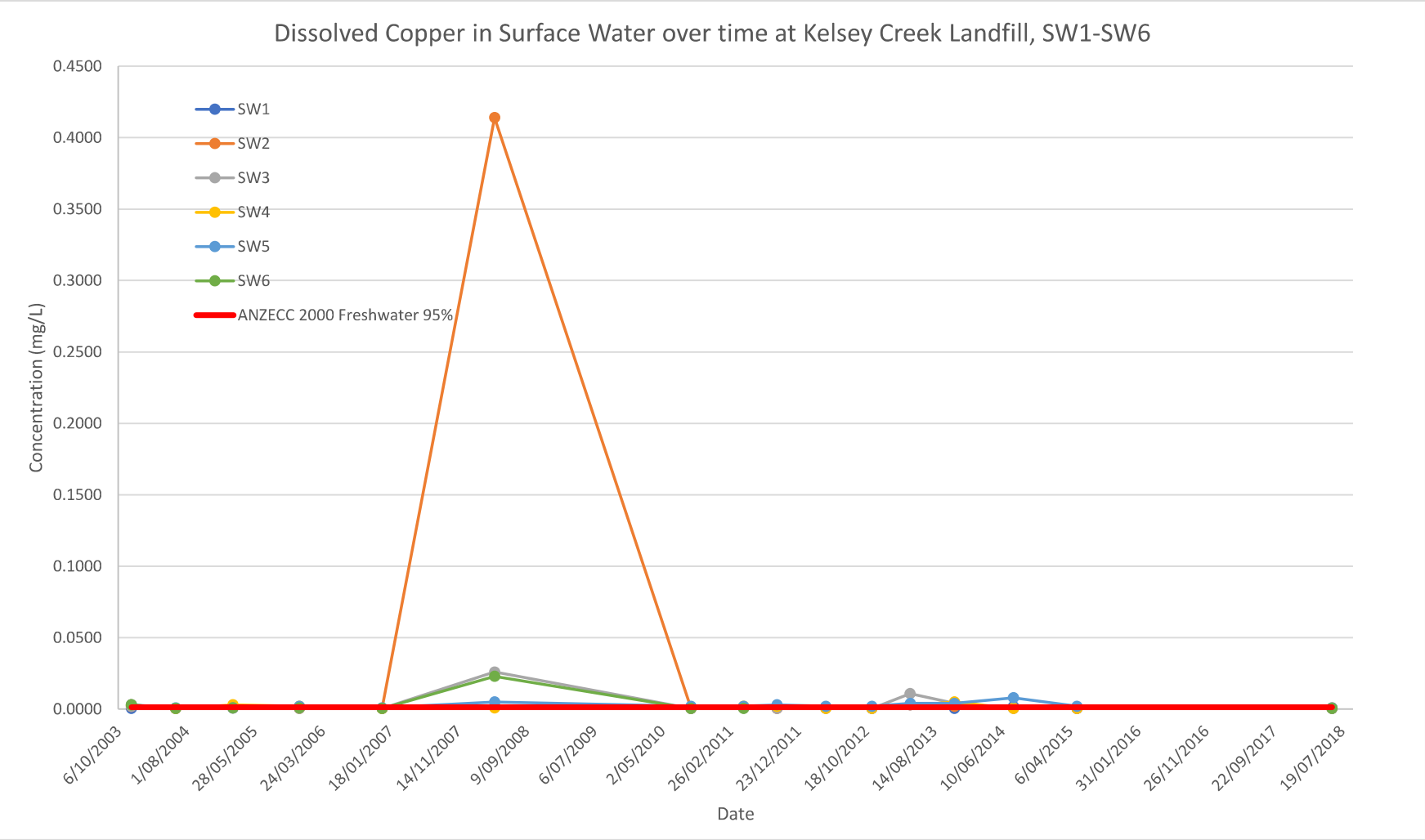

Total Cadmium in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
0.0003
0.0002
0.0002
0.0001
0.0001
0.0000
1/09/2002
14/01/2004
28/05/2005
10/10/2006
22/02/2008
6/07/2009
18/11/2010
1/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
4/02/2019
Date
SW1
SW2
SW3
SW4
SW5
SW6
ANZECC 2000 Freshwater 95%

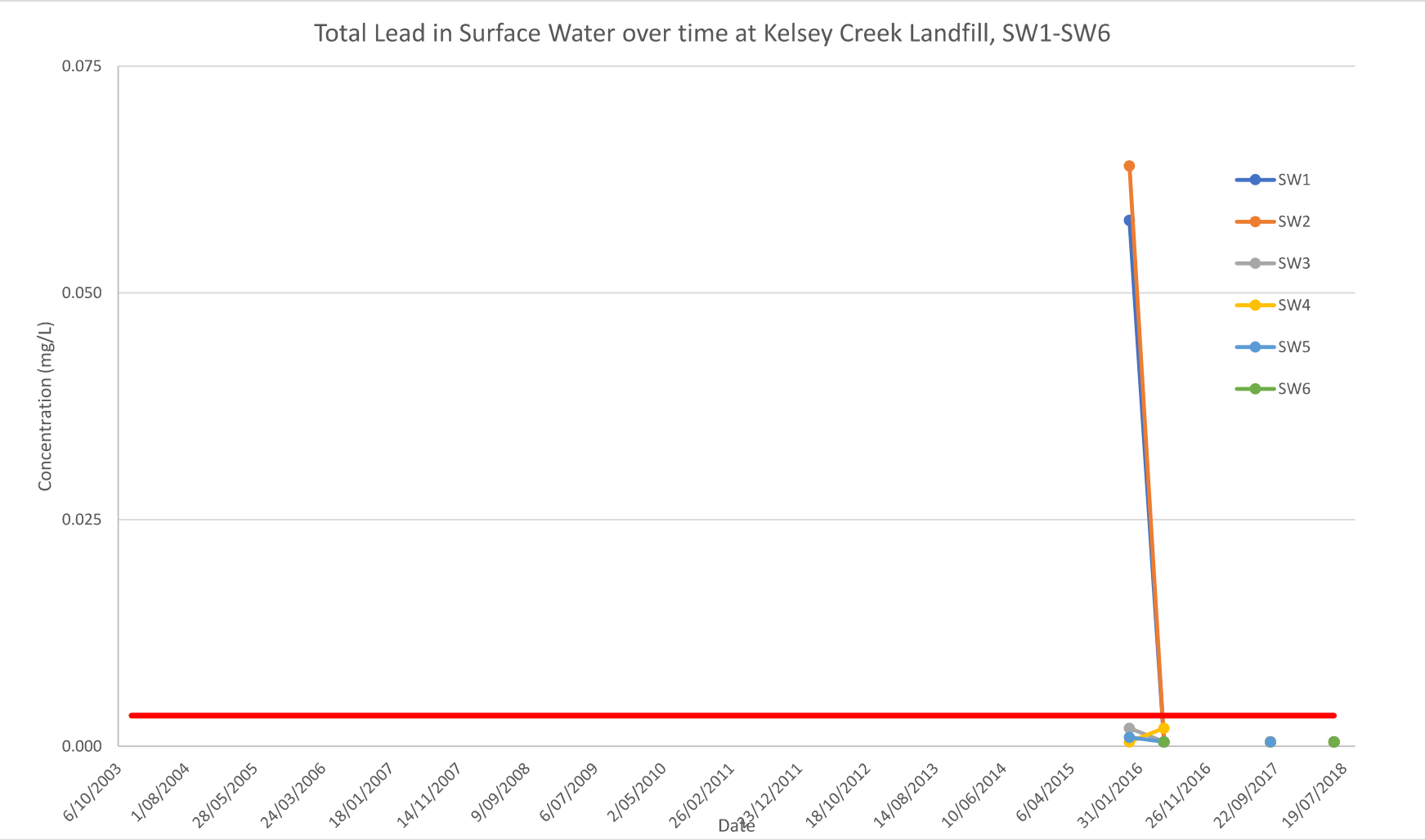

Dissolved Cadmium in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
0.0700
0.0600
0.0500
0.0400
0.0300
0.0200
0.0100
0.0000
1/09/2002
14/01/2004
28/05/2005
10/10/2006
22/02/2008
6/07/2009
18/11/2010
1/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
4/02/2019
Date
SW1
SW2
SW3
SW4
SW5
SW6
ANZECC 2000 Freshwater 95%

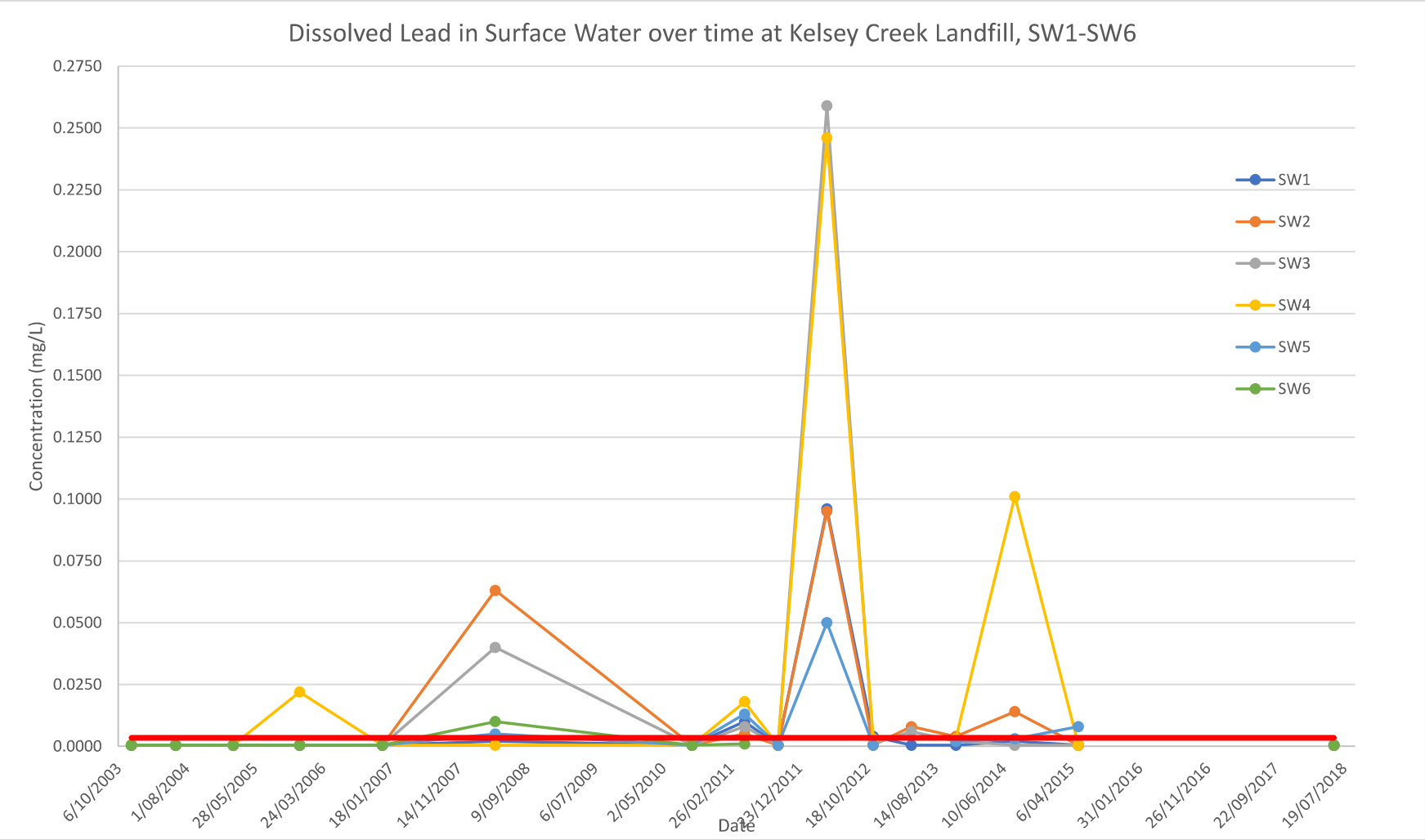

Total Chromium in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
0.7000
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
Concentration (mg/L)
6/07/2009
18/11/2010
1/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
4/02/2019
Date
SW1
SW2
SW3
SW4
SW5
SW6
L1

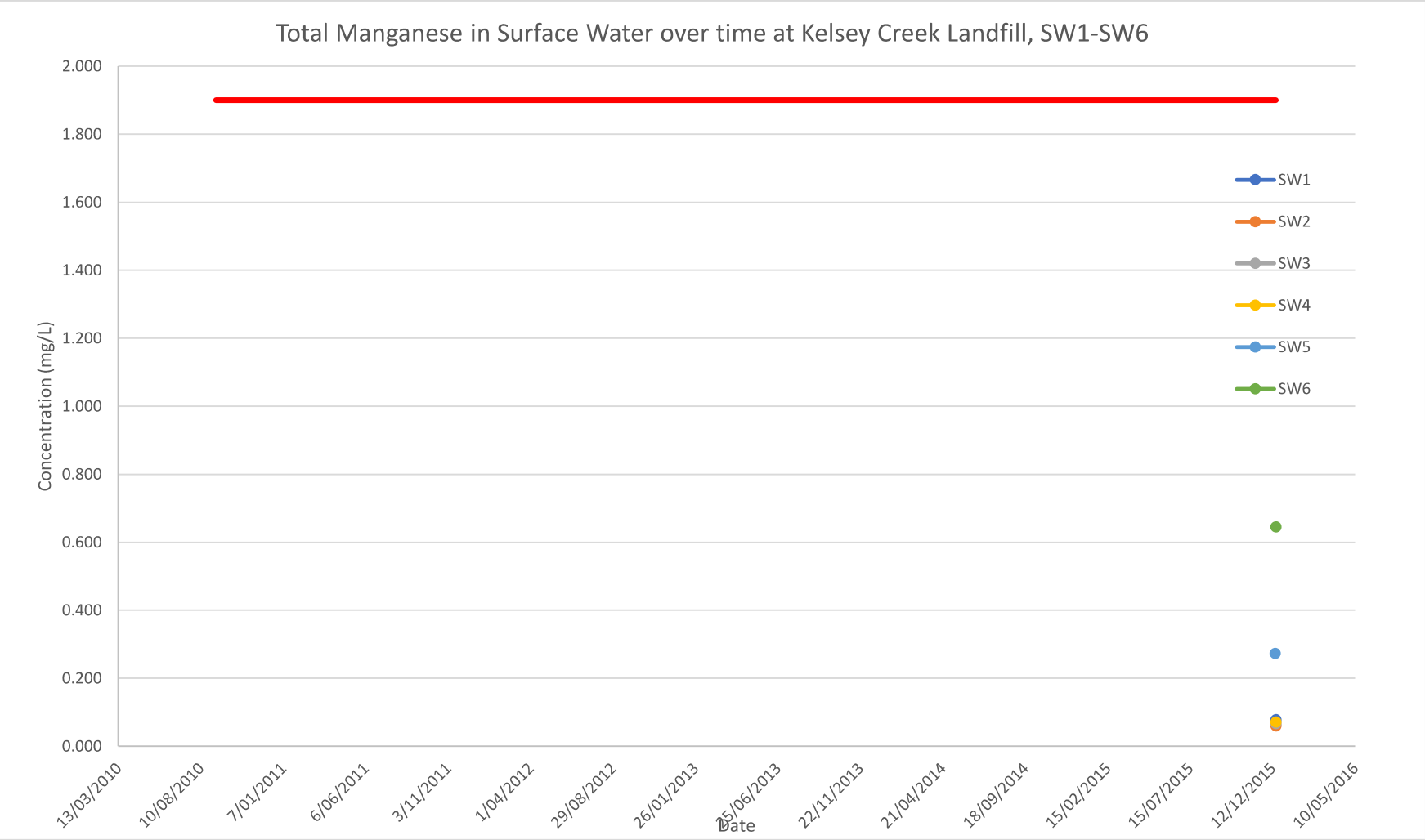

Dissolved Chromium in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
0.7000
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
Concentration (mg/L)
20/03/2003
14/12/2005
9/09/2008
6/06/2011
2/03/2014
26/11/2016
Date
SW1
SW2
SW3
SW4
SW5
SW6
L1

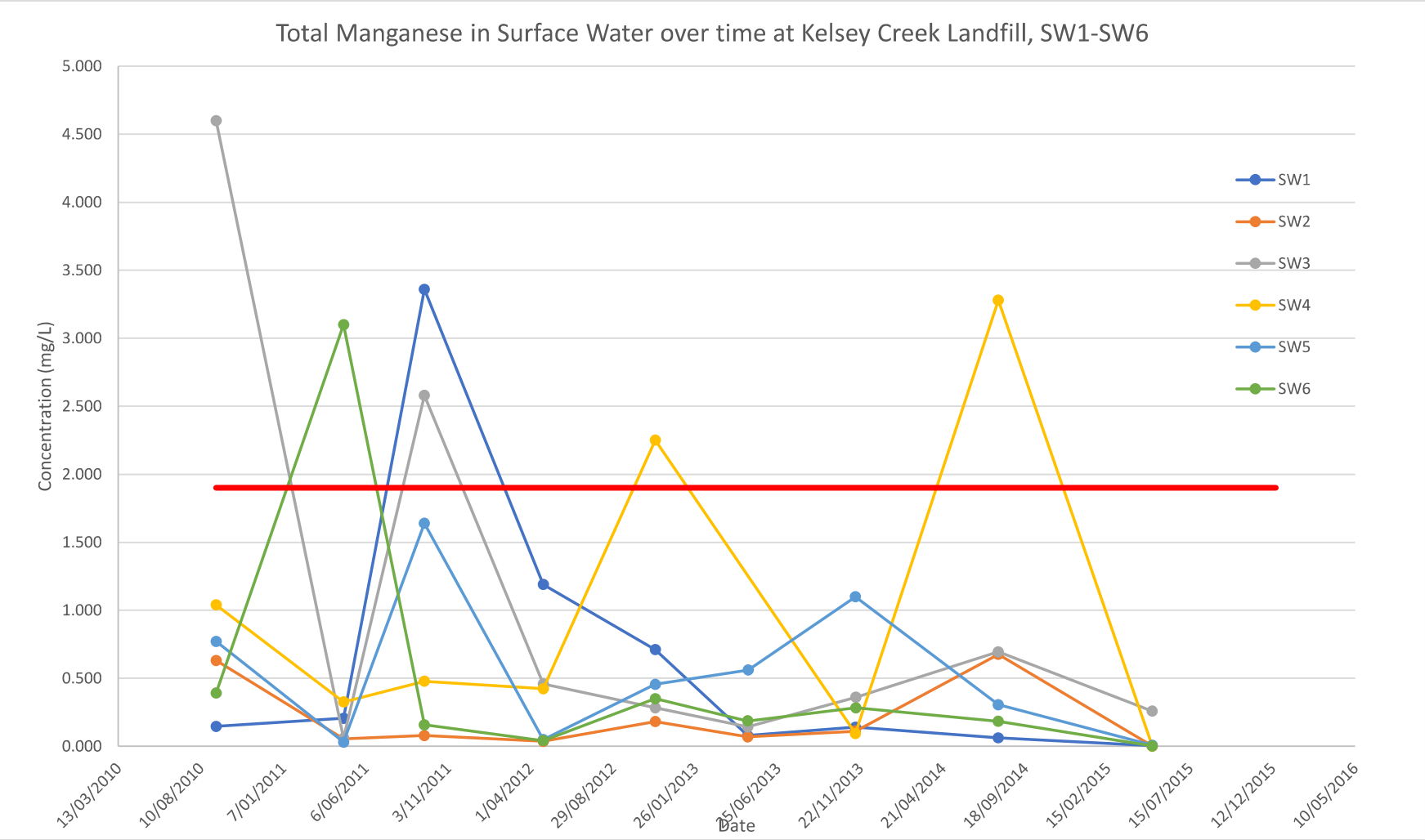

Total Copper in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
0.00
0.00
0.00
0.00
0.00
SW1
SW2
SW3
SW4
SW5
SW6
ANZECC 2000 Freshwater 95%
6/10/2003
1/08/2004
28/05/2005
24/03/2006
18/01/2007
14/11/2007
9/09/2008
6/07/2009
2/05/2010
26/02/2011
23/12/2011
18/10/2012
14/08/2013
10/06/2014
6/04/2015
31/01/2016
26/11/2016
22/09/2017
19/07/2018
Date

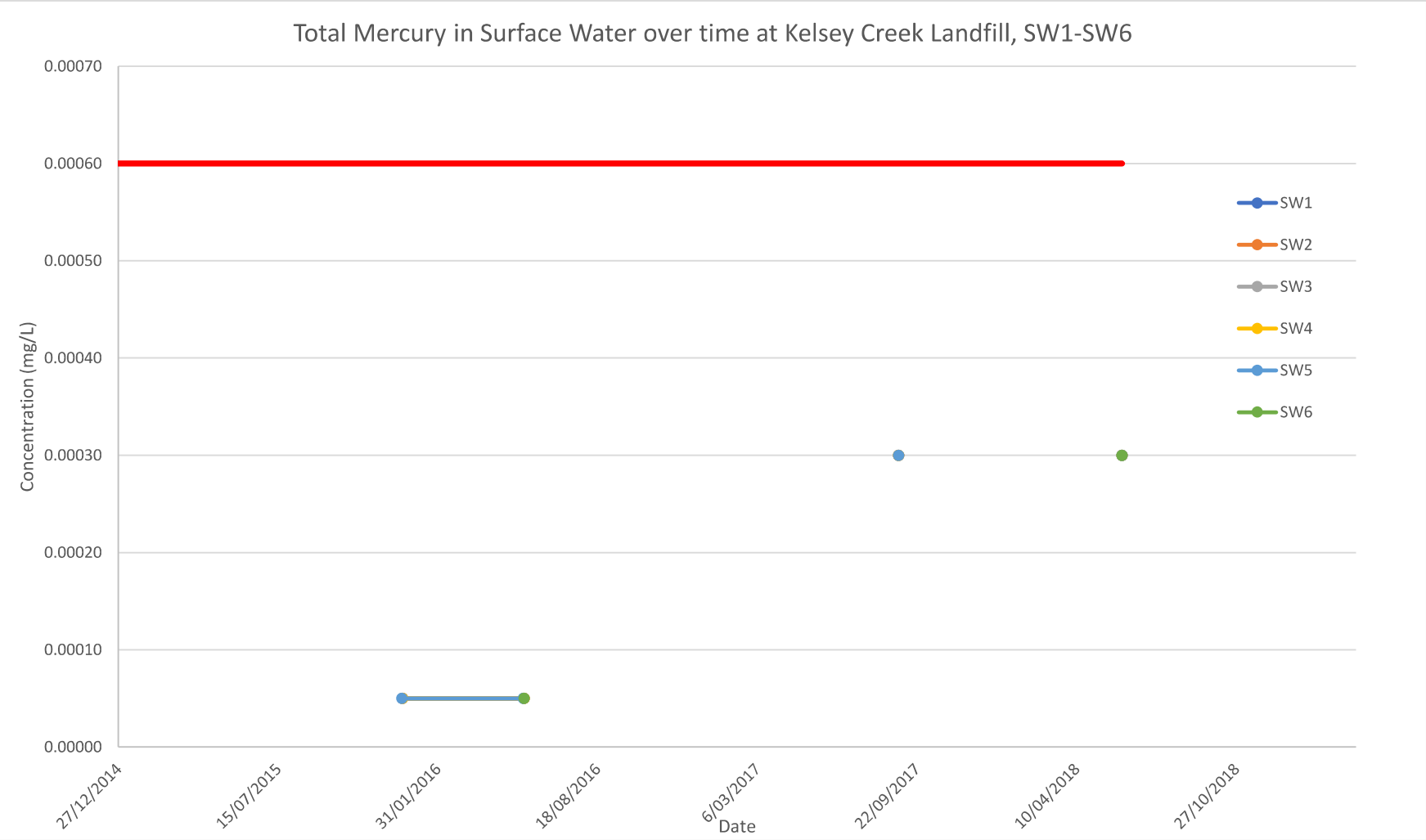

Dissolved Copper in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
0.4500
0.4000
0.3500
0.3000
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
SW1
SW2
SW3
SW4
SW5
SW6
ANZECC 2000 Freshwater 95%
6/10/2003
1/08/2004
28/05/2005
24/03/2006
18/01/2007
14/11/2007
9/09/2008
6/07/2009
2/05/2010
26/02/2011
23/12/2011
18/10/2012
14/08/2013
10/06/2014
6/04/2015
31/01/2016
26/11/2016
22/09/2017
19/07/2018
Date

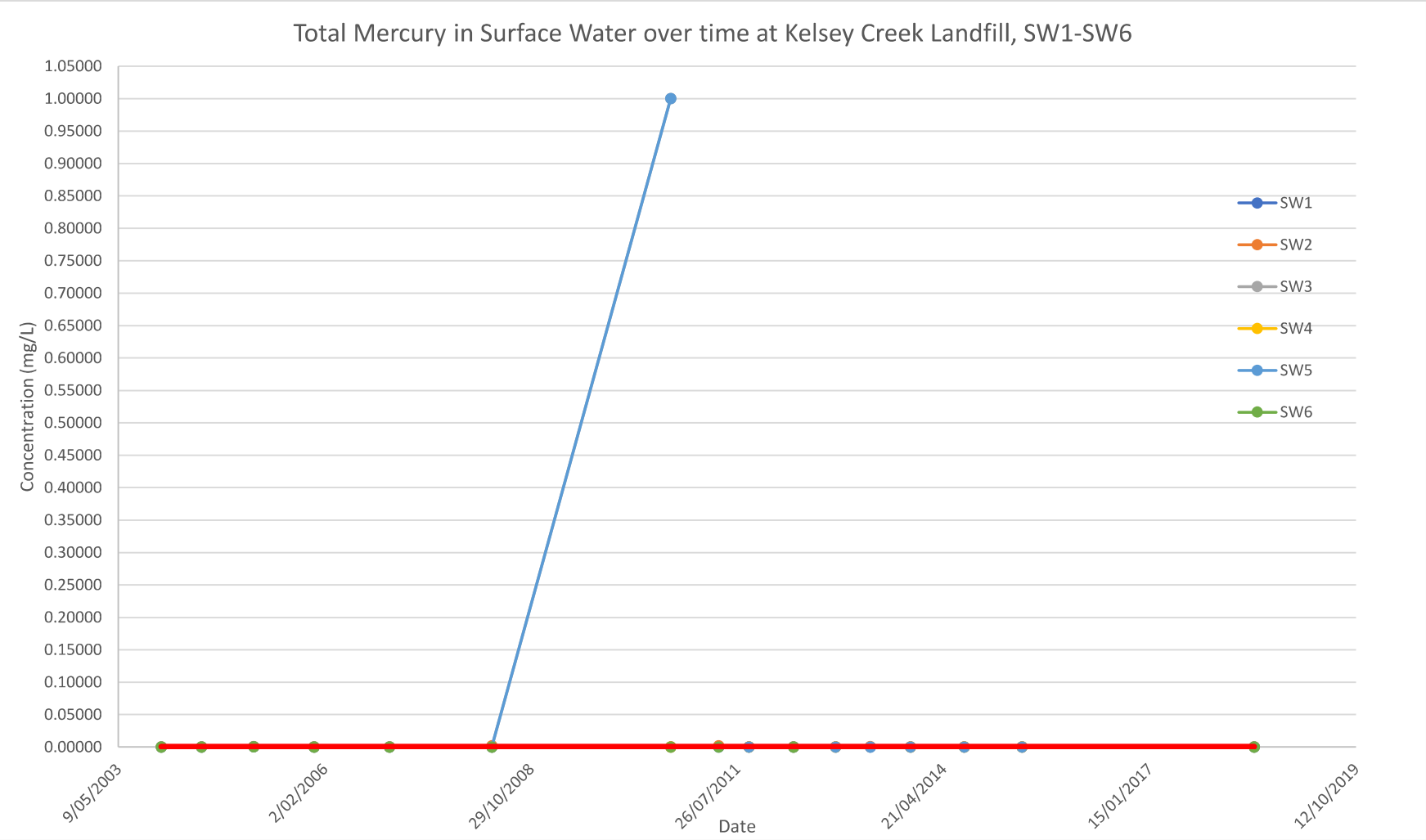

Total Lead in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
0.075
0.050
0.025
0.000
Concentration (mg/L)
SW1
SW2
SW3
SW4
SW5
SW6
6/10/2003
1/08/2004
28/05/2005
24/03/2006
18/01/2007
14/11/2007
9/09/2008
6/07/2009
2/05/2010
26/02/2011
23/12/2011
18/10/2012
14/08/2013
10/06/2014
6/04/2015
31/01/2016
26/11/2016
22/09/2017
19/07/2018
Date

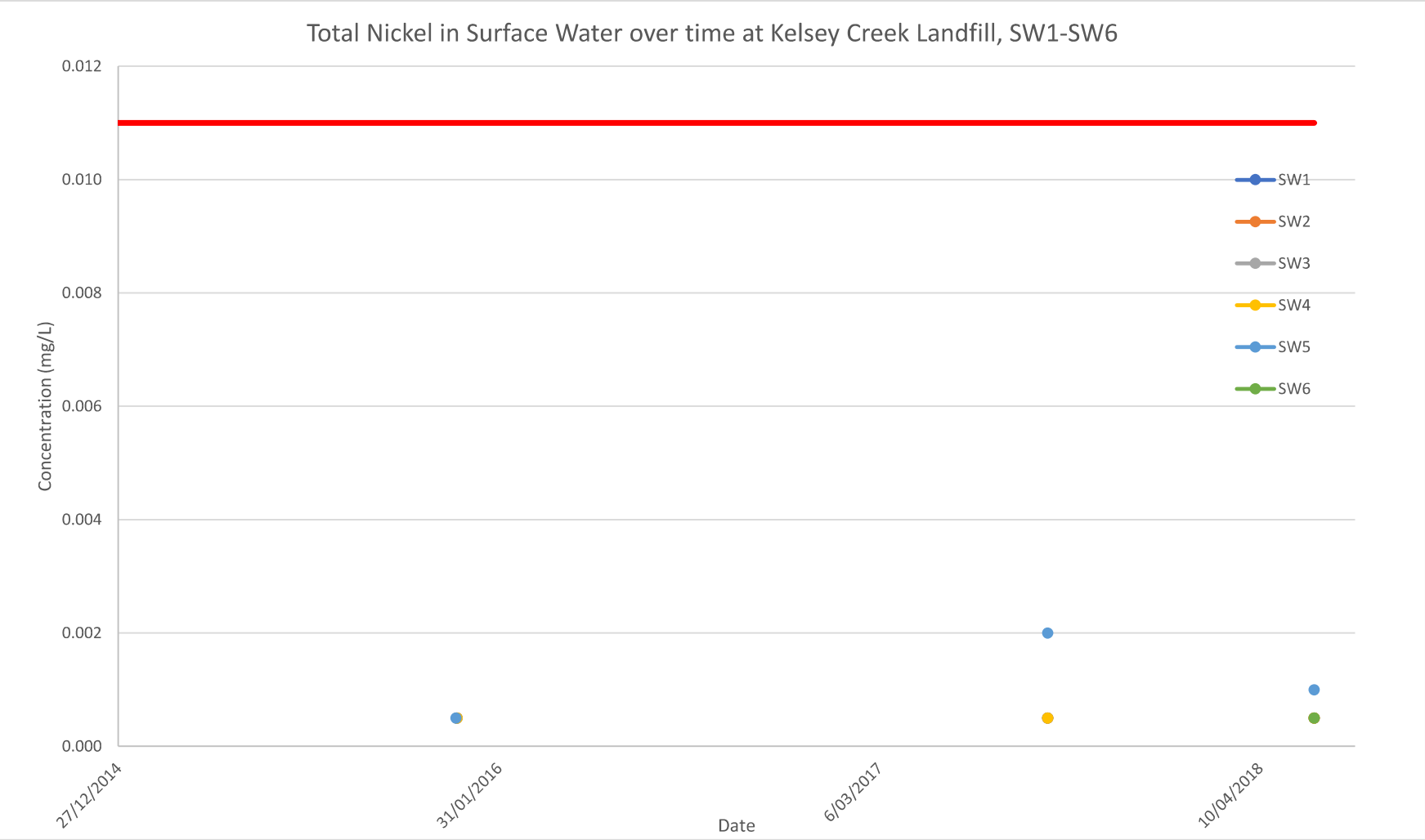

Dissolved Lead in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
0.2750
0.2500
0.2250
0.2000
0.1750
0.1500
0.1250
0.1000
0.0750
0.0500
0.0250
0.0000
6/10/2003
1/08/2004
28/05/2005
24/03/2006
18/01/2007
14/11/2007
9/09/2008
6/07/2009
2/05/2010
26/02/2011
23/12/2011
18/10/2012
14/08/2013
10/06/2014
6/04/2015
31/01/2016
26/11/2016
22/09/2017
19/07/2018
Date
SW1
SW2
SW3
SW4
SW5
SW6

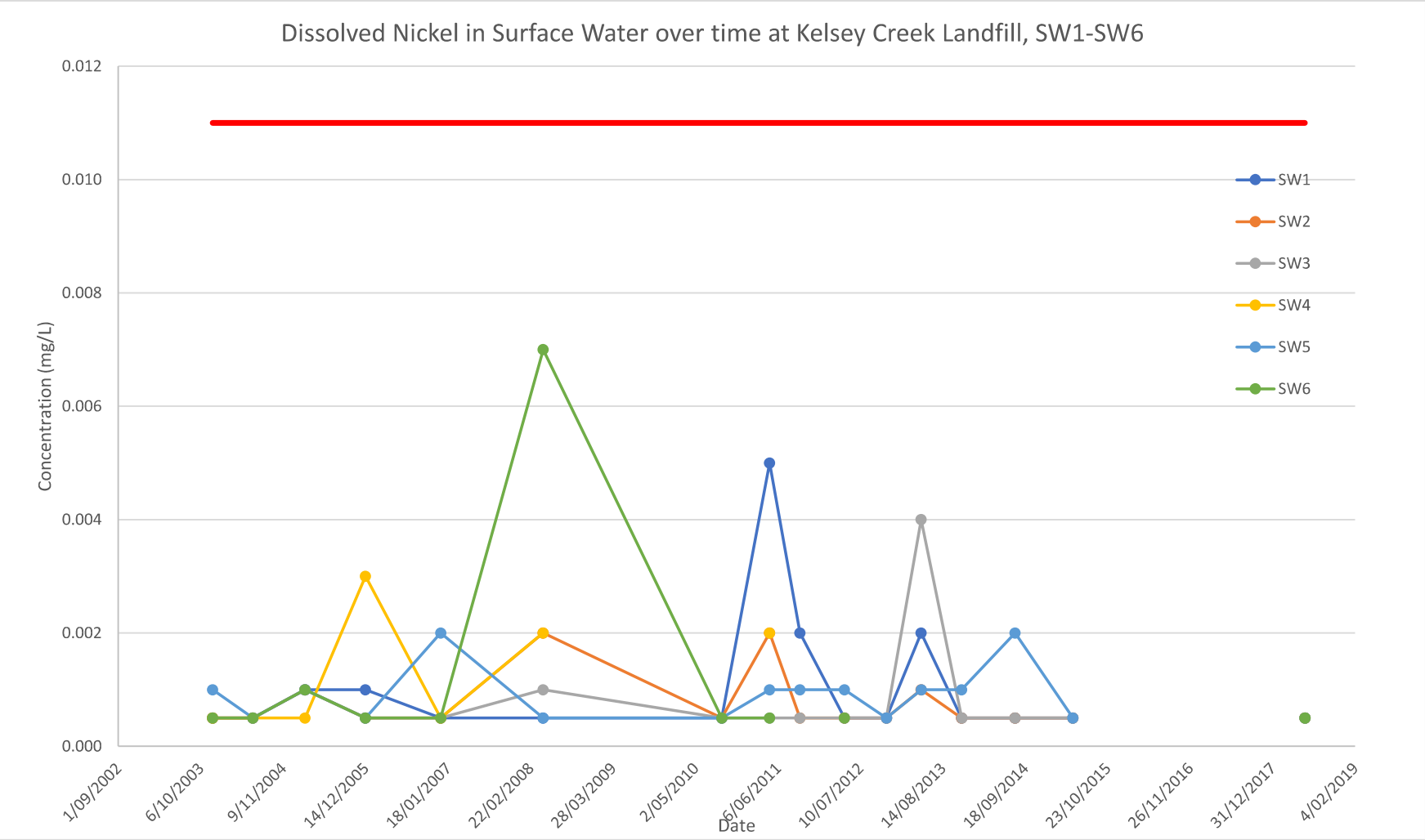

Total Manganese in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
2.000
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
SW1
SW2
SW3
SW4
SW5
SW6
13/03/2010
10/08/2010
7/01/2011
6/06/2011
3/11/2011
1/04/2012
29/08/2012
26/01/2013
25/06/2013
22/11/2013
21/04/2014
18/09/2014
15/02/2015
15/07/2015
12/12/2015
10/05/2016
Date

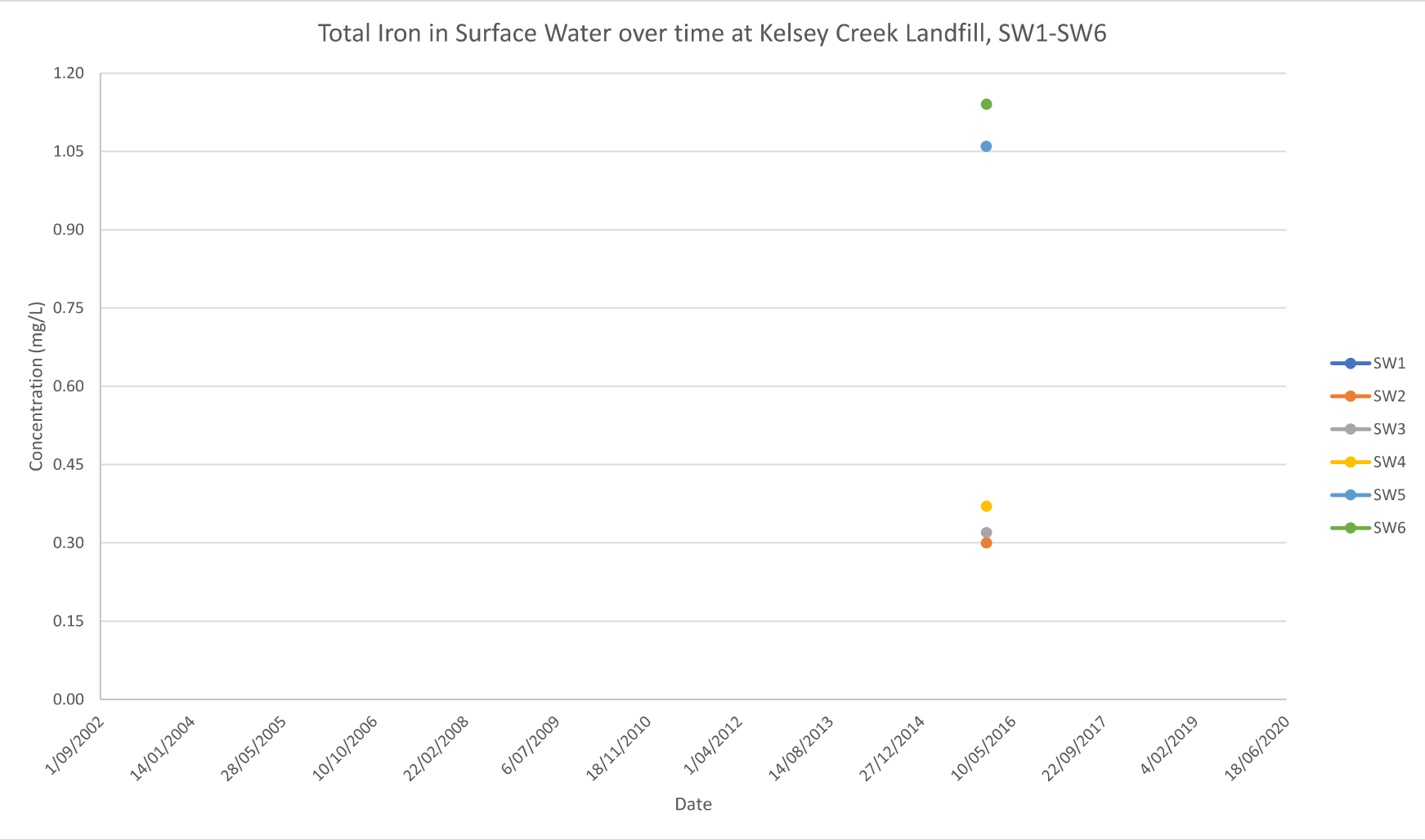

Total Manganese in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
5.000
4.500
4.000
3.500
3.000
2.500
2.000
1.500
1.000
0.500
0.000
13/03/2010
10/08/2010
7/01/2011
6/06/2011
3/11/2011
1/04/2012
29/08/2012
26/01/2013
25/06/2013
22/11/2013
21/04/2014
18/09/2014
15/02/2015
15/07/2015
12/12/2015
10/05/2016
Date
SW1
SW2
SW3
SW4
SW5
SW6

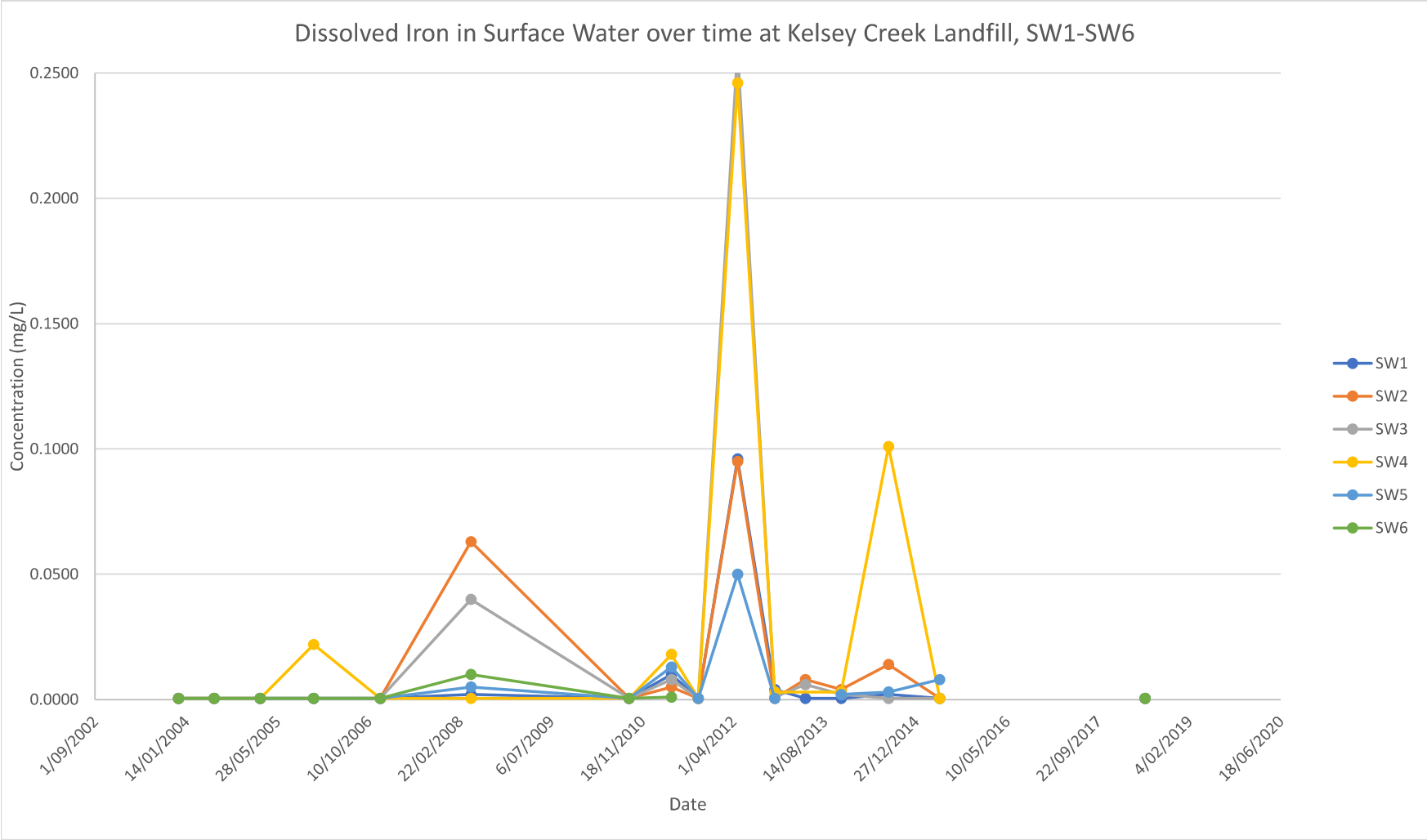

Total Mercury in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
0.00070
0.00060
0.00050
0.00040
0.00030
0.00020
0.00010
0.00000
Concentration (mg/L)
SW1
SW2
SW3
SW4
SW5
SW6
27/12/2014
15/07/2015
31/01/2016
18/08/2016
6/03/2017
22/09/2017
10/04/2018
27/10/2018
Date

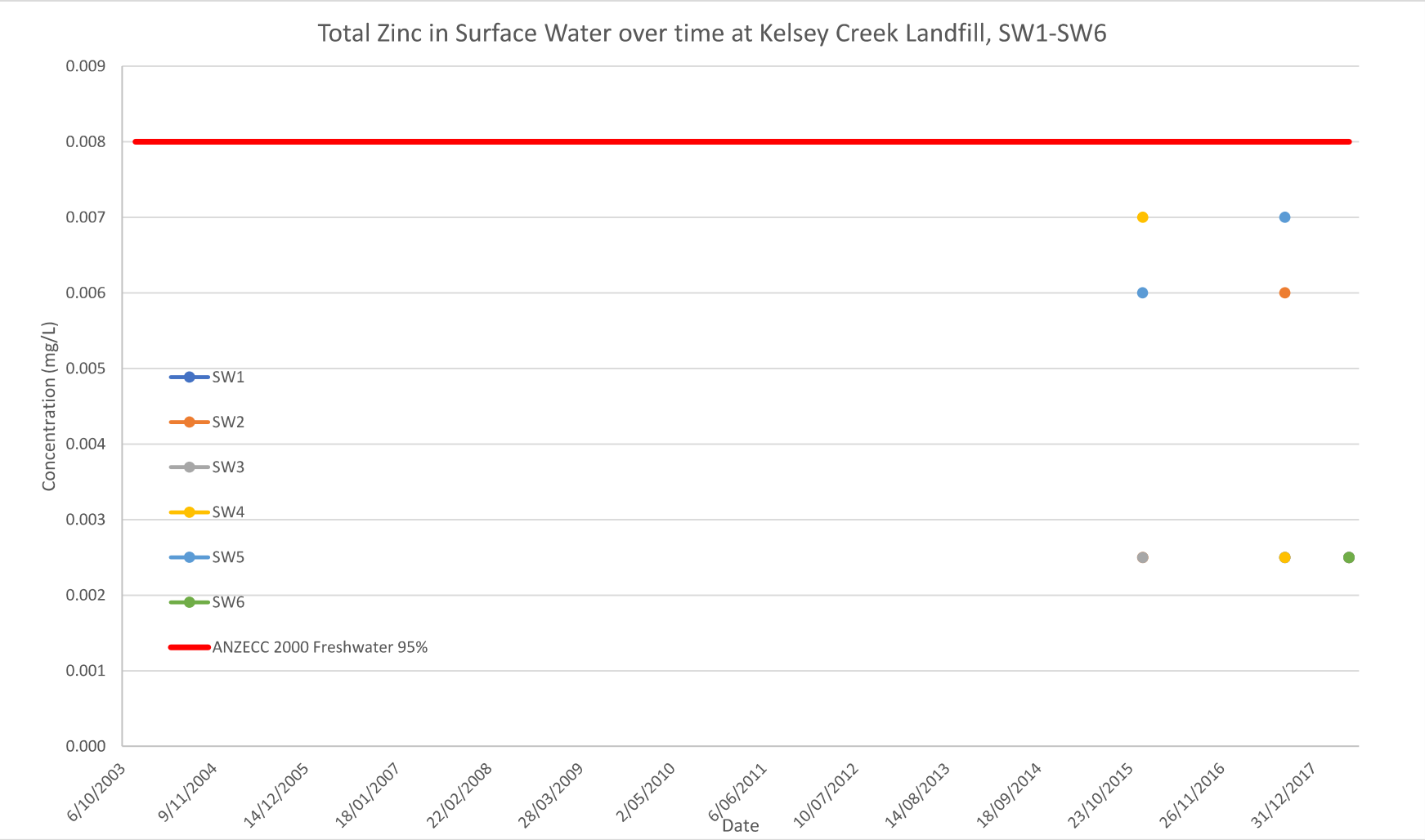

Total Mercury in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
1.05000
1.00000
0.95000
0.90000
0.85000
0.80000
0.75000
0.70000
0.65000
0.60000
0.55000
0.50000
0.45000
0.40000
0.35000
0.30000
0.25000
0.20000
0.15000
0.10000
0.05000
0.00000
9/05/2003
2/02/2006
29/10/2008
26/07/2011
21/04/2014
15/01/2017
12/10/2019
Date
SW1
SW2
SW3
SW4
SW5
SW6

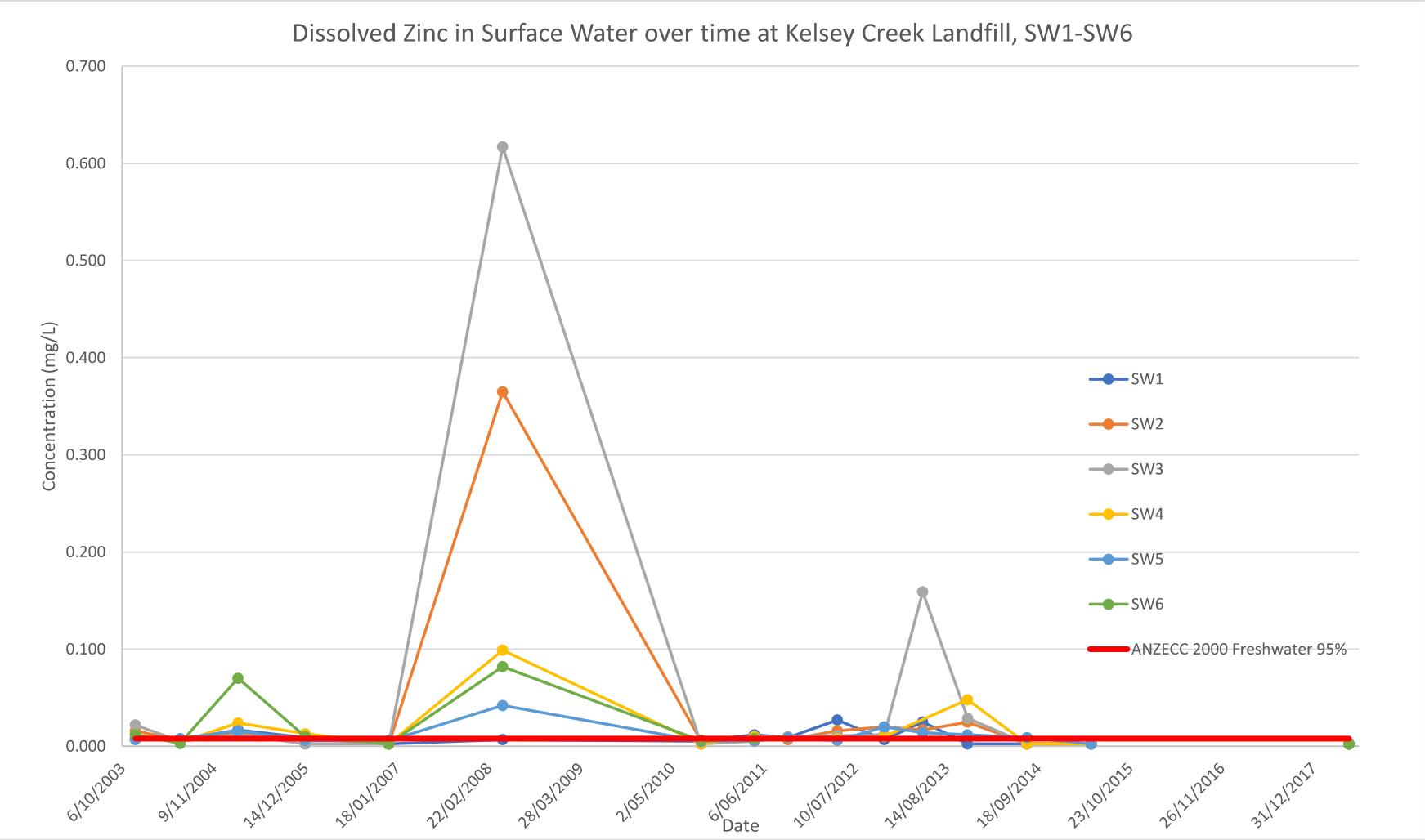

Total Nickel in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
0.012
0.010
0.008
0.006
0.004
0.002
0.000
Concentration (mg/L)
SW1
SW2
SW3
SW4
SW5
SW6
27/12/2014
31/01/2016
6/03/2017
10/04/2018
Date

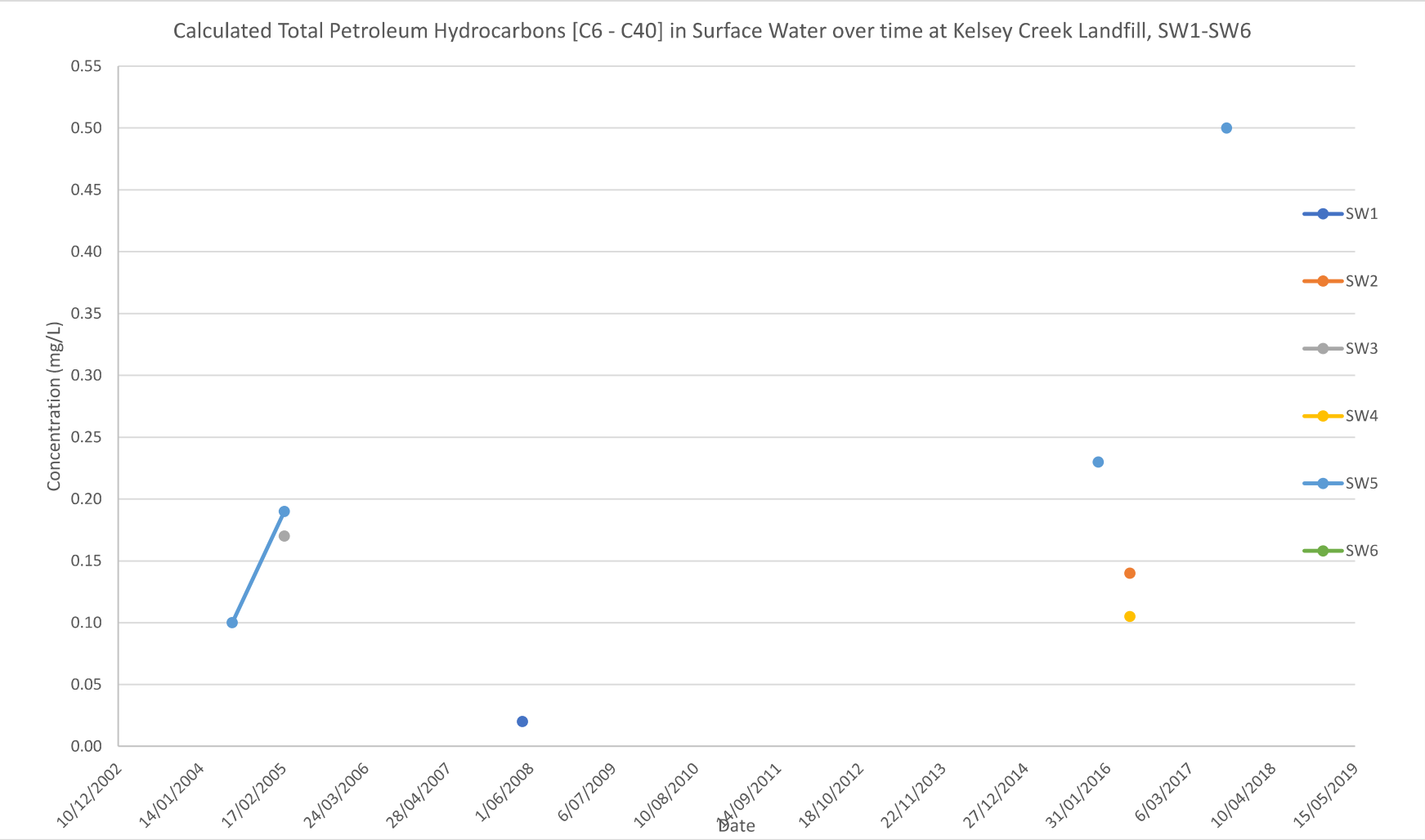

Dissolved Nickel in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
0.012
0.010
0.008
0.006
0.004
0.002
0.000
Concentration (mg/L)
SW1
SW2
SW3
SW4
SW5
SW6
1/09/2002
6/10/2003
9/11/2004
14/12/2005
18/01/2007
22/02/2008
28/03/2009
2/05/2010
6/06/2011
10/07/2012
14/08/2013
18/09/2014
23/10/2015
26/11/2016
31/12/2017
4/02/2019
Date


Total Iron in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
1.20
1.05
0.90
0.75
0.60
0.45
0.30
0.15
0.00
1/09/2002
14/01/2004
28/05/2005
10/10/2006
22/02/2008
6/07/2009
18/11/2010
1/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
4/02/2019
18/06/2020
Date
SW1
SW2
SW3
SW4
SW5
SW6


Dissolved Iron in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
0.2500
0.2000
0.1500
0.1000
0.0500
0.0000
1/09/2002
14/01/2004
28/05/2005
10/10/2006
22/02/2008
6/07/2009
18/11/2010
1/04/2012
14/08/2013
27/12/2014
10/05/2016
22/09/2017
4/02/2019
18/06/2020
Date
SW1
SW2
SW3
SW4
SW5
SW6


Total Zinc in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
0.009
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
0.000
SW1
SW2
SW3
SW4
SW5
SW6
ANZECC 2000 Freshwater 95%
6/10/2003
9/11/2004
14/12/2005
18/01/2007
22/02/2008
28/03/2009
2/05/2010
6/06/2011
10/07/2012
14/08/2013
18/09/2014
23/10/2015
26/11/2016
31/12/2017
Date

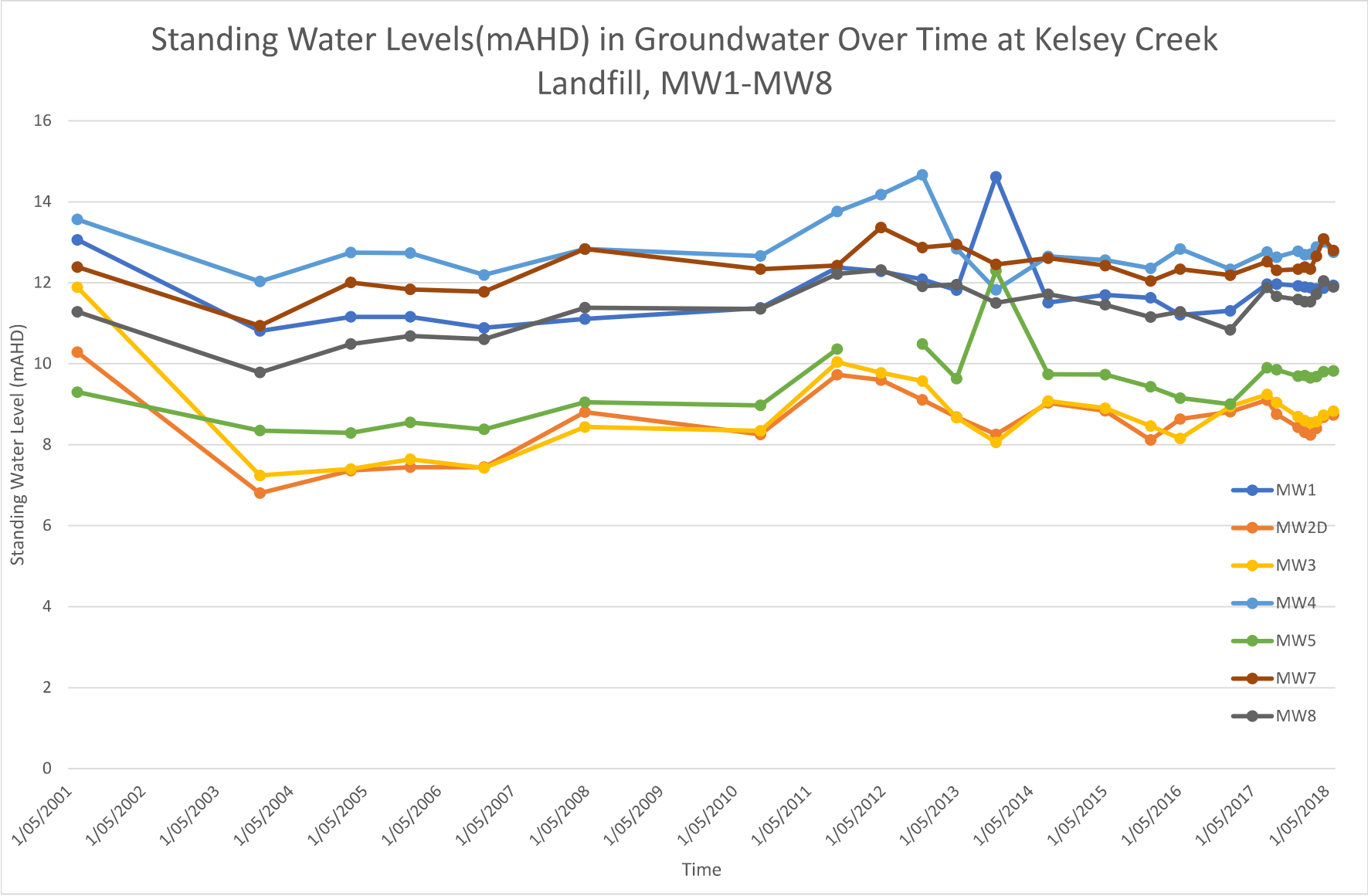

Dissolved Zinc in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
6/10/2003
9/11/2004
14/12/2005
18/01/2007
22/02/2008
28/03/2009
2/05/2010
6/06/2011
10/07/2012
14/08/2013
18/09/2014
23/10/2015
26/11/2016
31/12/2017
Date
SW1
SW2
SW3
SW4
SW5
SW6
ANZECC 2000 Freshwater 95%

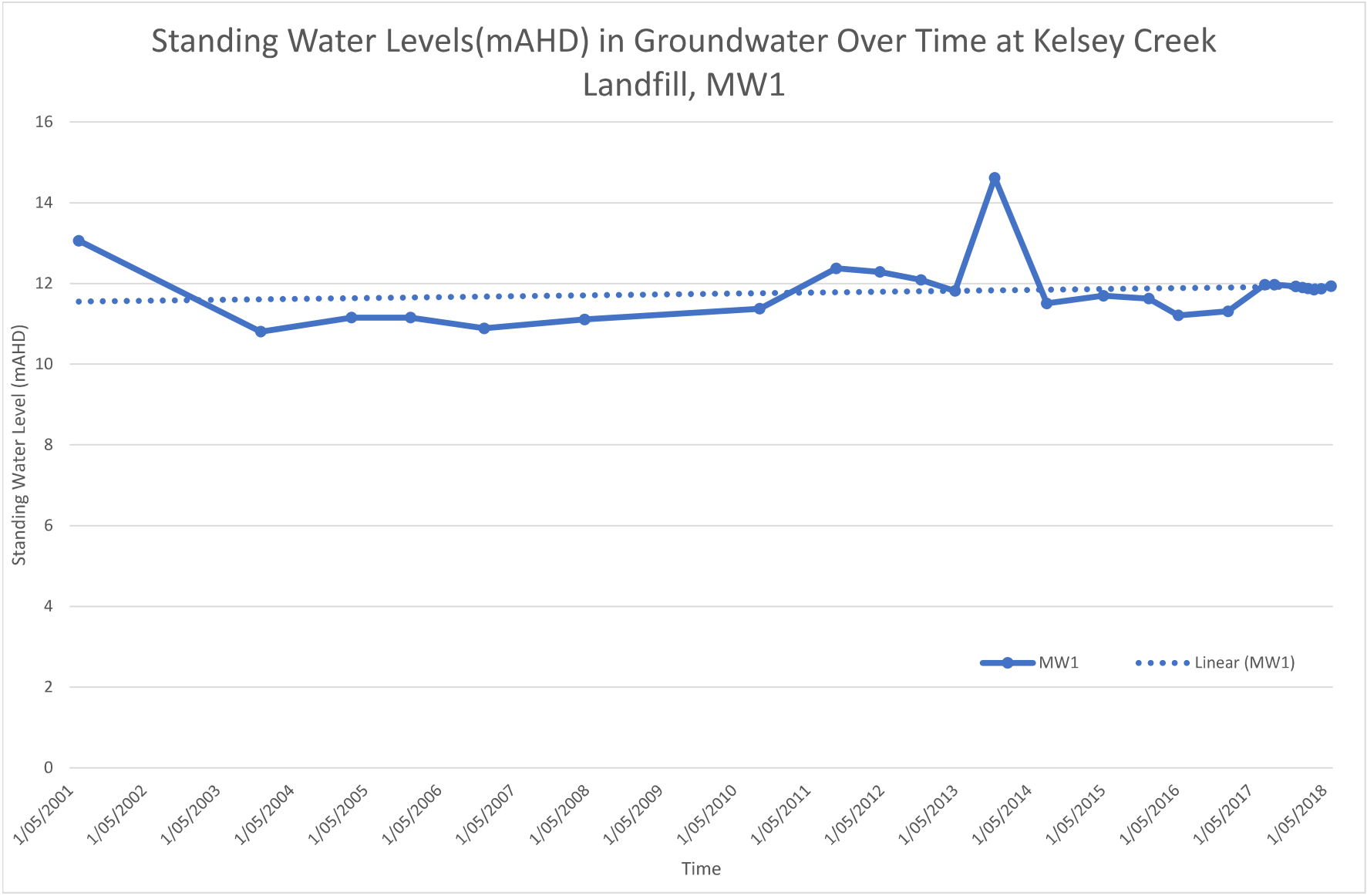

Calculated Total Petroleum Hydrocarbons [C6 - C40] in Surface Water over time at Kelsey Creek Landfill, SW1-SW6
Concentration (mg/L)
0.55
0.50
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
10/12/2002
14/01/2004
17/02/2005
24/03/2006
28/04/2007
1/06/2008
6/07/2009
10/08/2010
14/09/2011
18/10/2012
22/11/2013
27/12/2014
31/01/2016
6/03/2017
10/04/2018
15/05/2019
Date
SW1
SW2
SW3
SW4
SW5
SW6

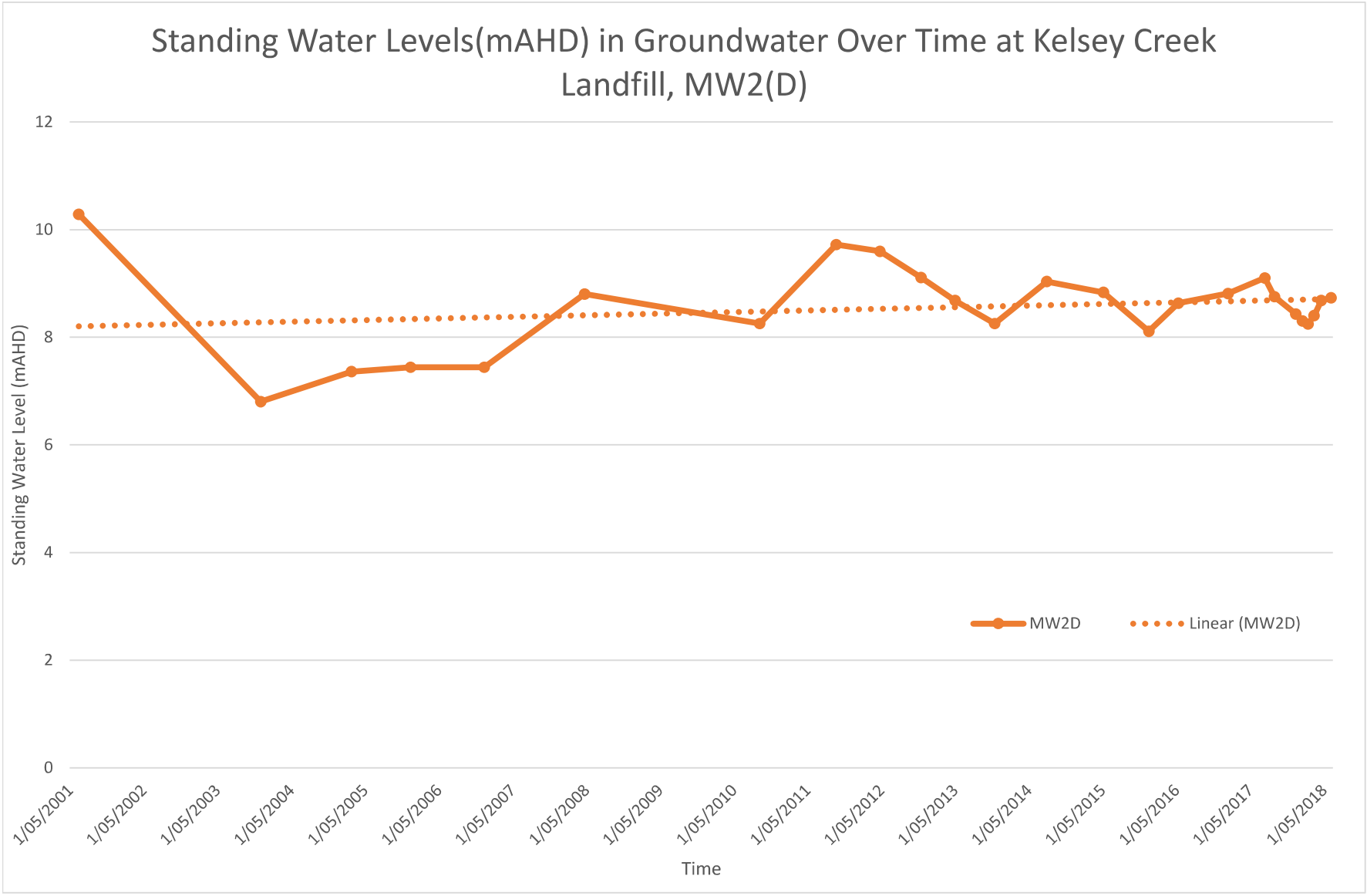
APPENDIX L

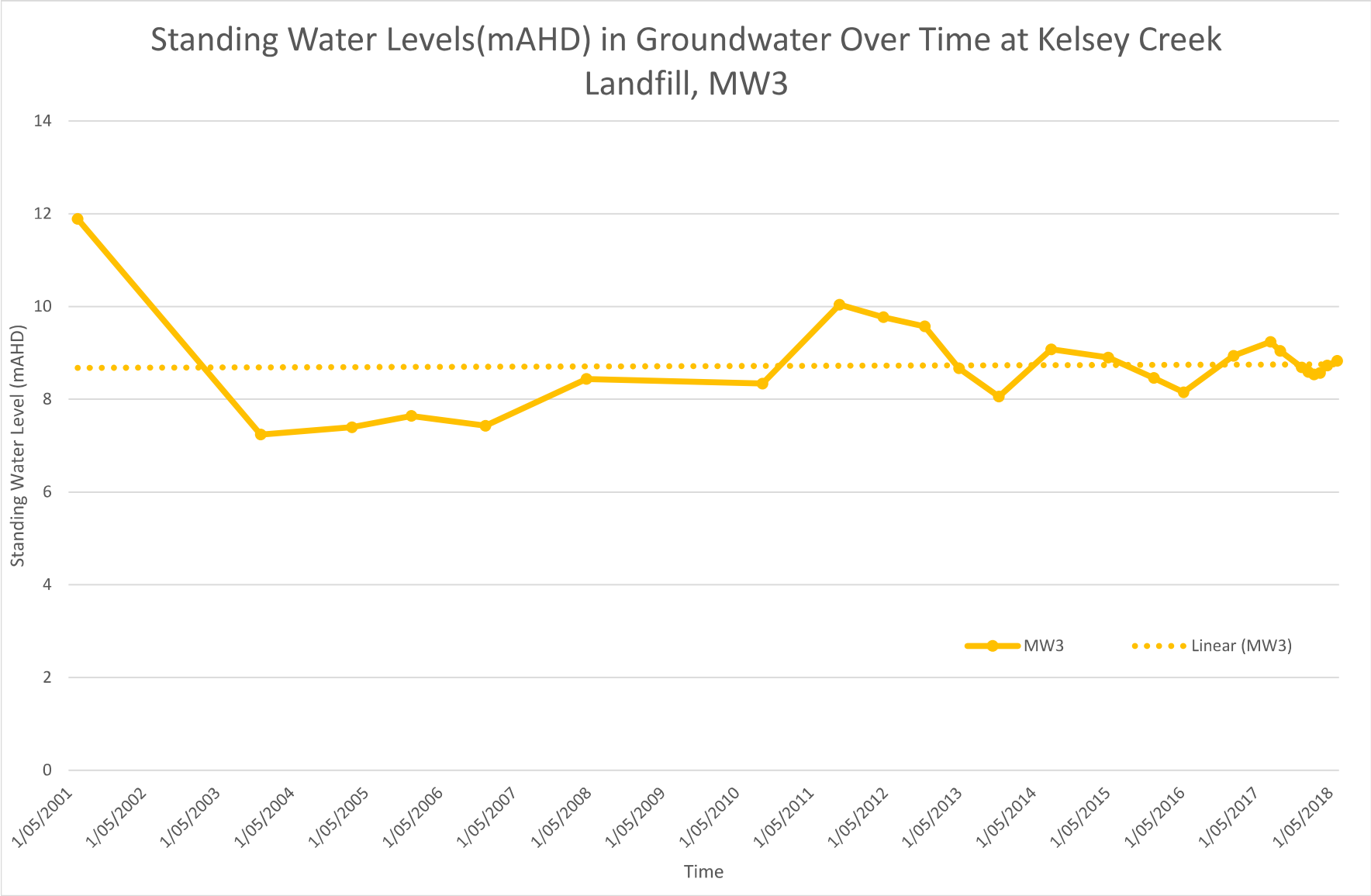
Standing Water Levels – Groundwater

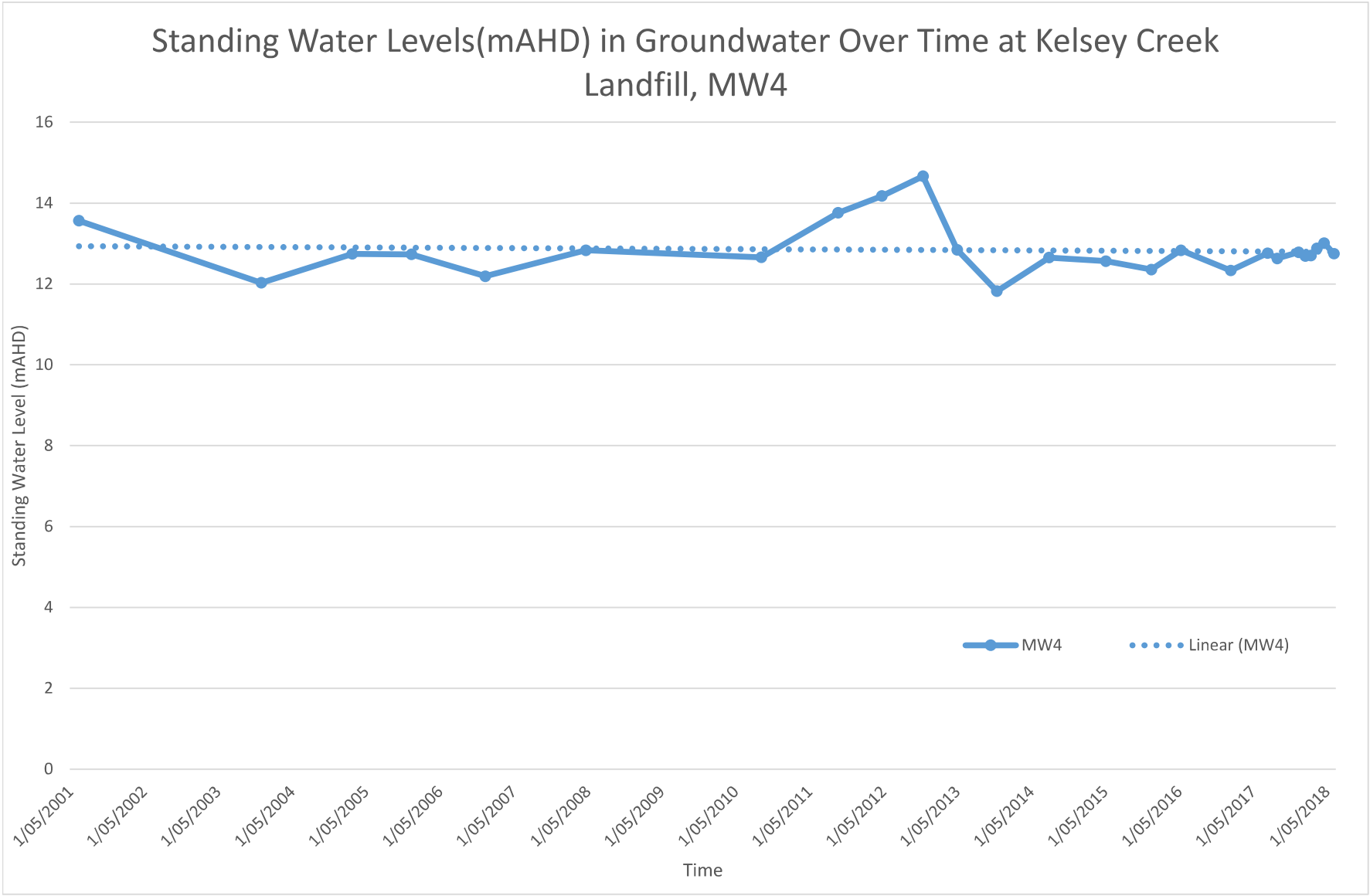
Appendix K Standing Water Level at Kelsey Creek Landfills

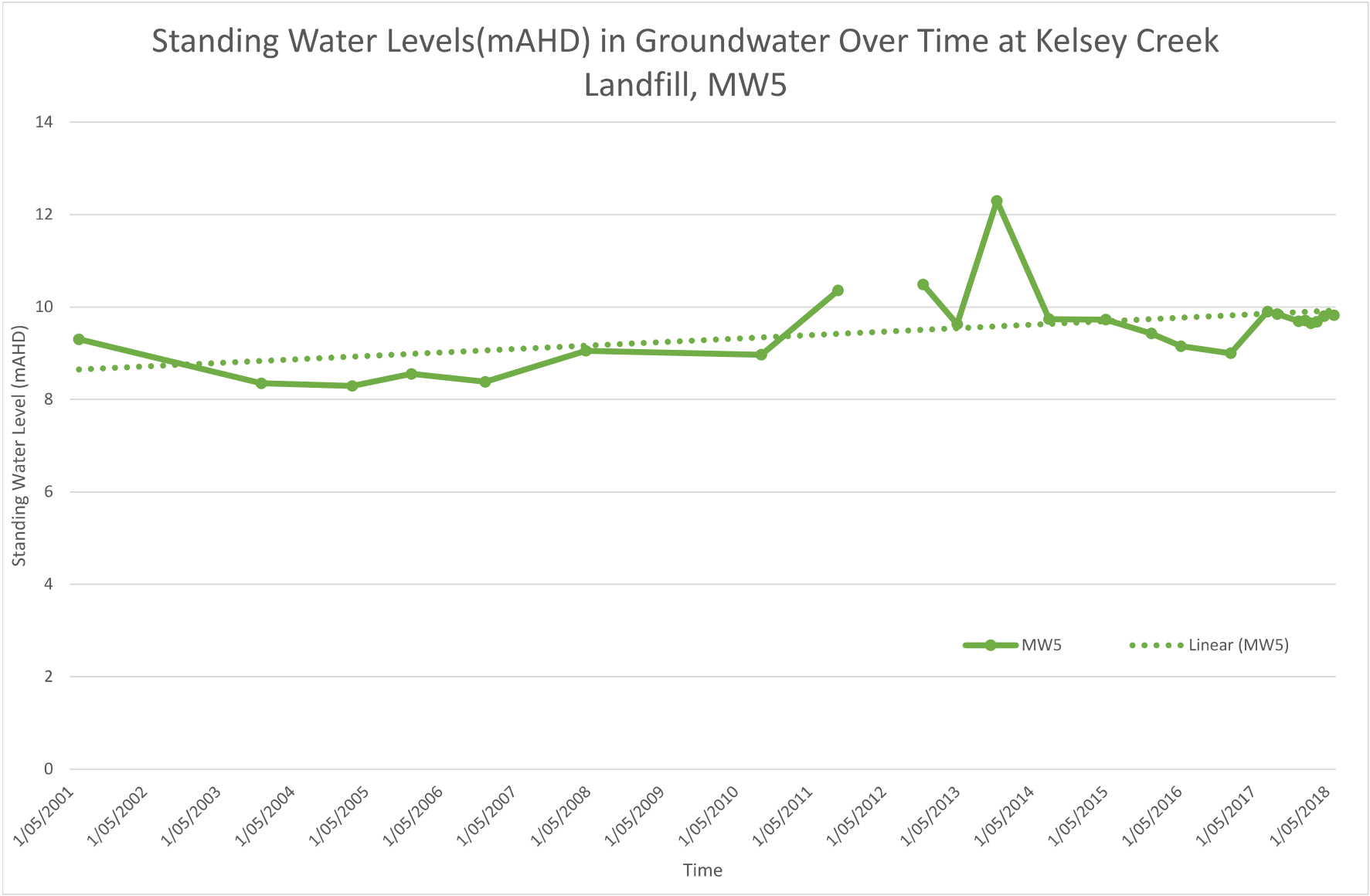


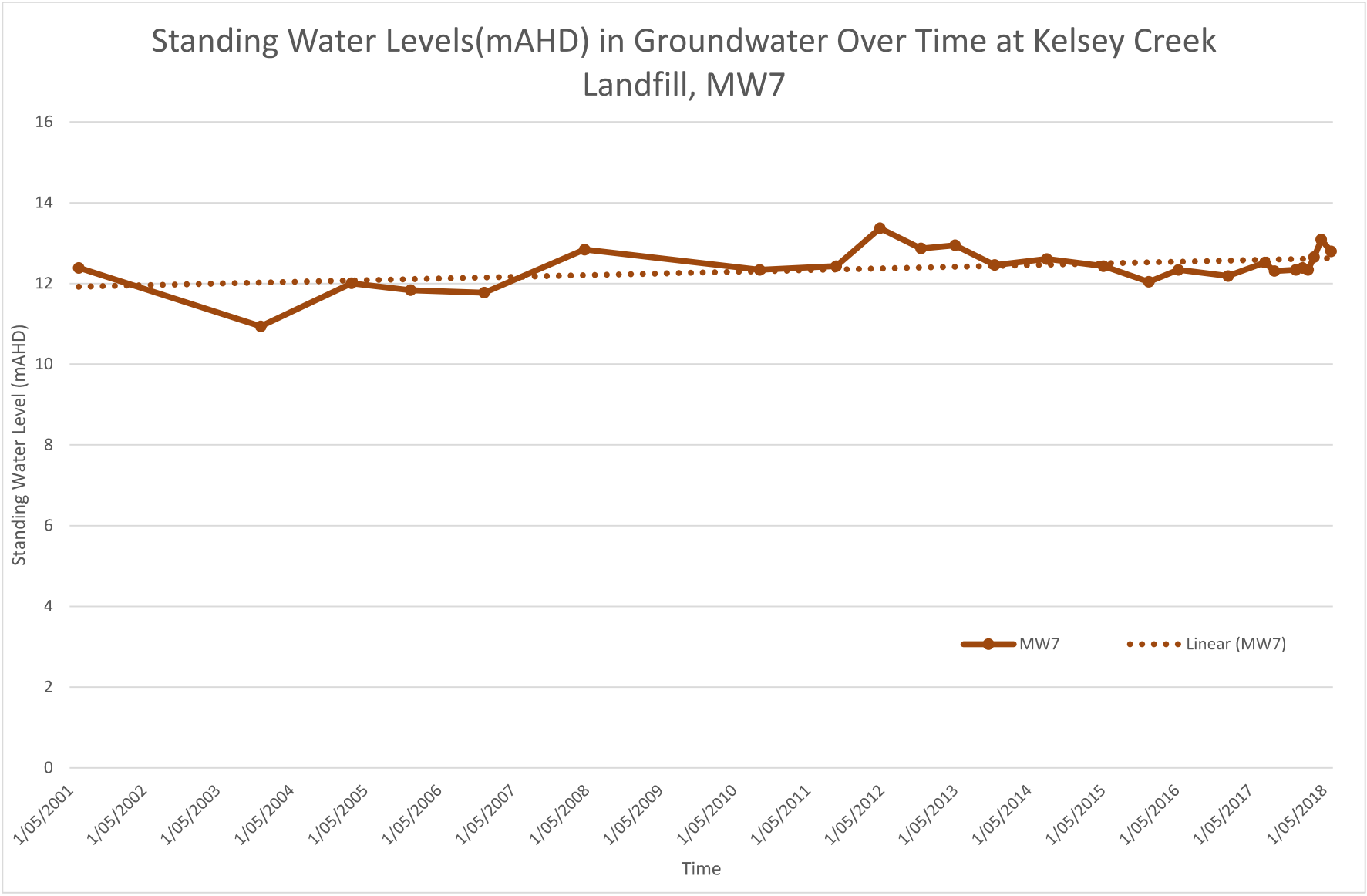

Standing Water Levels(mAHD) in Groundwater Over Time at Kelsey Creek Landfill, MW1
Standing Water Level (mAHD)
16
14
12
10
8
6
4
2
0
1/05/2001
1/05/2002
1/05/2003
1/05/2004
1/05/2005
1/05/2006
1/05/2007
1/05/2008
1/05/2009
1/05/2010
1/05/2011
1/05/2012
1/05/2013
1/05/2014
1/05/2015
1/05/2016
1/05/2017
1/05/2018
Time
MW1
Linear (MW1)

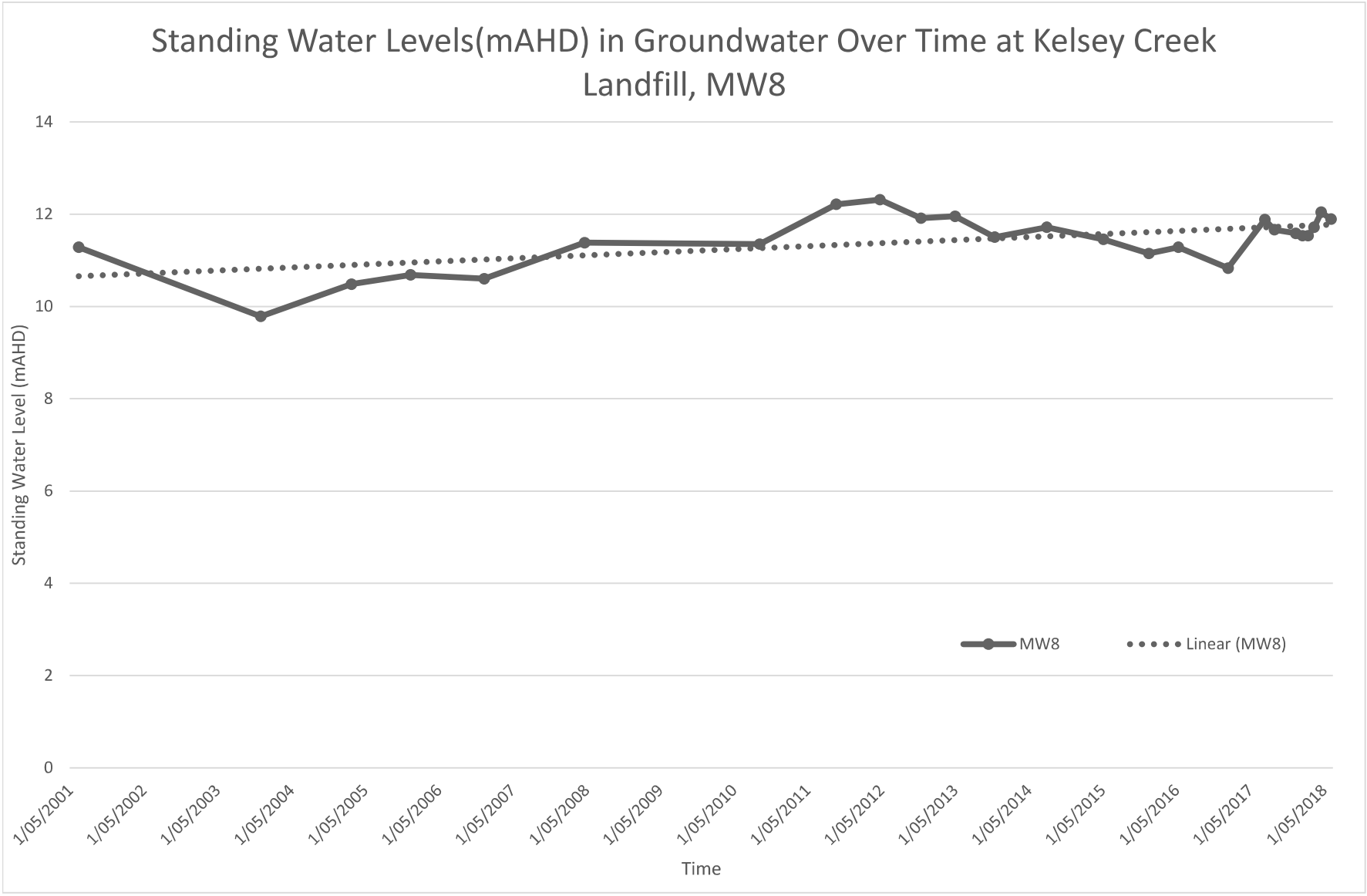

Standing Water Levels(mAHD) in Groundwater Over Time at Kelsey Creek Landfill, MW2(D)
Standing Water Level (mAHD)
12
10
8
6
4
2
0
MW2D
Linear (MW2D)
1/05/2001
1/05/2002
1/05/2003
1/05/2004
1/05/2005
1/05/2006
1/05/2007
1/05/2008
1/05/2009
1/05/2010
1/05/2011
1/05/2012
1/05/2013
1/05/2014
1/05/2015
1/05/2016
1/05/2017
1/05/2018
Time


Standing Water Levels(mAHD) in Groundwater Over Time at Kelsey Creek Landfill, MW3
Standing Water Level (mAHD)
14
12
10
8
6
4
2
0
1/05/2001
1/05/2002
1/05/2003
1/05/2004
1/05/2005
1/05/2006
1/05/2007
1/05/2008
1/05/2009
1/05/2010
1/05/2011
1/05/2012
1/05/2013
1/05/2014
1/05/2015
1/05/2016
1/05/2017
1/05/2018
Time
MW3
Linear (MW3)


Standing Water Levels(mAHD) in Groundwater Over Time at Kelsey Creek Landfill, MW4
Standing Water Level (mAHD)
16
14
12
10
8
6
4
2
0
1/05/2001
1/05/2002
1/05/2003
1/05/2004
1/05/2005
1/05/2006
1/05/2007
1/05/2008
1/05/2009
1/05/2010
1/05/2011
1/05/2012
1/05/2013
1/05/2014
1/05/2015
1/05/2016
1/05/2017
1/05/2018
Time
MW4
Linear (MW4)


Standing Water Levels(mAHD) in Groundwater Over Time at Kelsey Creek Landfill, MW5
Standing Water Level (mAHD)
14
12
10
8
6
4
2
0
1/05/2001
1/05/2002
1/05/2003
1/05/2004
1/05/2005
1/05/2006
1/05/2007
1/05/2008
1/05/2009
1/05/2010
1/05/2011
1/05/2012
1/05/2013
1/05/2014
1/05/2015
1/05/2016
1/05/2017
1/05/2018
Time
MW5
Linear (MW5)


Standing Water Levels(mAHD) in Groundwater Over Time at Kelsey Creek Landfill, MW7
Standing Water Level (mAHD)
16
14
12
10
8
6
4
2
0
1/05/2001
1/05/2002
1/05/2003
1/05/2004
1/05/2005
1/05/2006
1/05/2007
1/05/2008
1/05/2009
1/05/2010
1/05/2011
1/05/2012
1/05/2013
1/05/2014
1/05/2015
1/05/2016
1/05/2017
1/05/2018
Time
MW7
Linear (MW7)


Standing Water Levels(mAHD) in Groundwater Over Time at Kelsey Creek Landfill, MW8
Standing Water Level (mAHD)
14
12
10
8
6
4
2
0
MW8
Linear (MW8)
1/05/2001
1/05/2002
1/05/2003
1/05/2004
1/05/2005
1/05/2006
1/05/2007
1/05/2008
1/05/2009
1/05/2010
1/05/2011
1/05/2012
1/05/2013
1/05/2014
1/05/2015
1/05/2016
1/05/2017
1/05/2018
Time

APPENDIX M

Important Information

The document ("Report") to which this page is attached and which this page forms a part of, has been issued by Golder Associates Pty Ltd ("Golder") subject to the important limitations and other qualifications set out below.

This Report constitutes or is part of services ("Services") provided by Golder to its client ("Client") under and subject to a contract between Golder and its Client ("Contract"). The contents of this page are not intended to and do not alter Golder's obligations (including any limits on those obligations) to its Client under the Contract.

This Report is provided for use solely by Golder's Client and persons acting on the Client's behalf, such as its professional advisers. Golder is responsible only to its Client for this Report. Golder has no responsibility to any other person who relies or makes decisions based upon this Report or who makes any other use of this Report. Golder accepts no responsibility for any loss or damage suffered by any person other than its Client as a result of any reliance upon any part of this Report, decisions made based upon this Report or any other use of it.

This Report has been prepared in the context of the circumstances and purposes referred to in, or derived from, the Contract and Golder accepts no responsibility for use of the Report, in whole or in part, in any other context or circumstance or for any other purpose.

The scope of Golder's Services and the period of time they relate to are determined by the Contract and are subject to restrictions and limitations set out in the Contract. If a service or other work is not expressly referred to in this Report, do not assume that it has been provided or performed. If a matter is not addressed in this Report, do not assume that any determination has been made by Golder in regards to it.

At any location relevant to the Services conditions may exist which were not detected by Golder, in particular due to the specific scope of the investigation Golder has been engaged to undertake. Conditions can only be verified at the exact location of any tests undertaken. Variations in conditions may occur between tested locations and there may be conditions which have not been revealed by the investigation and which have not therefore been taken into account in this Report.

Golder accepts no responsibility for and makes no representation as to the accuracy or completeness of the information provided to it by or on behalf of the Client or sourced from any third party. Golder has assumed that such information is correct unless otherwise stated and no responsibility is accepted by Golder for incomplete or inaccurate data supplied by its Client or any other person for whom Golder is not responsible. Golder has not taken account of matters that may have existed when the Report was prepared but which were only later disclosed to Golder.

Having regard to the matters referred to in the previous paragraphs on this page in particular, carrying out the Services has allowed Golder to form no more than an opinion as to the actual conditions at any relevant location. That opinion is necessarily constrained by the extent of the information collected by Golder or otherwise made available to Golder. Further, the passage of time may affect the accuracy, applicability or usefulness of the opinions, assessments or other information in this Report. This Report is based upon the information and other circumstances that existed and were known to Golder when the Services were performed and this Report was prepared. Golder has not considered the effect of any possible future developments including physical changes to any relevant location or changes to any laws or regulations relevant to such location.

Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification



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