AGL Upstream Investments Pty Ltd

Tiedman Irrigation Trial - August 2013 Water Compliance Report

Gloucester Gas Project

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PARSONS BRINCKERHOFF

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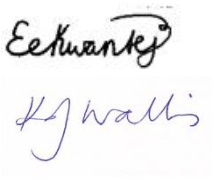
Prepared by:	Ellen Kwantes, Kelly-Jane Wallis	Date: 21/08/2013	Signature: 
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Glossary

Alluvium	Unconsolidated sediments (clays, sands, gravels and other materials) deposited by flowing water. Deposits can be made by streams on river beds, floodplains, and alluvial fans.
Alluvial aquifer	Permeable zones that store and produce groundwater from unconsolidated alluvial sediments. Shallow alluvial aquifers are generally unconfined aquifers.
Aquifer	Rock or sediment in a formation, group of formations, or part of a formation that is saturated and sufficiently permeable to transmit economic quantities of water.
Aquifer properties	The characteristics of an aquifer that determine its hydraulic behaviour and its response to abstraction.
Bore	A structure drilled below the surface to obtain water from an aquifer or series of aquifers.
Coal	A sedimentary rock derived from the compaction and consolidation of vegetation or swamp deposits to form a fossilised carbonaceous rock.
Coal seam	A layer of coal within a sedimentary rock sequence.
Coal seam gas (CSG)	Coal seam gas is a form of natural gas (predominantly methane) that is extracted from coal seams.
Concentration	The amount or mass of a substance present in a given volume or mass of sample, usually expressed as microgram per litre (water sample) or micrograms per kilogram (sediment sample).
Datalogger	A digital recording instrument that is inserted in monitoring and pumping bores to record pressure measurements and water level variations.
Electrical Conductivity (EC)	A measure of a fluid's ability to conduct an electrical current and is an estimation of the total ions dissolved. It is often used as a measure of water salinity.
Groundwater	The water contained in interconnected pores or fractures located below the water table in the saturated zone.
Micro Siemens per centimetre (µS/cm)	A measure of water salinity commonly referred to as EC (see also Electrical Conductivity). Most commonly measured in the field with calibrated field meters.
Monitoring bore	A non-pumping bore, is generally of small diameter that is used to measure the elevation of the water table and/or water quality. Bores generally have a short well screen against a single aquifer through which water can enter.
Recharge	The process which replenishes groundwater, usually by rainfall infiltrating from the ground surface to the water table and by river water reaching the

	water table or exposed aquifers. The addition of water to an aquifer.
Recharge area	A geographic area that directly receives infiltrated water from surface and in which there are downward components of hydraulic head in the aquifer. Recharge generally moves downward from the water table into the deeper parts of an aquifer then moves laterally and vertically to recharge other parts of the aquifer or deeper aquifer zones.
Salinity	The concentration of dissolved salts in water, usually expressed in EC units or milligrams of total dissolved solids per litre (mg/L TDS).
Salinity classification	Fresh water quality – water with a salinity <800 µS/cm. Marginal water quality – water that is more saline than freshwater and generally waters between 800 and 1,600 µS/cm. Brackish quality – water that is more saline than freshwater and generally waters between 1,600 and 4,800 µS/cm. Slightly saline quality – water that is more saline than brackish water and generally waters with a salinity between 4,800 and 10,000 µS/cm. Moderately saline quality – water that is more saline than brackish water and generally waters between 10,000 and 20,000 µS/cm. Saline quality – water that is almost as saline as seawater and generally waters with a salinity greater than 20,000 µS/cm. Seawater quality – water that is generally around 55,000 µS/cm.
Screen	A type of bore lining or casing of special construction, with apertures designed to permit the flow of water into a bore while preventing the entry of aquifer or filter pack material.
Water quality	Term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.
Water quality data	Chemical, biological, and physical measurements or observations of the characteristics of surface and ground waters, atmospheric deposition, potable water, treated effluents, and waste water and of the immediate environment in which the water exists.
Well	Pertaining to a gas exploration well or gas production well.

Abbreviations

AGL	AGL Upstream Investments Pty Ltd
BoM	Bureau of Meteorology
CSG	Coal seam gas
DRE	Division of Resources and Energy
GFDA	Gas Field Development Area
GGP	Gloucester Gas Project
NOW	NSW Office of Water
REF	Review of Environmental Factors
WMP	Water management plan

Units

m	metres
mAHD	metres Australian Height Datum
mbgl	metres below ground level

Executive summary

AGL Upstream Investments Pty Ltd (AGL) is proposing to develop the Gloucester Gas Project (GGP) which will comprise several stages of development; however, only one stage, the Stage 1 Gas Field Development Area (GFDA) is currently approved. A comprehensive groundwater investigation (Phase 2 Groundwater Investigations) was completed in early 2012 to confirm the hydrogeological conceptual model across the Stage 1 GFDA (Parsons Brinckerhoff 2012). Surface water and groundwater investigations are ongoing pending the commencement of the GGP.

As part of its current exploration program, AGL proposes to irrigate a maximum of 70 megalitres of produced water over a maximum area of 40 hectares over a three year period. The water from exploration programs, which is currently stored in the Tiedman and Stratford dams, is blended with water from freshwater sources to optimise the quality and use for irrigation. The (blended water) irrigation trial began on 29 April 2013 for the Stage 1A area and on 1 May 2013 for the Stage 1B area.

A surface water and groundwater monitoring program commenced in October 2011 and was established in accordance with the Water Management Plan (AGL 2012). The monitoring aims to ensure that the quality of the water used for irrigation is appropriate and that the application of irrigated water does not result in negative impacts on the local surface water or groundwater resources.

This compliance report (first in a series of three 6 monthly reports during the irrigation trial) is a requirement of the NSW Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS). The water monitoring program and compliance reporting must be in accordance with the approved water management plan.

There were a few minor exceedances of the adopted thresholds or guidelines during the monitoring period, however there is no change in natural surface water or groundwater quality, or water levels as a result of the current irrigation trial activities.

The water quality in the TSD was within the ANZECC (2000) guidelines for irrigation, with exception of pH, which exceeded the guideline by 0.09 pH units. The blended water in the TSD is considered suitable for irrigation.

1. Introduction

1.1 Gloucester Gas Project

AGL Upstream Investments Pty Ltd (AGL) is proposing to build the Gloucester Gas Project (GGP) which comprises several stages of development facilitating the extraction of coal seam gas (CSG) from the Gloucester Basin. Concept Plan and Project Approval (Part 3A Approval) for the Stage 1 Gas Field Development Area (GFDA) was granted on 22 February 2011 under Part 3A of the *Environmental Planning and Assessment Act (1979) (EP&A Act)*. In addition the project received approval under the *Environment Protection and Biodiversity Conservation Act (1999) (EPBC Act)* (EPBC Approval) on 11 February 2013.

The GGP will involve depressurising of deep groundwater and the extraction of gas from multiple coal seams within the Gloucester coal measures. Target coal seam depths will vary from site to site but are expected to range between 200 and 1000 metres below ground level (mbgl). The current GGP includes the construction, operation and decommissioning of not more than 110 coal seam gas wells and associated infrastructure, including gas and water gathering lines within the Stage 1 GFDA.

The dewatering of water bearing coal seams will result in produced water. Irrigation has been identified as the preferred water management and reuse method for produced water at Gloucester, and consequently an irrigation trial is underway to demonstrate the sustainability of irrigating salt tolerant crops on improved soils on AGL's Tiedman property at Stratford.

Part V approval under the *EP&A Act* for the irrigation program was issued in July 2012 (DRE 2012) for a period of two years.

1.2 Irrigation trial

AGL proposes to irrigate a maximum of 70 megalitres (ML) of produced water over a maximum area of 40 hectares (ha) over a two to three year period. This will include water from exploration programs which is currently stored in the Tiedman and Stratford dams, as well as any rainfall which falls in the dams and any additional water produced from the 2013 and 2014 exploration activities. This water will be blended with fresh water from sources including the Avon River to optimise the quality of the irrigated water.

The 40 ha irrigation area is divided into two areas, Stage 1A and 1B (Figure 1.1):

- Stage 1A is the intensive irrigation trial area serviced by a lateral move irrigator in the north-west portion of the Tiedman property. The lateral move irrigator irrigates a maximum area of 18.2 ha, including 16 x 0.77 ha plots (12.3 ha) incorporating four different soil improvements. A small additional (adjacent) area for enhancements to the trial program may also be serviced by the lateral move irrigator or irrigation line hydrants in the Stage 1A area.
- Stage 1B comprises the existing irrigation area of about 8.6 ha plus an expansion area to the west and south (if required). It is highly unlikely that this additional area of 21 ha will be required.

The irrigation water is a blended water mix with an electrical conductivity (EC) of around 1,500 µS/cm (although salinities up to 2000 µS/cm were proposed in the REF). The target water salinity is expected to be in the range 1,400 to 1,600 µS/cm. The blended water comprises an estimated ratio of three parts fresh water and one part produced water. Freshwater is sourced from local farm dams and the Avon River. The irrigation program will allow salt tolerant crops to be grown, with continuous cropping over summer and winter.

The main irrigation trial began on 29 April 2013 for the Stage 1A area and on 1 May 2013 for the Stage 1B area (using blended water). Low salinity produced water was also irrigated across the Stage 1B area from 16 October to 8 December 2012, to create some 'air space' in the Tiedman South produced water holding dam for blending the remaining produced water with fresh water sources.

During the quarter to 30 June 2013, 4.66 ML of blended irrigation water was applied to the Stage 1A area and 1.72 ML of blended irrigation water was applied to the Stage 1B area. Some 14.5 ML of (low salinity) produced water was previously applied to the Stage 1B area in late 2012.

1.3 Objectives

The objectives of the irrigation trial and the associated water monitoring program are to ensure that the quality of the water used for irrigation is appropriate and that the application of blended water does not result in negative impacts on the local surface water or groundwater resources. This monitoring program mostly focuses on the Stage 1A irrigation area, as it is the intensive irrigation trial area.

The water monitoring program and compliance reporting must be in accordance with the approved water management plan. Details of the approved water management plan are provided in section 2.3.

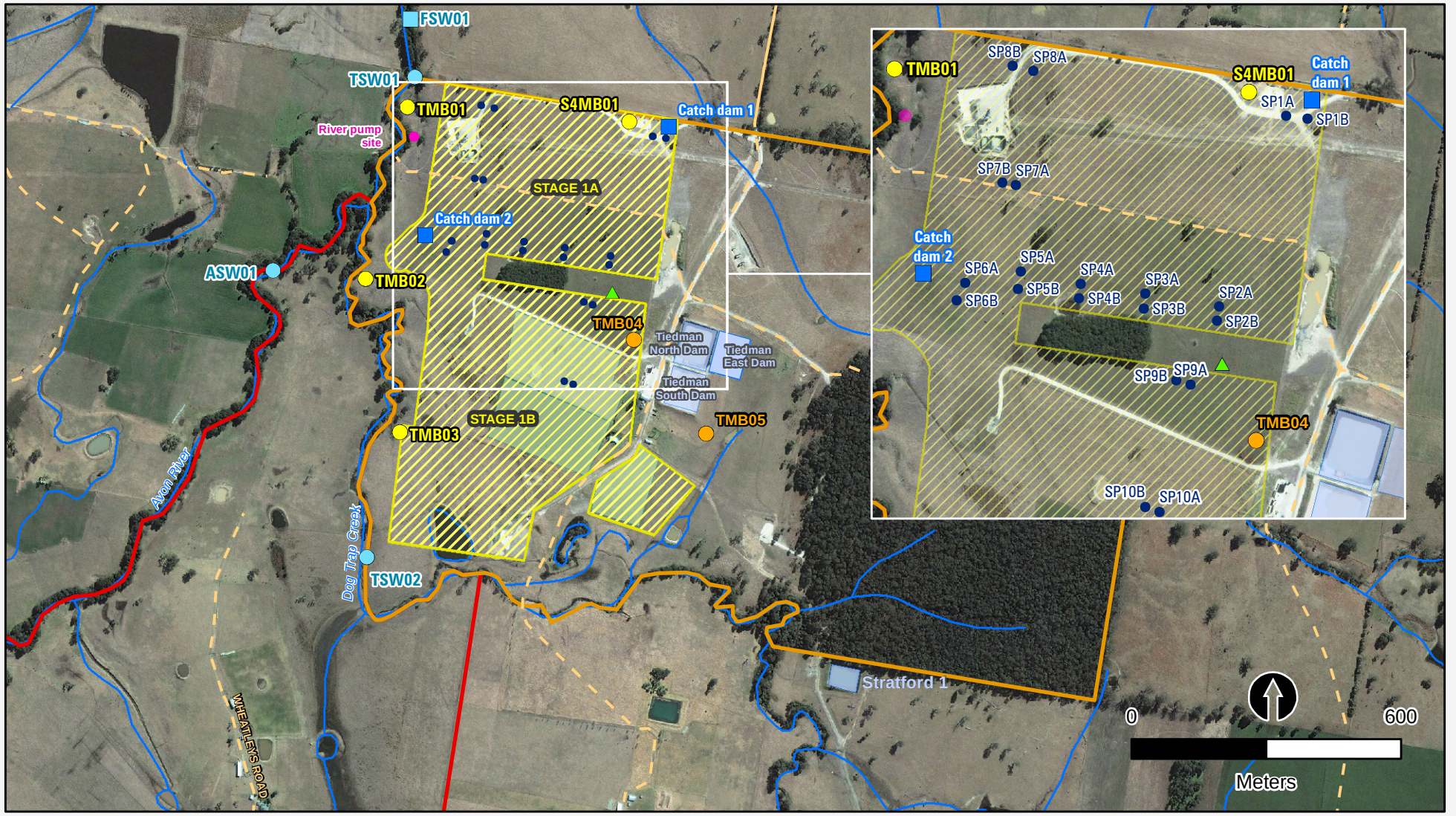
Approval for the irrigation trial was given by DTIRIS–Division of Resources and Energy (DRE) in July 2012.

This report presents the first compliance report of water level and quality data gathered for the three months of the irrigation trial between April 2013 and June 2013. Baseline monitoring data were used to derive site specific water quality guideline values determined where water quality analytes exceed the ANZECC (2000) criteria for irrigation purposes (Parsons Brinckerhoff 2013a).

1.4 Report structure

The structure of the report is as follows:

- Section 2: provides an overview of the monitoring network and methodology.
- Section 3: presents the results of monitoring of the Tiedmans water dams and the seepage monitoring locations.
- Section 4: presents the surface water monitoring results.
- Section 5: presents the groundwater monitoring results.
- Section 6: provides a discussion of the monitoring results for this reporting period.
- Section 7: presents conclusions and recommendations for future monitoring.
- Section 8: outlines limitations relating to analysis and reporting of data.
- Section 9: comprises the references used in this report.



Groundwater monitoring bore
Stream gauge
Surface water monitoring location
Seepage monitoring bore
Perched shallow piezometer
River pump site
AGL weather station
Catch dam
Produced water dam
Stage 1 irrigation area
Atkins Property
Tiedman Property
Roads
Tracks

Figure 1.1 Irrigation monitoring network

2. Monitoring network and methodology

2.1 Monitoring network and purpose

The water monitoring network during the period of the irrigation trial is summarised in Table 2.1 and shown on Figure 1.1.

Table 2.1 Summary of the water monitoring network

Monitoring category	Monitoring ID	Monitoring purpose	Assessment method	Monitoring commencement
Blended irrigation water	Tiedman south dam (TSD)	Monitor water quality of blended irrigation water	Compare against ANZECC (2000) irrigation guideline values	October 2011
Produced water	Tiedman north dam (TND) Tiedman east dam (TED)	Monitor water quality of produced water		October 2011 May 2013
Shallow alluvial groundwater	TMB01 TMB02 TMB03	Monitor groundwater levels and quality in the shallow alluvial aquifer adjacent to Dog Trap Creek and the Avon River for any potential impact from the project	Compare against site specific threshold values	February 2011
Shallow rock groundwater	S4MB01	Monitor water levels and quality in the first fractured bedrock aquifer for any potential impact from the project	Compare against site specific threshold values	January 2011
Perched groundwater # (seepage monitoring bores)	TMB04 TMB05	Detect any potential leakage from the dams to form perched water in the weathered rock profile adjacent to the dams	Compare with water quality in Tiedman dams	April 2011
Perched groundwater	SP1A/B to SP10A/B	Monitor perched groundwater quality in and near the irrigation area for any potential impact from the project		To be triggered when irrigation predominates over rainfall, and a perched water table develops
Surface water	ASW01 TSW01 TSW02 FSW01	Monitor water levels and quality of the Avon River and Dog Trap Creek for any potential impact from the project	Compare against site specific threshold values	March 2011 March 2011 April 2012 February 2012
Irrigation plot runoff	Catch dam 2 (CDW)	Monitor water quality of any irrigation plot runoff	Compare against site specific	May 2013

Monitoring category	Monitoring ID	Monitoring purpose	Assessment method	Monitoring commencement
	Catch dam 1 (CDE)		threshold values	

(1) Key # - these sites not monitored during the period.

The purpose of the groundwater and surface water monitoring locations for the Stage 1A and 1B irrigation trial areas are to assess and protect the possible receptors of blended irrigated water, including:

- surface water sources of the Avon River and Dog Trap Creek
- the alluvial aquifer, adjacent and down gradient of the irrigation areas
- the shallow bedrock aquifer below the irrigation areas.

The storage dams (Tiedman north, Tiedman south and Tiedman east dams) are of a 'turkey's nest' style construction and located on high ground (beyond the floodplain) and are designed to prevent ingress from surface run off. Tiedman south dam is the primary blended water irrigation dam and is monitored to determine if the blended water complies with the ANZECC (2000) irrigation water quality guidelines. Additional surface water locations are also monitored during high rainfall events to assess any runoff from the irrigation trial area.

The two seepage monitoring bores, TMB04 and TMB05, monitor any soil/perched water in the weathered rock profile adjacent to the Tiedman dams. The purpose of these bores is to detect any potential leakage from the dams. Details of these bores are provided at Table 2.2.

Table 2.2 Seepage monitoring bore details

Monitoring bore	Total depth (m)	Screened interval (mbgl)	Lithology
TMB04	15	8 – 14	Weathered rock
TMB05	10	6 – 9	Weathered rock

There are three stream gauges where surface water levels and quality are monitored, TSW01, TSW02 and ASW01 (Table 2.3). The FSW01 sampling location on Avon River downstream of Tiedman property is monitored during high rainfall events only and therefore was not sampled in May 2013.

Table 2.3 Stream gauges

Gauge ID	Location
TSW01	Avon River downstream of the confluence with Dog Trap Creek and the irrigation areas, adjacent to monitoring bore TMB01.
TSW02	Dog Trap Creek, upstream of the irrigation areas.
ASW01	Avon River upstream of the confluence with Dog Trap Creek.
FSW01	Avon River downstream of the Tiedman property and the confluence with Dog Trap Creek and the irrigation areas.

Three groundwater monitoring bores are screened within the shallow alluvial aquifer associated with the Avon River and Dog Trap Creek (TMB01, TMB02 and TMB03). One monitoring bore (S4MB01) is screened in the first fractured bedrock aquifer (Tiedman property). Details are presented in Table 2.4.

Table 2.4 Groundwater monitoring bore details

Monitoring bore	Total depth (m)	Screened interval (mbgl)	Lithology	Formation
TMB01	12.0	7 – 10	Clay	Avon River alluvium
TMB02	15.5	9 – 12	Mixed gravels	Avon River alluvium
TMB03	12.5	5 – 11	Mixed gravels and sand	Avon River alluvium
S4MB01	66.0	58 – 64	Sandstone	Shallow Rock: Leloma Formation

(1) mbgl -= meters below ground level.

2.2 Monitoring program

Water quality is the primary monitoring requirement at all sites, although water levels are also measured continuously at the dedicated stream gauges (ASW01, TSW02 and TSW01) and the dedicated shallow monitoring bores (TMB01, TMB02 and TMB03 and S4MB01). The seepage monitoring bores (TMB04 and TMB05) had dataloggers installed in May 2013 as part of an expanded water level monitoring program.

The salinity of the blended irrigation water is tracked via a salinity (EC) logger in the TSD. This logger has been operational since late 2011. It was taken out of TSD in December 2012 and not deployed for several months. On the completion of the new produced water dam, it was moved to the TED on 12 March 2013 rather than reinstalled in the TSD due to operation and maintenance requirements. Desludging activities were subsequently carried out on both TND and TSD in April-June 2013. These activities were completed in July 2013 and it is planned to relocate the EC logger back into the TSD dam in August 2013. EC loggers were installed at CDW and CDE on 7 May 2013 and data until 30 June 2013 has been included in this compliance report.

Quarterly water monitoring is undertaken and scheduled at most sites with six monthly reporting. The water compliance reporting events are aligned with soils compliance reporting events. The schedule of sampling events and reporting is provided in Table 2.5.

Table 2.5 Schedule of sampling/reporting events

Event	Type	Sampling event	Compliance report
Baseline #	Water Soil	October 2011 – September 2012 January 2013	January 2013 May 2013
Irrigation 1 #	Water Soil	May 2013 May 2013	August 2013 (this report) August 2013
Irrigation 2	Water Soil	August 2013 and November 2013 November 2013	January 2014 January 2014
Irrigation 3	Water Soil	February 2014 and May 2014 May 2014	July 2014 July 2014

(1) # - completed events.

Groundwater level monitoring commenced in January 2011 and surface water level monitoring commenced in March 2011. The baseline water quality monitoring program commenced in October 2011 and was reported in January 2013 (Parsons Brinckerhoff 2013a) following 12 months of baseline data collection. The majority of the monitoring network has been in place since January 2011 as part of the extensive groundwater investigation for the Stage 1 GFDA, as described in Parsons Brinckerhoff (2012).

The ten paired shallow perched piezometers (SP1A/B to SP10A/B; 0.3-1.2 m and 1.5 m deep) within and just outside the trial irrigation area (Stage 1A) were not sampled during the reporting period. Water levels are provided in the soils compliance report (Fodder King 2013).

FSW01 (d/s Avon River), Catch dam 2 (CDW) and Catch dam 1 (CDE) will be monitored during high rainfall events. The catch dams were monitored for water quality during the reporting period; however FSW01 was not included in the May 2013 monitoring program.

A pre-irrigation water sample was taken from the TSD on 24 April 2013 and a comprehensive suite of samples was taken from all (operational) monitoring locations in May 2013.

2.3 Approved water management plan

The water management plan (WMP) was prepared, as requested by the NSW Office of Water (NOW) as part of the Review of Environmental Factors (REF) approval process. The WMP is titled '*Water Management Plan for the Tiedman Irrigation Program – Gloucester'* (AGL 2012). The WMP was based on the outline provided in the REF (Parsons Brinckerhoff 2011), NOW's letter of 12 August 2011, baseline monitoring initiated by AGL, discussions with NOW in December 2011, and additional information provided in February 2012.

Approval for the irrigation trial was given by DTIRIS–Division of Resources and Energy (DRE) in July 2012. Table 2.6 summarises the groundwater and surface water monitoring scope as outlined in the WMP.

Table 2.6 Groundwater and surface water monitoring scope

Monitoring ID	Description	Water levels	Routine water quality and sampling frequency	Extra sampling event
Tiedman north dam (TND)	Tiedman north dam	Not required	Metals, nutrients, cations/anions – quarterly Hydrocarbons – annually	Physical parameters – monthly
Tiedman south dam (TSD)	Tiedman south dam	Not required	Salinity logger – continuous Metals, nutrients, cations/anions – quarterly Hydrocarbons – annually	Physical parameters – monthly
Tiedman east dam (TED)	Tiedman east dam	Not required	Metals, nutrients, cations/anions – quarterly Hydrocarbons – annually	Physical parameters – monthly
Catch dam 1 (CDE)	North-east of irrigation trial area	Not required	Salinity logger – continuous	Physical parameters, metals, nutrients, cations/anions –subject to test results from Catch Dam 1 (CDW) overflow event
Catch dam 2 (CDW)	South-west of irrigation trial area	Not required	Salinity logger – continuous	Physical parameters, metals, nutrients, cations/anions – sample and test first overflow event only then assess for future events
TMB04	Seepage monitoring bore, located west	Manual dips	Physical parameters then purge dry and	Physical inspection of surrounding area –

Monitoring ID	Description	Water levels	Routine water quality and sampling frequency	Extra sampling event
	of Tiedman north dam	quarterly	assess inflows – quarterly If inflow within 12-hours then physical parameters again, metals, nutrients, cations/anions	monthly
TMB05	Seepage monitoring bore, located south of the Tiedman dams	Manual dips quarterly	Physical parameters then purge dry and assess inflows – quarterly If inflow within 12-hours then physical parameters again, metals, nutrients, cations/anions	Physical inspection of surrounding area – monthly
ASW01	Avon River (upgradient), located on the Atkins property	Yes continuous	Salinity logger – continuous Nominal physical parameters, metals, nutrients, cations/anions – quarterly Hydrocarbons – annually	None planned
TSW02	Dog Trap Creek	Yes continuous	Salinity logger – continuous Physical parameters, metals, nutrients, cations/anions – quarterly Hydrocarbons – annually	None planned
TSW01	Avon River, located downgradient of the Tiedman boundary	Yes continuous	Salinity logger – continuous Nominal physical parameters, metals, nutrients, cations/anions –quarterly Hydrocarbons – annually	None planned
FSW01	Avon River, located downgradient, on the Farley property	Not required	Physical parameters, metals, nutrients, cations/anions – quarterly Hydrocarbons – annually	Physical parameters, metals, nutrients, cations/anions – sample and test first overflow event only then assess for future events
TMB01	Avon River alluvium, located downgradient, on the site boundary	Yes continuous	Nominal physical parameters, metals, cations/anions – quarterly Hydrocarbons and nutrients – annually	None planned
TMB02	Avon River/Dog Trap Creek alluvium (mid site)	Yes continuous	Nominal physical parameters, metals, cations/anions – quarterly Hydrocarbons and nutrients – annually	None planned

Monitoring ID	Description	Water levels	Routine water quality and sampling frequency	Extra sampling event
TMB03	Dog Trap Creek alluvium (southern site)	Yes continuous	Nominal physical parameters, metals, cations/anions – quarterly Hydrocarbons and nutrients – annually	None planned
S4MB01	Northern site boundary (rock aquifer)	Yes continuous	Nominal physical parameters, metals, cations/anions – quarterly Hydrocarbons and nutrients – annually	None planned

2.4 Water level monitoring

2.4.1 Groundwater level monitoring

Groundwater levels are electronically and manually measured in all monitoring bores. Pressure transducers with dataloggers suspended in the monitoring bore water column are programmed to record a groundwater level measurement every six hours. Manual measurements using an electronic dip meter are recorded every monitoring round and this is used to calibrate the logger data.

A barometric datalogger installed above the water table at S5MB01, located approximately 1 km to the east of the irrigation trial area, records changes in atmospheric pressure. Data from this logger are used to correct for the effects of changing barometric pressure and barometric efficiency on groundwater levels.

2.4.2 Surface water level monitoring

Stream gauge stations include gauge boards and dataloggers to continuously monitor surface water levels and EC. Loggers installed at the stream gauges are set to take a reading every 15 minutes (at TSW01 and ASW01) or 60 minutes (TSW02). All measurements are verified and calibrated by manual gauge readings and EC measurements.

2.5 Water quality monitoring

Routine water quality sampling was completed at all the nominated sites in Table 2.6 during the period. Salinity (EC) loggers are installed at three river locations (ASW01, TSW02 and TSW01), the blended water irrigation dam (TSD) (until March 2013), the Tiedman Dam East (TED) (March - June 2013) and in the two catch dams (CDW and CDE).

EC measurements are recorded electronically and manually measured during quarterly sampling events. The EC dataloggers suspended in the dams and surface water are programmed to record EC measurements every six hours.

2.5.1 Methodology

Three sampling methods were used to obtain surface water and groundwater samples:

- Submersible Whale pump at groundwater monitoring bores screened within relatively permeable geological materials, TMB01, TMB02 and TMB03. A minimum of three well volumes was purged prior to sampling.
- Submersible Whale pump at the seepage monitoring bores TMB04 and TMB05 which are screened within material of very low permeability. The physical parameters of the purged groundwater were initially tested, then the bores were purged dry and if any inflow was observed within 12 hours then physical parameters were tested again and a sample taken for analysis.
- In-situ snap sampler for groundwater monitoring bore S4MB01, screened within material of relatively low permeability.
- Grab sample using a rinsed sampling bucket for surface water samples.

EC and pH were monitored during purging to ensure that they had stabilised prior to sample collection. Samples were sent to a NATA accredited laboratory for analysis, under the appropriate chain-of-custody protocols for chemical analysis. A comprehensive water quality monitoring suite was adopted for the May 2013 event (details are provided in Table 2.7).

Table 2.7 Analytical suite (May 2013)

Category	Parameters	
Field parameters	EC Temperature Dissolved oxygen	Redox potential pH
General parameters	EC Total suspended solids	Total dissolved solids (TDS)
Major ions	Calcium Magnesium Sodium Potassium	Chloride Bicarbonate Sulphate Fluoride Dissolved silica
Metals and minor/trace elements	Aluminium Arsenic Barium Boron Beryllium Bromine Cadmium Cobalt Copper Iron	Manganese Molybdenum Mercury Nickel Lead Selenium Strontium Uranium Vanadium Zinc
Nutrients	Total nitrogen Ammonia Phosphorus (reactive)	Nitrate Nitrite Total organic carbon (TOC)
Hydrocarbons	Phenol compounds Polycyclic aromatic hydrocarbons (PAH)	Total petroleum hydrocarbons (TPH)/total recoverable hydrocarbons (TRH) Benzene, toluene, ethyl benzene

		and xylenes (BTEX)
Dissolved gases*	Methane	

(1) * Only for the Tiedman dams and surface water monitoring locations.

Water quality samples were collected in the sample bottles provided by the laboratory, with the appropriate preservation when required. Table 2.8 details the sample bottles used. Samples undergoing dissolved metal analysis were filtered through 0.45 µm filters in the field prior to collection.

Table 2.8 Sample bottles

Category	Sample bottle
Major cations/anions	1 x 1 L plastic, unpreserved
Dissolved metals	1 x 60 mL plastic, preserved
Nutrients	1 x 125 mL plastic, preserved
TOC	1 x 40 mL amber glass, preserved
Phenols/PAH/TPH (C_{10}-C_{36})	1 x 500 mL amber glass, unpreserved
TPH (C_6-C_9)/BTEX	2 x 40 ml amber glass, preserved
Methane	2 x 40 ml amber glass, preserved

2.5.2 Assessment criteria

The guidelines for fresh and marine water quality (ANZECC 2000) recommend developing site specific guideline values that are derived from local reference data. Section 7.4.4.1 of the ANZECC guidelines details the requirement of a minimum of two years of continuous monthly data at the reference site to establish a valid threshold value taken at the 80th percentile. The guideline allows for the threshold value to be modified as new baseline data become available by applying a rolling 80th percentile value incorporating the latest 24-month monitoring period. Where data are insufficient to calculate a valid threshold value, the guideline recommends deriving a single value from available data as an interim measure and to compare the median of the test site data to this value. Table 2.9 details the procedure adopted to derive site specific threshold values.

Table 2.9 Threshold values (ANZECC 2000)

Type	Samples required	Threshold value
Initial	1 to 7 consecutive samples	The highest detected value, or laboratory detection limit if undetected
Interim	8 to 17 consecutive samples	The 80th percentile of baseline data for each water type group, or the 80th percentile of baseline for the highest reading in that water type group, or laboratory detection limit if undetected
Final	18 to 24 consecutive samples	

The highest detected values have been adopted on the assumption that the baseline data (Parsons Brinckerhoff 2013a) reflects natural (pre-irrigation) conditions at the site. No thresholds are provided for irrigation plot runoff to the catch dams as these were first monitored in May 2013.

The water quality and irrigation guidelines together with the site specific threshold values derived from the (pre-irrigation) baseline monitoring (Parsons Brinckerhoff 2013a) for alluvial groundwater, shallow bedrock groundwater and surface water are provided in Table 2.10. No thresholds are provided for perched groundwater at the Tiedman Dams because the soil/pore water is not a water source.

Table 2.10 Site specific threshold values and ANZECC (2000) irrigation guidelines

Analyte	Alluvial aquifer threshold value	Shallow bedrock threshold value	Surface water threshold value	ANZECC – irrigation guideline value[+]
pH (range)	6.5-8.0*~	6.5-8.0*~	6.5-8.0*~	6 – 9
EC (µS/cm)	8,500	6,200	125-2,200*~	2,000^
Sodium (mg/L)	N/A	N/A	N/A	460[#]
Aluminium (mg/L)	0.055~	0.055~	0.34	5
Boron (mg/L)	N/A	N/A	N/A	5
Cadmium (mg/L)	0.0002~	0.0002~	0.0004	0.01
Copper (mg/L)	0.006	0.002	0.007	0.2
Manganese (mg/L)	1.9~	1.9~	1.9~	0.2
Molybdenum (mg/L)	N/A	N/A	N/A	0.01
Nickel (mg/L)	0.011~	0.011~	0.011~	0.2
Zinc (mg/L)	0.15	0.021	0.19	2
Total P (mg/L)	0.1	0.07	0.21	0.05
Ammonia (mg/L)	0.37	2.45	0.22	N/A

(1) ~ ANZECC 2000 - Water Quality Guidelines: 95% protection levels (threshold values) for the protection of freshwater aquatic ecosystems are adopted when maximum analyte concentration is lower than applicable ANZECC (2000) guideline value.

(2) * ANZECC 2000 – Water Quality Guideline: 95% protection levels for aquatic ecosystems, South-East Australia, low lying river ecosystems.

(3) + ANZECC 2000 - Water Quality Guidelines: Water quality for irrigation waters and general use, long-term threshold values.

(4) # medium risk of increasing crop cadmium concentrations and foliar injury in moderately tolerant crops.

(5) ^ Average root zone salinity threshold for Lucerne, Hunter River.

(6) – Maximum analyte concentration is lower than applicable ANZECC (2000) guideline value and thus no threshold value is required.

(7) N/A – no guideline values, and thus no threshold value.

3. Tiedman dams and seepage monitoring

3.1 Water quality results

The main water quality analytes for the Tiedman dams (TSD, TND and TED) and seepage monitoring bores (TMB04 and TMB05) are presented in Table 3.1 (and the full suite in Appendix A). The monthly water quality parameters collected by AGL are also tabulated and provided in Appendix A. The analytical results for TSD are compared to the ANZECC (2000) guidelines for Primary Industries (irrigation) as the blended water within this dam is used for irrigation. A comparison of the analytical results for the produced water in TND and TED with the ANZECC (2000) irrigation guidelines is also made, however this is for reference only.

Table 3.1 Tiedman dams and seepage monitoring bores results for May 2013

Analyte~	ANZECC (2000) Irrigation#	TSD (Pre-irrigation sample)*	TSD	TND	TED	TMB04	TMB05
pH (pH units)	6.00–9.00	9.28	**9.09**	**9.58**	**9.79**	7.27	6.11
EC (µS/cm)	2,000^	1,543	1,679	**3,991**	1,214	6,987	6,779
Sodium	460	200	214	**763**	218	1090	952
Aluminium	5	0.04	0.05	0.12	0.08	0.04	0.38
Boron	5	0.16	0.19	0.76	0.19	<0.05	<0.05
Cadmium	0.01	<0.0001	<0.0001	<0.0001	<0.0001	0.0002	0.0025
Copper	0.2	0.002	0.001	<0.001	0.001	0.001	0.01
Manganese	0.2	0.009	0.012	0.003	0.108	9.34	16.2
Molybdenum	0.01	0.009	0.007	**0.019**	0.006	<0.001	0.001
Nickel	0.2	<0.001	<0.001	<0.001	0.001	0.028	0.116
Zinc	2	0.012	0.022	0.018	0.03	0.107	1.16
Total P	0.05	<0.01	0.42	**1.69**	0.51	0.13	0.07
Ammonia	N/A	0.06	0.03	0.02	0.02	0.29	3.96
Methane (µg/L)	N/A	N/A	26	<10	<10	N/A	N/A

(1) ~ in mg/L unless otherwise specified. All metals are dissolved.
(2) # ANZECC 2000 - Water Quality Guidelines: Water quality for irrigation waters and general use, long-term threshold values.
(3) ^ Average root zone salinity threshold for Lucerne, Hunter River.
(4) N/A – no guideline value or not analysed.
(5) **Bold** – above ANZECC 2000 guideline (Tiedman dams only).
(6) *A pre-irrigation water sample was collected from TSD on 24 April 2013 before irrigation started on 29 April 2013.

3.2 Tiedman dams

The Tiedman dams comprise the Tiedman south dam (TSD), Tiedman north dam (TND) and Tiedman east dam (TED), the latter having been sampled for the first time in May 2013. TND stores produced water from the exploration programs while TED (at the present time) stores a mixture of produced water with mostly fresh water captured and ready for preparing the next batch of blended irrigation water. The water from these dams is blended in TSD prior to irrigation. Fresh water is sourced from local farm dams and the Avon River to optimise its water quality to within irrigation guideline values and to minimise soil degradation. No baseline threshold values are provided for TND or TED as the water quality of the produced water is different from the blended water that will be used for irrigation.

3.2.1 Water quality

3.2.1.1 Field parameters and major ion chemistry

The pre-irrigation sample at TSD had an EC of 1,543 µS/cm and the EC measurement in May 2013 was 1,679 µS/cm, which is below the guideline value of 2,000 µS/cm (ANZECC 2000). The EC at TED was similar to TSD, while the EC at TND was brackish and above the ANZECC guideline value.

The pH measurements are comparable between the three dams and were moderately alkaline, ranging from 9.09 (TSD) to 9.79 (TED), with the pre-irrigation having a pH of 9.28. All pH values were above the ANZECC guideline range of 6.00-9.00, although the pH for the blended dam water (TSD) was only slightly above the guideline at 9.09. The redox potential ranged from -121 mV at TSD to -135 mV at TED, indicating reducing conditions.

The water type for the Tiedman dams was Na-HCO_3-Cl as shown on the piper plots in Appendix C. All three Tiedman dams had chloride concentrations below the irrigation ANZECC (2000) guideline criteria (700 mg/L) whilst only the sodium concentration at TND (763 mg/L) was above the ANZECC irrigation guideline (460 mg/L). At the blended water irrigation dam (TSD) the sodium concentration was 214 mg/L.

The continuous EC logger data for the TSD to 12 December 2012 is plotted in Figure 3.1. The logger was removed from this dam and redeployed in TED in March 2013.

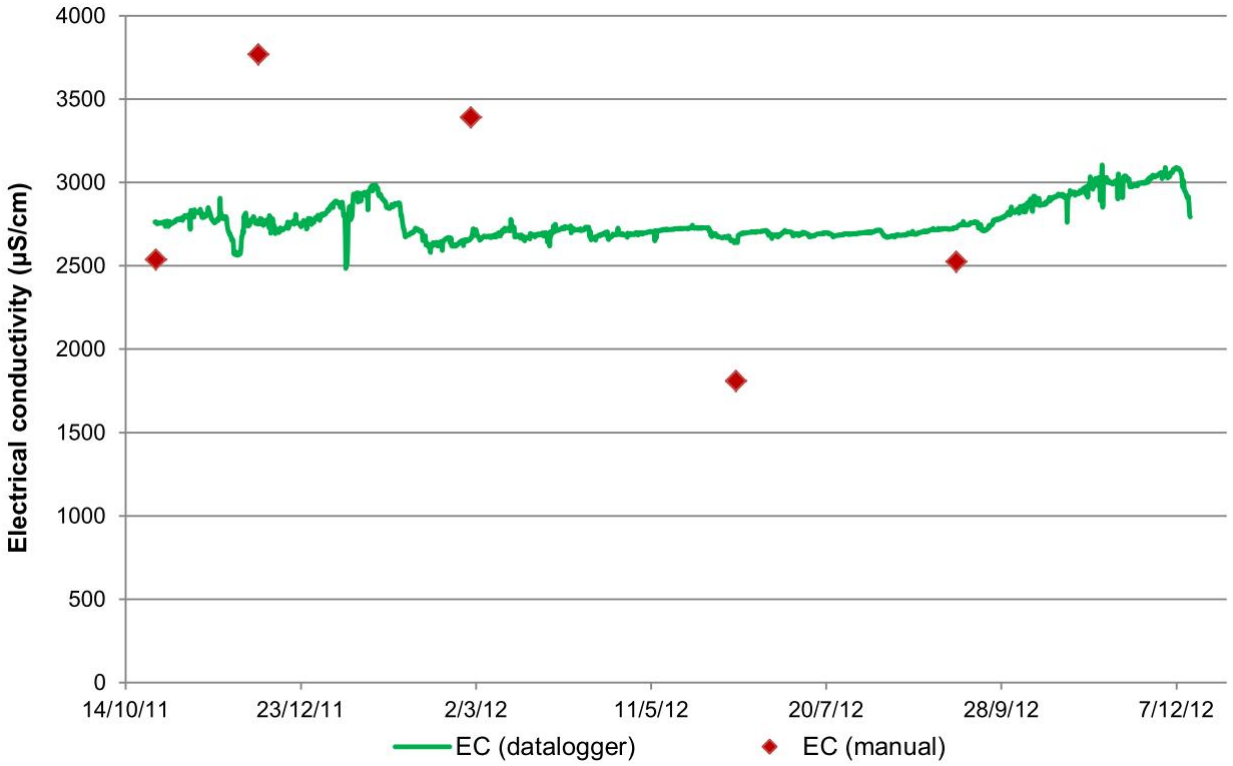


Figure 3.1 Continuous EC data at Tiedman south dam

3.2.1.2 Dissolved metals

The Tiedman dams all had aluminium, arsenic, barium, boron, iron, manganese, molybdenum, strontium and zinc concentrations above the laboratory limit of reporting (LOR). All dissolved metals are below the ANZECC (2000) guidelines for primary industries (irrigation) criteria with the exception of the molybdenum concentration at TND which is slightly above the ANZECC guideline. All other dissolved metal analytes were either equivalent to or were below the laboratory LOR. The pre-irrigation sample at TSD had dissolved metal values similar to the May 2013 values.

3.2.1.3 Nutrients

Ammonia concentrations measured at the dams in May 2013 ranged from 0.02 mg/L to 0.03 mg/L whilst the TSD pre-irrigation sample had an ammonia value of 0.06 mg/L. The total phosphorous concentrations ranged from 0.42 mg/L at TSD to 1.69 mg/L at TND. The concentration at TND is above the ANZECC 2000 guideline value. Total phosphorous was below the LOR in the TSD pre-irrigation sample.

Nitrite, nitrate and reactive phosphorous concentrations were below the laboratory LOR (0.01 mg/L) for all dam samples. TOC concentrations were detected above the laboratory LOR, between 21 mg/L and 29 mg/L, for each Tiedman dam.

3.2.1.4 Total petroleum hydrocarbons and aromatic hydrocarbons

TPH concentrations were detected at TND and TED in the May 2013 sampling round, with a C_{10}–C_{36} fraction sum of 0.39 µg/L and 0.38 µg/L respectively. TPH was not detected at TSD and BTEX were not detected at any of the Tiedman dams in May 2013. TPH and BTEX were not analysed for the TSD pre-irrigation sample.

3.2.1.5 Methane

Methane was measured as a one-off sampling event during the May 2013 monitoring program. TSD had a methane concentration of 26 µg/L, while TND and TED were below the LOR (<10 µg/L). There is no ANZECC (2000) irrigation guideline for methane.

3.3 Seepage monitoring around the Tiedman dams

3.3.1 Water levels

Both seepage bores have occasionally been dry following periods of low rainfall during the baseline monitoring period and it is assumed that a perched water table only develops after high rainfall events (Parsons Brinckerhoff 2013a). To confirm the correlation with rainfall rather than seepage from either of the dams, dataloggers were installed in May 2013. Groundwater levels were higher at TMB05 in March 2013 after high rainfall in January and February 2013. Both seepage bores have levels consistent with the baseline monitoring period (Figure 3.2).

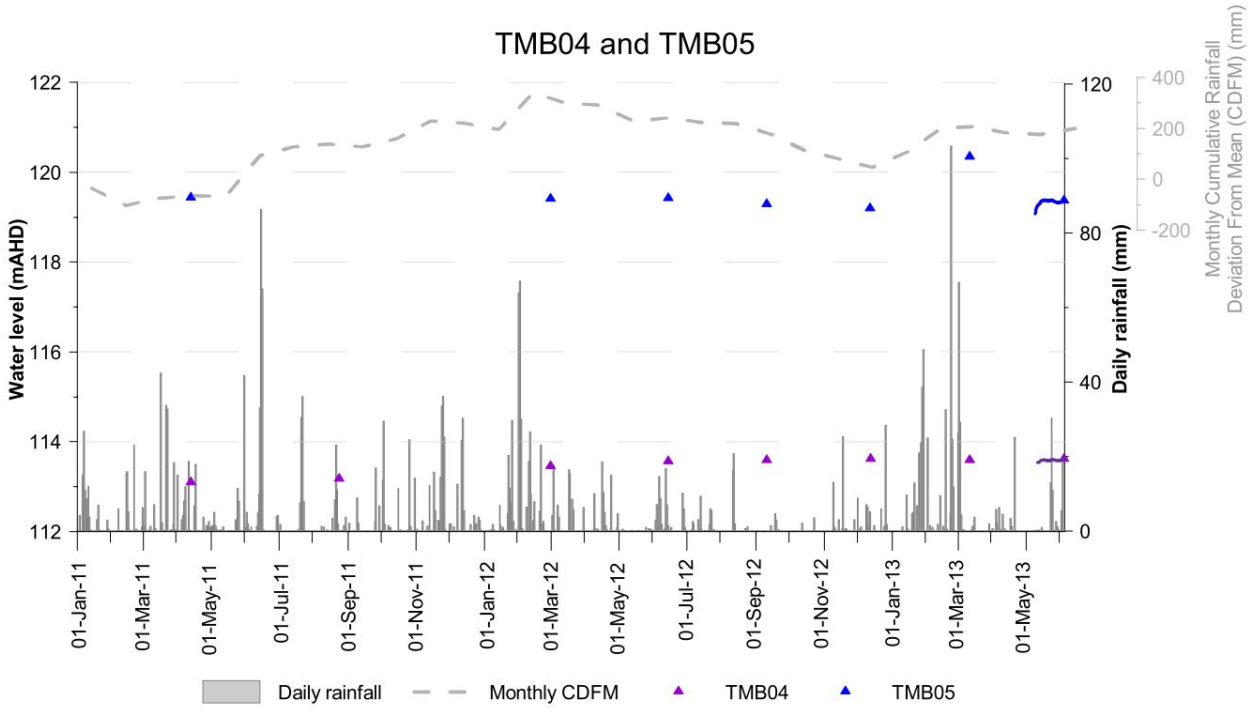


Figure 3.2 Groundwater levels for seepage monitoring bores (TMB04 and TMB05)

3.3.2 Water quality

These seepage monitoring bores had accumulated water present when the May 2013 sampling event commenced. Consequently both bores were purged and allowed to recover before water sampling took place.

3.3.2.1 Field parameters and major ions

The seepage bores had elevated salinity values of 6,987 µS/cm and 6,779 µS/cm and neutral to slightly acidic pH values of 7.27 and 6.11 for TMB04 and TMB05 respectively. In comparison to the results from the Tiedman dams, the pH is lower and EC higher.

The redox potential values were reducing at TMB04 (–119.0 mV) and slightly oxidising at TMB05 (0.8 mV).

Analysis of major ion components indicates that the water type for the seepage bores was Na–Mg–Cl (Appendix C). The proportion of chloride in the seepage bores, in particular, is notably higher than the proportion of chloride in the Tiedman dams.

3.3.2.2 Dissolved metals

Concentrations of dissolved aluminium, arsenic, barium, cadmium, cobalt, copper, iron, manganese, nickel, strontium and zinc were detected above the laboratory LOR in at least one of the two seepage monitoring bores. In particular, manganese concentrations were elevated at both seepage monitoring bores. All other dissolved metal analytes were either equivalent to or were below the laboratory LOR. There are distinct differences in the concentration of metals between the seepage bores and Tiedman dams.

3.3.2.3 Nutrients

Ammonia concentrations were 0.29 mg/L at TMB04 and 3.96 mg/L at TMB05. Nitrate concentrations were only above the LOR at TMB05 at a concentration of 0.23 mg/L. Total phosphorous concentrations were recorded above the LOR at 0.13 mg/L in TMB04 and 0.07 mg/L at TMB05.

Nitrite and reactive phosphorus concentrations were below the laboratory LOR (0.01 mg/L) and the TOC concentrations were detected above the laboratory LOR at 7 mg/L and 9 mg/L at TMB04 and TMB05 respectively.

4. Surface water monitoring

4.1 Surface water levels

Surface water levels from stream gauges TSW01, TSW02, and ASW01 are shown in Figure 4.1. All three stream gauges on the Avon River and Dog Trap Creek show sharp increases in water level in response to rainfall events, and relatively steep recession curves. This is consistent with a rapid runoff response from a relatively small upstream catchment with limited riverbank storage. Stream levels decrease over several weeks following each rainfall event to a relatively consistent base level that represents a small groundwater baseflow component in the Avon River.

Anecdotal information suggests that the Avon River and its major tributaries cease to flow during prolonged drought conditions. The apparent continuous flow conditions and minor baseflow observed during the current monitoring period may therefore reflect the relatively high rainfall conditions that have prevailed over the last few years.

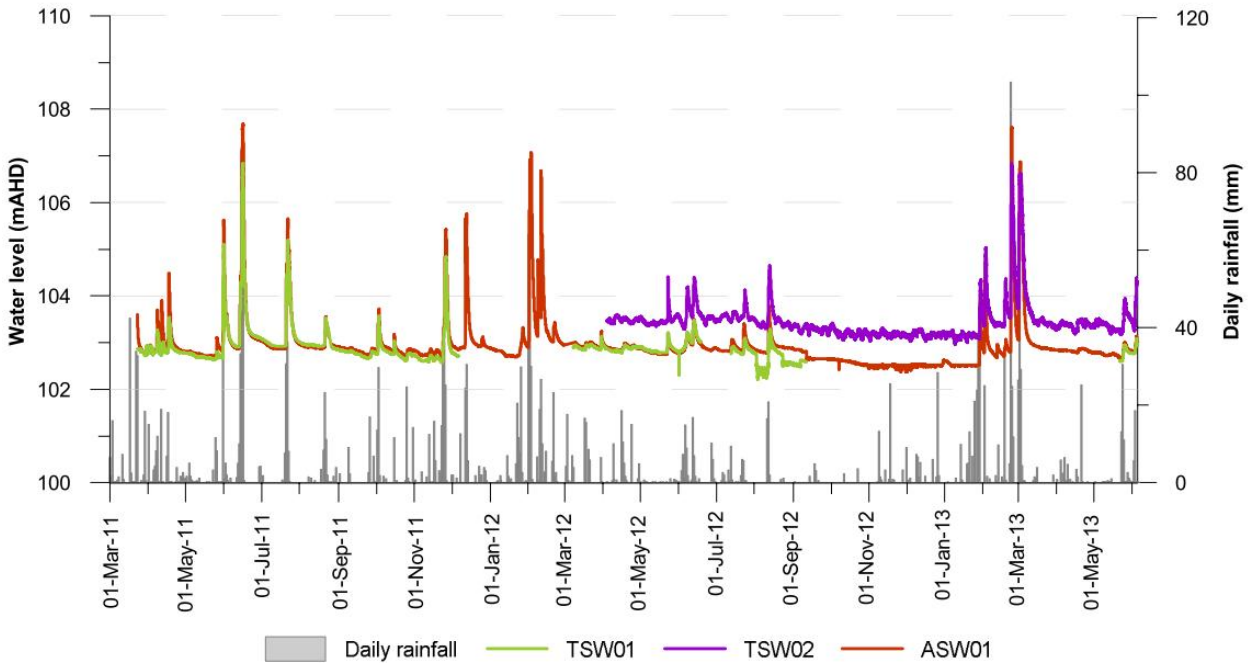


Figure 4.1 Surface water levels

4.2 Surface water quality

4.2.1 Surface water

In May 2013 the surface water sampling locations comprised of ASW01, TSW01 and TSW02. The surface water quality results for the main analytes and site specific (surface water) threshold values are presented in Table 4.1.

Water quality time-series plots are provided in Figures B-1 to B-15 of Appendix B, piper diagrams in Appendix C and laboratory analysis reports in Appendix D.

Table 4.1 Threshold values and May 2013 results for surface water monitoring locations

Analyte~	Threshold	TSW01	TSW02	ASW01
pH (pH units)	6.5-8.0#^	7.59	7.11	7.29
EC (µS/cm)	125-2,200#^	454	371	397
Sodium	N/A	52	53	45
Aluminium	0.34	0.05	0.07	0.02
Boron	N/A	<0.05	<0.05	<0.05
Cadmium	0.0004	<0.0001	<0.0001	<0.0001
Copper	0.007	0.005	0.002	<0.001
Manganese	1.9^	0.106	0.083	0.078
Molybdenum	N/A	<0.001	<0.001	<0.001
Nickel	0.011^	0.003	0.004	0.001
Zinc	0.19	0.013	0.006	0.009
Total P	0.21	0.1	0.07	<0.01
Ammonia	0.22	<0.01	<0.01	0.02

(1) ~ in mg/L unless otherwise specified. All metals are dissolved.
(2) ^ ANZECC 2000 - Water Quality Guidelines: 95% protection levels (threshold values) for the protection of freshwater aquatic ecosystems are adopted when maximum analyte concentration is lower than applicable ANZECC (2000) guideline value.
(3) # ANZECC 2000 – Water Quality Guideline: 95% protection levels for aquatic ecosystems, South-East Australia, low lying river ecosystems.
(4) N/A – no guideline values, and thus no threshold value.

4.2.1.1 Field parameters and major ion chemistry

Surface water salinity (measured as EC) is inversely correlated with rainfall and surface water flow. Typically surface water EC spikes then sharply decreases after rainfall events as relatively fresh runoff is routed into streams (Figure 4.2). This trend has been consistent since AGL commenced monitoring in March 2011. The initial spike (sudden transient increase) in EC is often seen in the initial runoff phase as readily dissolvable salts are flushed from the ground surface and shallow soils across the whole catchment. After the initial salinity spike and a reduction in EC levels, the EC gradually increases as flow decreases during periods of recession, and as groundwater discharge becomes a more dominant component of flow. Evaporative concentration of salts may also be taking place in residual and connected pools,

During monitoring, a period of anomalously low rainfall occurred in the months leading up to summer in 2013, which resulted in a period of 'no flow' or very low flow, when the river was characterised by multiple disconnected pools from September 2012 to January 2013. EC measurements from this period are therefore not considered to be representative of the salinity of flowing water in the Avon River and Dog Trap Creek, but may give some indication of local groundwater accessions.

The surface water can be classified mostly as fresh with an EC of 454 µS/cm at TSW01 in May 2013. From the continuous EC logging during 2013, the minimum EC was 80 µS/cm and the maximum EC was 1,165 µS/cm (TSW02). This was a transient initial spike following a high rainfall event.

The pH values were neutral ranging from 7.11 to 7.59 across the three sampling locations and below the upper surface water baseline threshold value of 7.90.

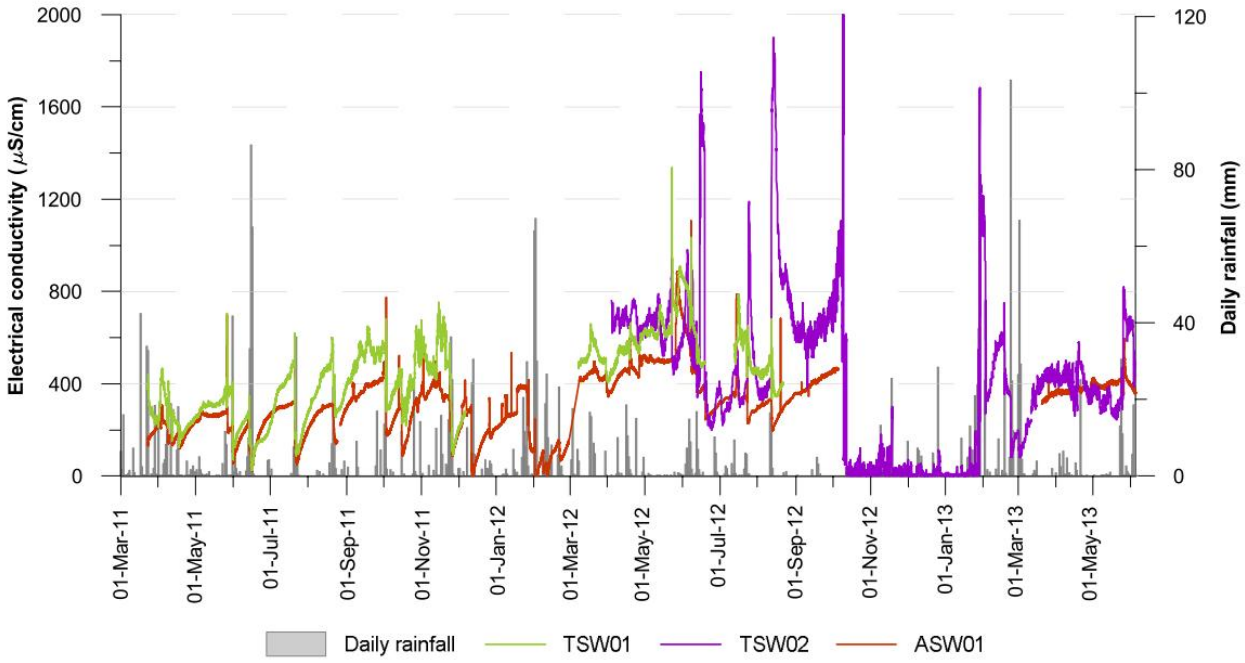


Figure 4.2 Continuous EC logging results at stream gauges

The redox potential ranged from -94.0 mV to -156.1 mV indicating a reducing environment. The water type was Na–Mg–Ca–Cl–HCO_3 as shown on the piper plot (Appendix C).

4.2.1.2 Dissolved metals

Concentration of dissolved aluminium, barium, boron, cobalt, copper, iron, manganese, nickel, strontium and zinc were detected above the laboratory LOR in at least one of the three surface water samples and all values were consistently below baseline threshold values. All other dissolved metal analytes were either equivalent to or were below the laboratory LOR.

4.2.1.3 Nutrients

Nutrient concentrations were consistently below the baseline threshold values. Ammonia, nitrite, reactive phosphorus, nitrate and TOC concentrations were low, often below the LOR in May 2013. The only total phosphorous concentration recorded above the LOR was at TWS02 (0.07 mg/L).

4.2.1.4 Hydrocarbons

No TPH, BTEX or other hydrocarbons were detected when sampled in May 2013.

4.2.1.5 Methane

Methane was measured as a one-off sampling event during the May 2013 monitoring program. A methane concentration of 14 µg/L was measured at ASW01, while concentrations at TSW01 and TSW02 were below the LOR (<10 µg/L).

4.2.2 Irrigation plot runoff

Irrigation plot runoff is captured by Catch dam 2 (CDW) and Catch dam 1 (CDE). These monitoring locations were sampled for the first time in May 2013, and therefore no baseline values are available for comparison. These locations are mostly event monitoring locations when there is a high rainfall event. The May 2013 results for key analytes are presented in Table 4.2 along with the surface water threshold values and the ANZECC (2000) guideline values for irrigation for comparison. The primary criteria for the comparison of

water quality results are the surface water threshold values as the Avon River is the receptor of water when there is high rainfall and there is an overflow event from the catch dams.

Water quality time-series plots are provided in Figures B-1 to B-15 of Appendix B, piper diagrams in Appendix C and laboratory analysis reports in Appendix D.

Table 4.2 May 2013 results for the catch dams

Analyte~	ANZECC (2000) irrigation#	Surface water threshold	Catch dam 2 (CDW)	Catch dam 1 (CDE)
pH (pH unit)	6.00–9.00	6.5-8.0#^	**9.43**	**9.39**
EC (µS/cm)	2,000*	125-2,200#^	1,277	1,186
Sodium	460	N/A	100	90
Aluminium	5	0.34	0.02	0.11
Boron	5	N/A	0.05	<0.05
Cadmium	0.01	0.0004	<0.0001	<0.0001
Copper	0.2	0.007	<0.001	0.004
Manganese	10	1.9^	0.039	0.452
Molybdenum	0.01	N/A	0.001	0.001
Nickel	0.2	0.011^	0.002	0.004
Zinc	2	0.19	0.047	0.118
Total P	0.05	0.21	**0.84**	**0.47**
Ammonia	N/A	0.22	0.06	0.12

(1) ~ in mg/L unless otherwise specified. All metals are dissolved.
(2) # ANZECC 2000 - Water Quality Guidelines: Water quality for irrigation waters and general use, long-term threshold values.
(3) * Average root zone salinity threshold for Lucerne, Hunter River.
(4) ^ANZECC 2000 - Water Quality Guidelines: 95% protection levels (threshold values) for the protection of freshwater aquatic ecosystems are adopted when maximum analyte concentration is lower than applicable ANZECC (2000) guideline value.
(5) # ANZECC 2000 – Water Quality Guideline: 95% protection levels for aquatic ecosystems, South-East Australia, low lying river ecosystems.
(6) N/A – no guideline values, and thus no threshold value.
(7) **Bold** - above threshold.

4.2.2.1 Field parameters and major ion chemistry

CDW and CDE had an EC of 1,277 and 1,186 µS/cm and elevated pH values of 9.43 and 9.39 respectively in May 2013. The pH values are higher than the range set for the surface water baseline threshold values. Dissolved oxygen values of 172.7 and 121.6 % saturation were measured in CDW and CDE respectively and the redox potential values were low at both locations (-120.8 mV and -131.4 mV respectively).

Sulfate is an important ionic species at the catchment dams shown by values reported of 443 and 380 mg/L. Analysis of major ion components indicate that the groundwater is dominated by magnesium, calcium and sulfate, as illustrated on the piper plot (Appendix C).

The continuous EC logger data for the CDW and CDE from 7 May 2013 to 30 June 2013 are plotted in Figures 4.3 and 4.4.

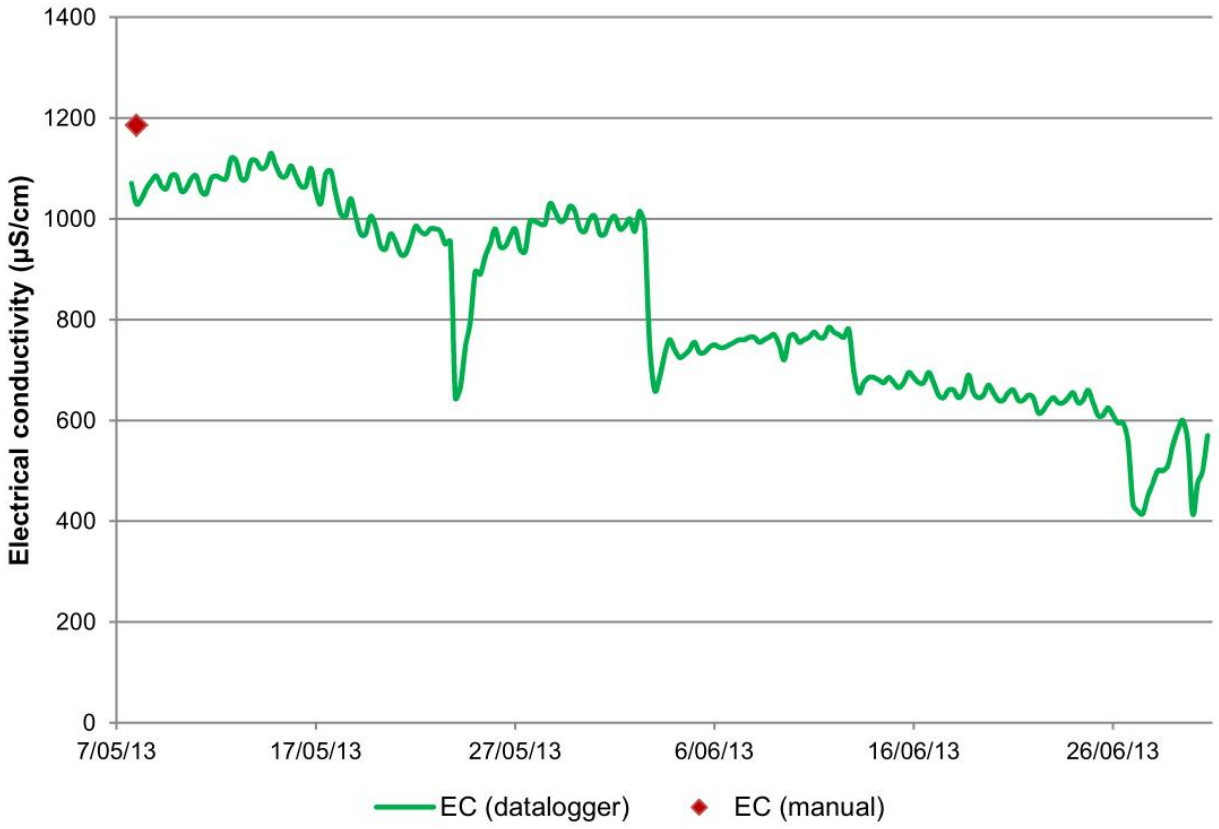


Figure 4.3 Continuous EC data at Catch dam 2 (CDW)

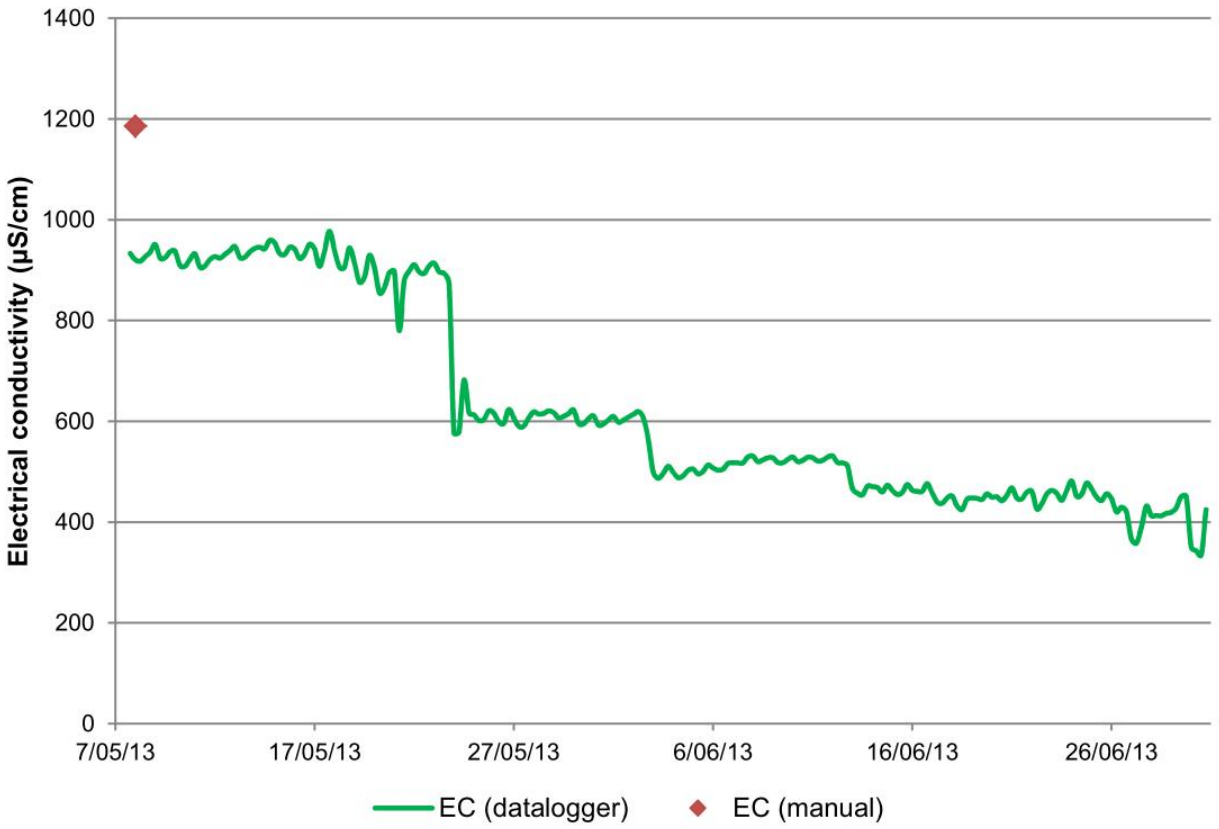


Figure 4.4 Continuous EC data at Catch dam 1 (CDE)

4.2.2.2 Dissolved metals

Concentrations of dissolved aluminium, arsenic, barium, cobalt, copper, iron, manganese, nickel, strontium and zinc were detected above the laboratory LOR and were consistently below the surface water baseline threshold values. All other dissolved metal analytes were either equivalent to or were below the laboratory LOR.

4.2.2.3 Nutrients

Ammonia and nitrate concentrations measured at the two catchment dams in May 2013 were 0.06 mg/L and 0.12 mg/L respectively. The total phosphorous concentration at both catchment dams exceeded the surface water baseline threshold values.

Nitrite concentrations were below the laboratory LOR (0.01 mg/L) as well as reactive phosphorus at the CDE dam, whilst at the CDW dam, reactive phosphorus was recorded at 0.02 mg/L.

The total organic carbon concentrations were detected above the laboratory LOR at 57 mg/L and 44 mg/L in CDW and CDE respectively.

4.2.2.4 Hydrocarbons

No TPH, BTEX or other hydrocarbons were detected at the catchment dams sampled in May 2013.

5. Groundwater monitoring

5.1 Groundwater levels

5.1.1 Shallow alluvium

In general, groundwater levels show a clear response to rainfall events but not irrigation events. The magnitude and rate of the response to rainfall varies between the shallow alluvial bores (Figure 5.1). The greatest groundwater level responses after heavy rainfall in January and February 2013 were observed at TMB01 (a maximum of approximately 2 m), followed by TMB02 (a maximum of approximately 1 m) and TMB03 (a maximum of approximately 0.5 m).

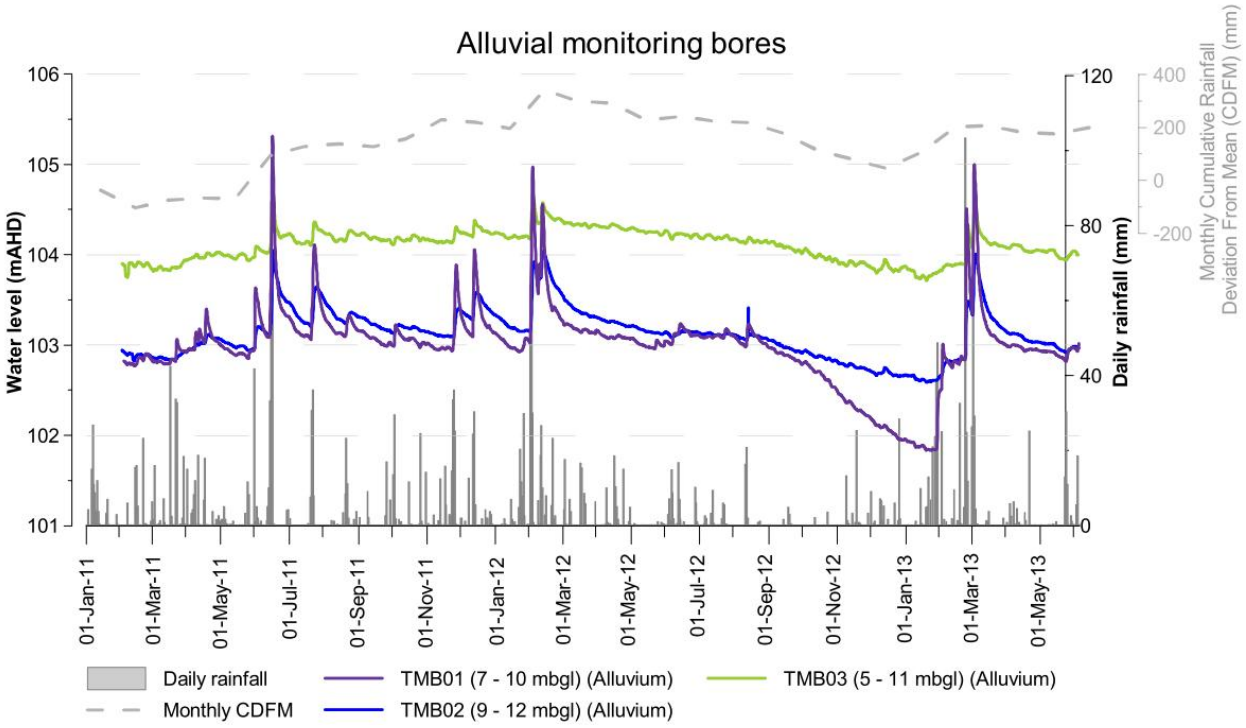


Figure 5.1 Groundwater levels for alluvial monitoring bores (TMB01, TMB02 and TMB03)

The groundwater level hydrographs can be divided into two main response types:

1. Monitoring bores TMB01 and TMB02 show a rapid response to rainfall recharge followed by a return to near-previous levels over a period of one to two months (i.e. a short term increase in storage). These responses imply direct recharge from rainfall and/or flooding and relatively high permeability of the alluvium.
2. Monitoring bore TMB03 shows a more subdued response to rainfall recharge. In addition groundwater responses are more pronounced for larger rainfall events that exceed a certain threshold (> ~35 mm/day). However smaller rainfall events show little or no obvious responses. Such responses imply rapid recharge during larger surface runoff and flooding events, but less significant recharge by direct rainfall infiltration alone.

These observations are consistent with field observations during bore installation that show that there is a clay layer (approximately 1–2 m in thickness) above the alluvial mixed gravels at some locations. The clay layer would impede recharge to groundwater due to smaller rainfall events.

No change in groundwater levels has been observed since the irrigation trial started.

5.1.2 Shallow bedrock

The hydrograph for S4MB01 is presented in Figure 5.2. The groundwater level shows no direct response to rainfall or irrigation. There has been a small 0.3 m increase in water level since early 2011 which is attributable to gradual recharge due to slow rainfall infiltration over a broad area. The effects of hydraulic testing ('slug' testing) and low flow sampling are visible in April 2011 and December 2011. The very slow recovery of groundwater levels after these events is consistent with low permeability in this unit (Parsons Brinckerhoff 2012).

Groundwater levels have remained steady this year with only a minimal increase in levels visible after heavy rainfall events in January and February 2013. Groundwater levels have not changed since the irrigation trial began.

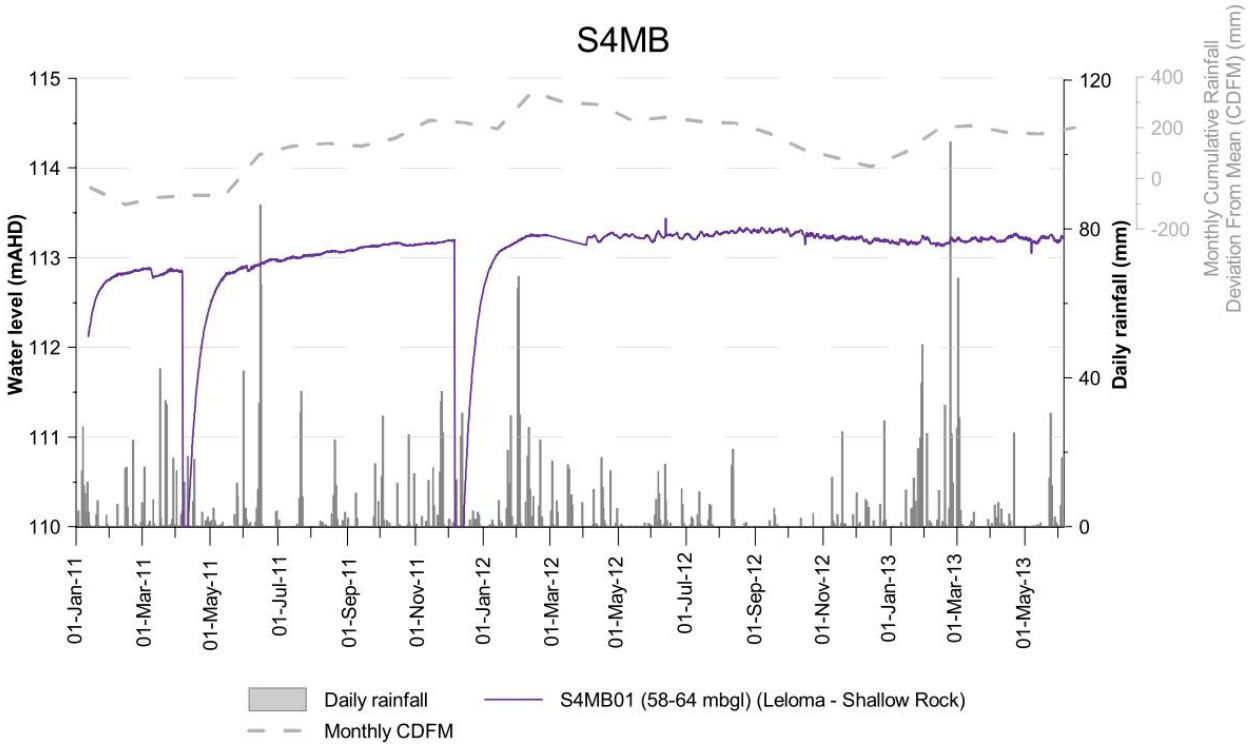


Figure 5.2 Groundwater levels for the shallow bedrock monitoring bore (S4MB01)

5.2 Groundwater quality

The water quality for shallow alluvial groundwater and shallow bedrock groundwater sampled in May 2013 is assessed in this section. Water quality data are presented in Appendix A. Time-series plots are provided in Figures B-1 to B-15 in Appendix B, piper diagrams in Appendix C and laboratory analysis reports in Appendix D.

5.2.1 Shallow alluvium

The groundwater quality results for the main analytes for the shallow alluvium bores (TMB01, TMB02 and TMB03) and site specific threshold values are presented in Table 5.1.

Table 5.1 Threshold values and May 2013 results for the shallow alluvium monitoring bores

Analyte~	Threshold	TMB01	TMB02	TMB03
pH (pH units)	6.5-8.0*^	6.5	**6.27**	6.52
EC (µS/cm)	8,500	7,841	3,605	5,827
Sodium	N/A	1,120	495	782
Aluminium	0.055^	<0.01	0.01	0.04
Boron	N/A	<0.05	<0.05	<0.05
Cadmium	0.0002^	<0.0001	<0.0001	<0.0001
Copper	0.006	0.003	<0.001	0.002
Manganese	1.9^	0.874	1.410	**1.92**
Molybdenum	N/A	<0.001	<0.001	<0.001
Nickel	0.011^	<0.001	0.002	<0.001
Zinc	0.15	0.017	0.028	0.015
Total P	0.10	0.09	0.07	0.02
Ammonia	0.37	<0.01	0.34	0.18

(1) ~ in mg/L unless otherwise specified. All metals are dissolved.

(2) ^ANZECC 2000 - Water Quality Guidelines: 95% protection levels (threshold values) for the protection of freshwater aquatic ecosystems are adopted when maximum analyte concentration is lower than applicable ANZECC (2000) guideline value.

(3) N/A – no guideline values, and thus no threshold value.

(4) **Bold** – above threshold or outside threshold range.

5.2.1.1 Field parameters and major ion chemistry

Groundwater within the shallow alluvium is brackish to slightly saline, ranging from ~3,600 µS/cm (TMB02) to 7,841 µS/cm (TMB01) and is typically of near neutral pH (6.27 to 6.52). The pH for TMB02 is slightly below the threshold.

Groundwater in the alluvium tends to be under reducing conditions, with redox values ranging from -103.8 mV to -180.5 mV.

Analysis of major ion components indicate that the groundwater is a Na–Mg–Cl type as shown on the Piper plots. Magnesium is an important ionic species at TMB01.

5.2.1.2 Dissolved metals

The dissolved metal concentrations in May 2013 are low and below the threshold values, except for manganese, which exceeds the threshold of 1.9 mg/L at TMB03 (1.92 mg/L).

5.2.1.3 Nutrients

Ammonia and total phosphorus concentrations were above the laboratory LOR although they both were below the baseline threshold values.

Nitrite, nitrate, reactive phosphorus and TOC concentrations were low and below the baseline threshold values.

5.2.1.4 Hydrocarbons

No TPH, BTEX or other hydrocarbons were detected at the alluvial bores during the May 2013 sampling event.

5.2.2 Shallow bedrock

One monitoring bore, S4MB01, is screened in the shallow bedrock aquifer. The groundwater quality results for the main analytes and site specific threshold values are presented in Table 5.2.

Table 5.2 Threshold values and May 2013 results for the shallow bedrock monitoring bore

Analyte~	Threshold	S4MB01
pH (pH units)	6.5-8.0*^	6.91
EC (µS/cm)	6,200	4,722
Sodium	N/A	691
Aluminium	0.055^	0.02
Boron	N/A	0.16
Cadmium	0.0002^	<0.0001
Copper	0.002	0.001
Manganese	1.9^	0.28
Molybdenum	N/A	<0.001
Nickel	0.011^	<0.001
Zinc	0.021	0.008
Total P	0.07	0.07
Ammonia	2.45	1.85

(1) ~ in mg/L unless otherwise specified. All metals are dissolved.
(2) ^ANZECC 2000 - Water Quality Guidelines: 95% protection levels (threshold values) for the protection of freshwater aquatic ecosystems are adopted when maximum analyte concentration is lower than applicable ANZECC (2000) guideline value.
(3) * ANZECC 2000 – Water Quality Guideline: 95% protection levels for aquatic ecosystems, South-East Australia, low lying river ecosystems.
(4) N/A – no guideline values, and thus no threshold value.

5.2.2.1 Field parameters and major ion chemistry

Groundwater sampled from S4MB01 in May 2013 was brackish (3,471 µS/cm) with near neutral pH (6.91) and with reducing conditions (-208.3 mV). All results are below the baseline threshold values.

The water type at S4MB01 was a Na-Ca-Cl type as shown on the Piper plots.

5.2.2.2 Dissolved metals

Aluminium, arsenic, barium, boron, copper, iron, manganese, uranium and zinc concentrations were above the laboratory LOR, but were below the baseline threshold values. The strontium concentration of 25.0 mg/L slightly exceeded the baseline threshold of 24.7 mg/L (Appendix B). The remaining dissolved metal analytes were below the laboratory LOR.

5.2.2.3 Nutrients

Ammonia and total phosphorus concentrations registered concentrations above the laboratory LOR although they both were below the baseline threshold values (Table 5.2).

Nitrite and reactive phosphorus concentrations were below the laboratory LOR (0.01 mg/L). The total organic carbon concentration of 35 mg/L was above the laboratory LOR, however, was below the baseline threshold for this analyte (135 mg/L).

5.2.2.4 Hydrocarbons

No TPH, BTEX or other hydrocarbons were detected at the shallow bedrock monitoring bore when sampled in May 2013.

6. Discussion

6.1 Water levels

Continuous monitoring indicates that the alluvial groundwater levels and surface water levels respond to rainfall recharge. The rainfall response is immediate and pronounced, and sharp recession curves are often observed. Such a response suggests moderate to high permeability in the shallow alluvial bores; and for the surface water a rapid runoff response from a relatively small upstream catchment. There appears to be limited riverbank storage and groundwater baseflow contributions. A minimal rainfall response is observed at the shallow bedrock monitoring bore (S4MB01) suggesting groundwater levels respond to limited rainfall recharge over a broad area.

Water levels have not altered in response to the irrigation trial.

6.2 Water quality

Groundwater and surface water quality parameters were assessed against site specific threshold values based on the baseline data set. Water quality parameters of the Tiedman dams were compared to the ANZECC (2000) water quality guidelines for irrigation, although only the blended water in TSD is used for irrigation.

6.2.1 Produced and blended irrigation water

6.2.1.1 Tiedman dams

TND and TED store produced water from exploration programs, while at TSD the water from these dams is blended with fresh water prior to irrigation. Water quality monitoring in the Tiedman dams indicates that the water is alkaline and brackish to slightly saline. The EC measurement in May 2013 for TSD was 1,679 µS/cm, which is below the guideline value of 2,000 µS/cm (ANZECC 2000). All pH values were above the ANZECC guideline range. Dissolved metal concentrations were mostly above the laboratory LOR, below the ANZECC (2000) guidelines and comparable between the three dams.

Total phosphorus, ammonia and TOC concentrations were elevated and overall nutrient concentrations were highest at TND (the dam with the highest percentage of produced water). The medium to heavy-end TPH fractions were elevated above the laboratory LOR at the TND and TED.

The water quality in TSD was within the ANZECC (2000) guidelines, with exception of pH, which exceeded the guideline by 0.09 pH units. The pH in this dam has consistently been above the guideline, however the pH has decreased over the monitoring period and is only slightly outside of the ANZECC guideline pH range of 6-9.

6.2.1.2 Seepage monitoring bores

The perched groundwater intersected by the seepage monitoring bores was slightly saline and slightly acidic to neutral. The pH and EC of this water differs to the results from the Tiedman dams: EC measurements are higher and pH concentrations lower in the soil/pore water compared to the dam water. Although the major cations and anions (sodium and chloride) were the same for the dams and seepage bores, the minor ion chemistry differed.

Dissolved metals were slightly elevated, in particular iron and manganese concentrations. Ammonia, total phosphorus and TOC concentrations were also elevated. Overall dissolved metal concentrations were higher

in the seepage bores (because of the nature of the parent soils and the weathered rock) compared to the Tiedman dams, while nutrient concentrations were relatively lower.

The differences in minor ion and dissolved metal chemistry, in addition to different nutrient concentrations, indicate that the soil/pore water in TMB04 and TMB05 is not derived from leakage from the Tiedman dams. In addition, the elevated salinity and high concentrations of certain trace metals, including iron and manganese, contrasts with both groundwater from the fractured rock elsewhere and also water from the dams.

6.2.2 Surface water

The EC of the surface water is inversely correlated with rainfall and surface water flow. Typically surface water EC sharply decreases after rainfall events (after an initial salinity spike) as relatively fresh runoff is routed into stream. The surface water can be classified as fresh and pH values were neutral.

Concentration of dissolved aluminium, barium, boron, cobalt, copper, iron, manganese, nickel, strontium and zinc were detected above the laboratory LOR and all values were consistently below baseline threshold values. With the exception of aluminium, cadmium, copper and zinc concentrations, surface water dissolved metal concentrations were typically lower than measurements observed in the shallow alluvium and shallow bedrock groundwater samples.

Nutrient concentrations were consistently below the baseline threshold values.

No change in water quality is observed as a result of the irrigation trial.

6.2.3 Irrigation plot runoff

CDW and CDE had a slightly saline water quality and elevated, alkaline pH above the range set for the surface water baseline threshold values. Sulfate is an important ionic species at the catchment dams.

Concentrations of dissolved metals were mostly detected above the laboratory LOR and were consistently below the surface water baseline threshold values. The total phosphorous concentrations at both catchment dams exceeded the surface water baseline threshold values. The TOC concentrations were elevated in both catch dams.

These values are not unexpected given the feedlot manure, and lime, gypsum, and zeolite additives that were used to improve the soils across the irrigation trial area. It should also be noted that this water is part of the first flush that is recycled back into the TSD or TED dams after the next high rainfall event.

6.2.4 Groundwater

Groundwater within the shallow alluvium ranges from brackish to slightly saline and is typically of near neutral pH. The pH of TMB02 was slightly below the threshold value. Most dissolved metals were above the laboratory LOR, but were below baseline threshold values for all analytes except for manganese at TMB03. Nutrient concentrations were mostly at or just above the laboratory LOR, although they were all below the baseline threshold values.

Groundwater in the shallow bedrock aquifer was brackish with near neutral pH. All dissolved metal concentrations were below the baseline threshold values with the exception of the strontium concentration, which slightly exceeded the baseline threshold value.

No change in water quality is observed as a result of the irrigation trial.

7. Conclusions and recommendations

A surface water and groundwater monitoring program for the irrigation trial commenced in October 2011 and was established in accordance with the Water Management Plan (AGL 2012). The monitoring aims to ensure that the quality of the water used for irrigation is appropriate and that the application of irrigated water does not result in negative impacts on the local surface water or groundwater resources.

The (blended water) irrigation trial began on 29 April 2013 for the Stage 1A area and on 1 May 2013 for the Stage 1B area. This compliance report for the irrigation trial is a condition of the DRE approval.

In accordance with the ANZECC (2000) guidelines for fresh and marine water quality, site specific guideline values were derived from local reference data. Where the development of site specific guidelines was not possible or appropriate, comparisons were made against ANZECC (2000) irrigation guidelines or the water quality in the Tiedman dams.

There were a few minor exceedances of the adopted thresholds or guidelines during the monitoring period, however there is no change in natural surface water or groundwater quality, or water levels as a result of the current irrigation trial activities.

The water quality in the TSD was within the ANZECC (2000) guidelines for irrigation, with exception of pH, which exceeded the guideline by 0.09 pH units. The blended water in the TSD is considered suitable for irrigation.

It is recommended surface water and groundwater monitoring should continue as outlined in the approved WMP (AGL 2012).

8. Statement of limitations

8.1 Scope of services

This groundwater monitoring status report (the report) has been prepared in accordance with the scope of services set out in the contract, or as otherwise agreed, between the client and Parsons Brinckerhoff (scope of services). In some circumstances the scope of services may have been limited by a range of factors such as time, budget, access and/or site disturbance constraints.

8.2 Reliance on data

In preparing the report, Parsons Brinckerhoff has relied upon data, surveys, analyses, designs, plans and other information provided by the client and other individuals and organisations, most of which are referred to in the report (the data). Except as otherwise stated in the report, Parsons Brinckerhoff has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report (conclusions) are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Parsons Brinckerhoff will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Parsons Brinckerhoff.

8.3 Environmental conclusions

In accordance with the scope of services, Parsons Brinckerhoff has relied upon the data and has conducted environmental field monitoring and/or testing in the preparation of the report. The nature and extent of monitoring and/or testing conducted is described in the report.

On all sites, varying degrees of non-uniformity of the vertical and horizontal soil or groundwater conditions are encountered. Hence no monitoring, common testing or sampling technique can eliminate the possibility that monitoring or testing results/samples are not totally representative of soil and/or groundwater conditions encountered. The conclusions are based upon the data and the environmental field monitoring and/or testing and are therefore merely indicative of the environmental condition of the sites at the time of preparing the report. Also, it should be recognised that site conditions can change with time.

Within the limitations imposed by the scope of services, the monitoring and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

8.4 Report for the benefit of the client

The report has been prepared for the benefit of the client (and no other party), but may be relied upon by the administering authority. Parsons Brinckerhoff assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of Parsons Brinckerhoff or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Except as provided below, parties other than the client should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

8.5 Other limitations

Parsons Brinckerhoff will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

9. References

- AGL 2012. Water Management Plan for the Tiedman Irrigation Program – Gloucester AGL dated May 2012
- AGL 2013. Weather station data, http://agk.com.au/gloucester/index.php/weather/, accessed 15/07/13
- ANZECC 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality Volumes 3 and 4. Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra.
- Bureau of Meteorology 2013a. Climate data, http://www.bom.gov.au/climate/data/, accessed 15/07/13
- Bureau of Meteorology 2013b. Annual evapotranspiration, http://www.bom.gov.au/jsp/ncc/climate_averages/evapotranspiration/index.jsp, accessed 05/03/13.
- DRE 2012. PEL 285: Approval to undertake Tiedman Irrigation Program, Gloucester. Letter to Ms Toni Laurie, AGL (05/07/2012).
- Fodder King 2013. Soil quality monitoring and management. Report 2 – Irrigation (Activities from 1 April to 30 June 2013) Tiedman Irrigation Trial" dated August 2013
- Parsons Brinckerhoff 2010. Gloucester Exploration Program – Irrigation Proposal: Review of Environmental Factors dated June 2011 PR_5506
- Parsons Brinckerhoff 2012. Phase 2 Groundwater Investigations – Stage 1 Gas Field Development Area, Gloucester Gas Project. Report dated January 2012 PR_5630.
- Parsons Brinckerhoff 2013a. Gloucester Gas Project – Tiedman Irrigation Trial Baseline Water Monitoring Program, Report dated January 2013 PR_6306
- Parsons Brinckerhoff 2013b, Hydrogeological Conceptual Model of the Gloucester Basin, Report dated 28 June 2013, 2162406A PR_7266
- D. Springer, R.J. Morrison and M.R. O'Donnell 2007. Water quality assessment – issues from a laboratory management perspective. In: R.J. Morrison, M.R. O'Donnell and S. Quin (Editors) *Water Quality in the Illawarra-South Coast Region of New South Wales*, GeoQuest Research Centre, University of Wollongong, pp 35-40.

Appendix A

Summary tables

Summary table: May 2013 Groundwater quality results

Water quality parameters	Units	TMB01	TMB02	TMB03	TMB04	TMB05	S4MB01	Tiedman south dam (TSD)^^	Tiedman south dam (TSD)	Tiedman north dam (TND)	Tiedman east dam (TED)	Catch dam west	Catch dam east	TSW01	TSW02	ASW01
Sample date		06/05/13	07/05/13	06/05/13	07/05/13	07/05/13	06/05/13	24/04/13	07/05/13	07/05/13	07/05/13	07/05/13	07/05/13	06/05/13	06/05/13	08/05/13
Formation		Alluvium	Alluvium	Alluvium	Seepage	Seepage	Shallow Bedrock	Dam	Dam	Dam	Dam	Irrigation plot runoff	Irrigation plot runoff	Surface Water	Surface Water	Surface Water
Field parameters																
Temperature	oC	18.8	17.78	18.14	18.36	17.95	19.68	21.62	19.66	19.89	18.02	18.09	17.94	15.29	16.95	12.49
EC	µS/cm	7841	3605	5827	6987	6779	4722	1543	1679	3991	1214	1277	1186	454	371	397
Dissolved Oxygen	% sat	na	61.7	91.2	42.6	111.1	**94.5**	na	71.3	79.5	89.6	172.7	121.6	104.3	92	48.3
Dissolved Oxygen	mg/L	na	**5.83**	**8.43**	3.93	10.42	**8.59**	na	6.46	7.05	8.48	16.19	11.97	na	8.87	5.15
pH	pH units	6.5	**6.27**	6.52	7.27	6.11	6.91	na	9.09	9.58	9.79	9.43	9.39	7.59	7.11	7.29
TDS	mg/L	na	na	na	na	na	na	1003	na	na	787	na	771	na	242	na
Redox	mV	-180.5	-103.8	-138.8	-119.0	0.8	-208.3	na	-121.3	-129.3	-135.2	-120.8	-131.4	-156.1	-95.1	-94
General parameters																
pH	pH units	7.10	6.98	7.18	6.54	5.98	7.58	9.28	9.24	9.54	9.84	9.26	9.18	7.21	7.20	7.49
EC	µS/cm	8170	3690	5980	7220	6770	4850	1380	1730	4080	1220	1330	1210	402	365	397
TDS	mg/L	4240	2150	3420	3910	3930	2790	924	914	2430	720	958	865	168	150	161
Laboratory analytes																
Hydroxide Alkalinity as CaCO3	mg/L	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	mg/L	<1	<1	<1	<1	<1	<1	109	109	586	180	55	62	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	mg/L	483	170	427	166	37	298	194	213	669	74	82	102	50	40	74
Total Alkalinity as CaCO3	mg/L	483	170	427	166	37	298	303	321	1260	254	136	164	50	50	74
Total hardnas as CaCO3	mg/L	na	na	na	na	na	na	36	42	na	na	na	na	na	na	na
Sulfate as SO4 2-	mg/L	93	37	215	683	245	138	87	103	<1	128	443	380	31	48	8
Sulphur as S	mg/L	na	na	na	na	na	na	27	29	na	na	na	na	na	na	na
Chloride	mg/L	2430	1000	1480	1890	2150	1210	218	266	563	164	102	94	72	48	72
Calcium	mg/L	203	126	228	90	44	217	6	7	3	11	89	78	12	7	16
Magnesium	mg/L	218	82	146	221	218	49	5	6	1	13	58	59	9	8	9
Sodium	mg/L	1120	495	782	1090	952	691	200	214	763	218	100	90	52	53	45
Potassium	mg/L	3	4	3	26	33	7	160	195	266	40	32	30	2	2	3
Fluoride	mg/L	0.2	0.1	0.2	0.8	0.7	0.2	0.2	0.2	0.6	0.2	0.3	0.2	<0.1	<0.1	0.1
Dissolved metals																
Aluminium	mg/L	<0.01	0.01	0.04	0.04	0.38	0.02	0.04	0.05	0.12	0.08	0.02	0.11	0.05	0.07	0.02
Arsenic	mg/L	0.001	0.003	0.004	0.002	<0.001	0.002	0.002	0.002	0.005	0.002	0.002	0.003	<0.001	<0.001	<0.001
Beryllium	mg/L	<0.001	<0.001	<0.001	<0.001	0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	mg/L	0.212	0.624	0.270	0.078	0.087	1.160	0.11	0.115	0.222	0.058	0.077	0.121	0.050	0.038	0.044
Cadmium	mg/L	<0.0001	<0.0001	<0.0001	0.0002	0.0025	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	mg/L	<0.001	0.006	0.003	0.055	0.248	<0.001	<0.001	<0.001	<0.001	0.001	0.002	0.004	<0.001	<0.001	0.002
Copper	mg/L	0.003	<0.001	0.002	0.001	0.01	0.001	0.002	0.001	<0.001	0.001	<0.001	0.004	0.005	0.002	<0.001
Lead	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	mg/L	0.874	1.410	**1.92**	9.34	16.2	0.280	0.009	0.012	0.003	0.108	0.039	0.452	0.106	0.083	0.078
Molybdenum	mg/L	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	0.009	0.007	0.019	0.006	0.001	0.001	<0.001	<0.001	<0.001
Nickel	mg/L	<0.001	0.002	<0.001	0.028	0.116	<0.001	<0.001	<0.001	<0.001	0.001	0.002	0.004	0.003	0.004	0.001
Selenium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	mg/L	5.49	2.87	6.67	0.918	0.695	**25.0**	0.218	0.262	0.28	0.177	0.559	0.452	0.249	0.191	0.23
Uranium	mg/L	0.002	<0.001	0.007	<0.001	<0.001	0.002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	mg/L	0.017	0.028	0.015	0.107	1.16	0.008	0.012	0.022	0.018	0.03	0.047	0.118	0.013	0.006	0.009
Boron	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	0.16	0.16	0.19	0.76	0.19	0.05	<0.05	0.06	<0.05	<0.05
Iron	mg/L	2.57	5.12	3.33	14.7	14.9	0.53	0.54	0.47	<0.05	0.15	<0.05	0.2	0.45	0.26	0.71
Bromine	mg/L	4.0	3.1	3.1	4.7	2.7	3.0	0.6	1.2	2.5	0.6	0.6	0.6	0.4	0.2	0.3
Nutrients																
Ammonia as N	mg/L	<0.01	0.34	0.18	0.29	3.96	1.85	0.06	0.03	0.02	0.02	0.06	0.12	<0.01	<0.01	0.02
Nitrite as N	mg/L	<0.01	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate as N	mg/L	<0.01	<0.01	0.01	<0.01	0.23	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01
Total Phosphorous	mg/L	0.09	0.07	0.02	0.13	0.07	0.07	<0.01	0.42	1.69	0.51	0.84	0.47	0.1	0.07	<0.01
Reactive Phosphorous	mg/L	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	0.01	<0.01
Total Organic Carbon	mg/L	4	1	2	7	9	33	14	15	29	21	57	44	9	12	3
Total petroleum hydrocarbons																
C6-C9 Fraction	µg/L	<20	<20	<20	na	na	<20	na	<20	<20	<20	<20	<20	<20	<20	<20
C10-C14 Fraction	µg/L	<50	<50	<50	na	na	<50	na	<50	70	<50	<50	<50	<50	<50	<50
C15-C28 Fraction	µg/L	<100	<100	<100	na	na	<100	na	<100	270	310	<100	<100	<100	<100	<100
C29-C36 Fraction	µg/L	<50	<50	<50	na	na	<50	na	<50	50	70	<50	<50	<50	<50	<50
C10-C36 Fraction (sum)	µg/L	<50	<50	<50	na	na	<50	na	<50	390	380	<50	<50	<50	<50	<50
Total recoverable hydrocarbons																
C6-C10 Fraction	µg/L	<20	<20	<20	na	na	<20	na	<20	<20	<20	<20	<20	<20	<20	<20
C6-C10 Fraction minus BTEX (F1)	µg/L	<20	<20	<20	na	na	<20	na	<20	<20	<20	<20	<20	<20	<20	<20
>C10-C16 Fraction	µg/L	<100	<100	<100	na	na	<100	na	<100	110	<100	<100	<100	<100	<100	<100
>C16-C34 Fraction	µg/L	<100	<100	<100	na	na	<100	na	<100	270	340	<100	<100	<100	<100	<100
>C34-C40 Fraction	µg/L	<100	<100	<100	na	na	<100	na	<100	<100	<100	<100	<100	<100	<100	<100
>C10-C40 Fraction (sum)	µg/L	<100	<100	<100	na	na	<100	na	<100	380	340	<100	<100	<100	<100	<100
Aromatic hydrocarbons																
Benzene	µg/L	<1	<1	<1	na	na	<1	na	<1	<1	<1	<1	<1	<1	<1	<1
Toluene	µg/L	<2	<2	<2	na	na	<2	na	<2	<2	<2	<2	<2	<2	<2	<2
Ethyl Benzene	µg/L	<2	<2	<2	na	na	<2	na	<2	<2	<2	<2	<2	<2	<2	<2
m&p-Xylenes	µg/L	<2	<2	<2	na	na	<2	na	<2	<2	<2	<2	<2	<2	<2	<2
o-Xylenes	µg/L	<2	<2	<2	na	na	<2	na	<2	<2	<2	<2	<2	<2	<2	<2
Total xlyenes	µg/L	<2	<2	<2	na	na	<2	na	<2	<2	<2	<2	<2	<2	<2	<2
Sum of BTEX	µg/L	<1	<1	<1	na	na	<1	na	<1	<1	<1	<1	<1	<1	<1	<1
Naphthalene	µg/L	<5	<5	<5	na	na	<5	na	<5	<5	<5	<5	<5	<5	<5	<5
Dissolved gases																
Methane	µg/L	na	na	na	na	na	na	na	26	<10	<10	na	na	<10	<10	14.00
Phenolic compounds																
Phenol	µg/L	1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2-Chlorophenol	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2-Methylphenol	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
3-&4-Methylphenol	µg/L	102	<2.0	<2.0	na	na	<2.0	na	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
2-Nitrophenol	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2.4-Dimethylphenol	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2.4-Dichlorophenol	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2.6-Dichlorophenol	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
4-Chloro-3-Methylphenol	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2.4.6-Trichlorophenol	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
2.4.5-Trichlorophenol	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Pentachlorophenol	µg/L	<2.0	<2.0	<2.0	na	na	<2.0	na	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Polycyclic aromatic hydrocarbons																
Naphthalene	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b)fluoranthene	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	µg/L	<0.5	<0.5	<0.5	na	na	<0.5	na	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	µg/L	<1.0	<1.0	<1.0	na	na	<1.0	na	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0

Notes:

Bold number indicates that result is above Baseline threshold value

^^ Pre-Irrigation sample

na - not analysed

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Summary table: Monthly water quality parameters (AGL)

March 2013

WQ Parameters	Date	Salinity (EC)	Temp	pH	Eh/ORP
Units		*dS/m*	*°C*		*mV*
Sites					
Tiedman North Dam	26-Mar-13	3.947	27.8	9.71	31.8
Tiedman South Dam	26-Mar-13	0.53	28.3	9.02	41.1
Tiedman East Dam	26-Mar-13	1.333	29.9	10.67	4.1

April 2013

WQ Parameters	Date	Salinity (EC)	Temp	pH	Eh/ORP
Units		*dS/m*	*°C*		*mV*
Sites					
Tiedman North Dam	30-Apr-13	4.102	23.48	9.74	33.3
Tiedman South Dam	30-Apr-13	1.534	22.26	9.62	38.6
Tiedman East Dam	30-Apr-13	1.396	22.88	10.1	27.6
Catch dam 1 (east)	30-Apr-13	1.23	23.76	9.09	47.9
Catch dam 2 (west)	30-Apr-13	1.31	23.96	9.79	46.7
Avon River at pump site	23-Apr-13	0.406	16.75	8.37	111.4

May 2013

WQ Parameters	Date	Salinity (EC)	Temp	pH	Eh/ORP
Units		*dS/m*	*°C*		*mV*
Sites					
Tiedman North Dam	31-May-13	3.967	13.47	9.3	30.9
Tiedman South Dam	31-May-13	1.602	13.53	8.9	57
Tiedman East Dam	31-May-13	1.201	13.26	9.5	24.2
Stratford #3 Dam	31-May-13	1.855	14.11	9.41	28.2
Catch dam 1 (east)	31-May-13	0.676	12.61	8.19	73.3
Catch dam 2 (west)	31-May-13	0.953	12.52	8.17	72.4
Avon River at pump site	31-May-13	0.532	12.54	8.6	64.6

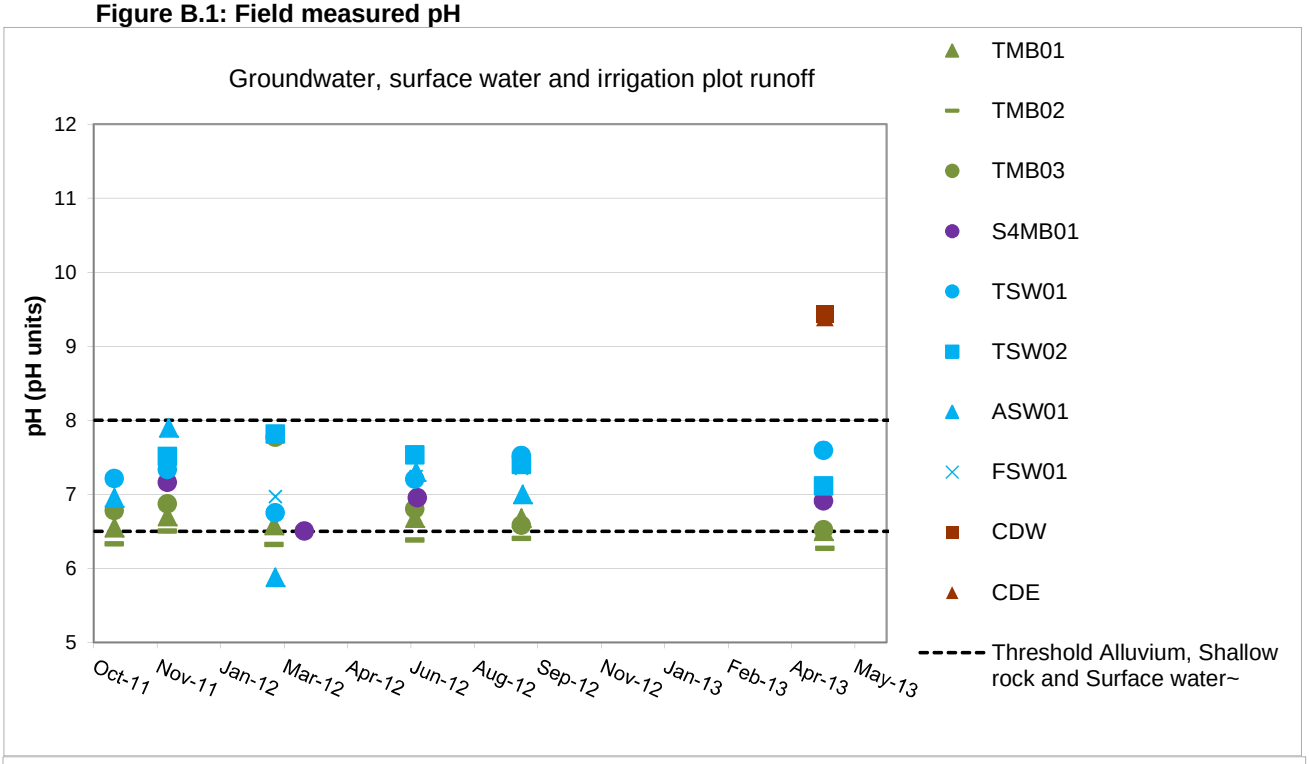
June 2013

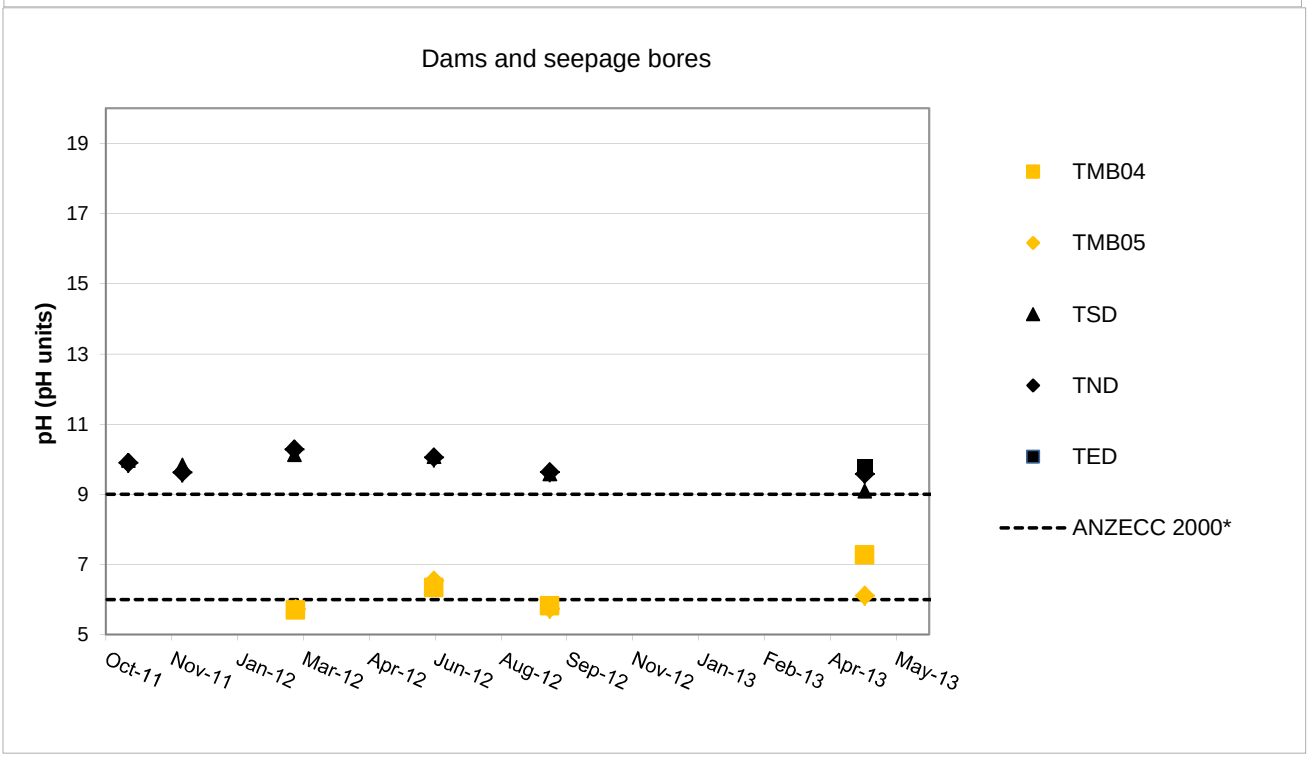
WQ Parameters	Date	Salinity (EC)	Temp	pH	Eh/ORP
Units		*dS/m*	*°C*		*mV*
Sites					
Tiedman North Dam	28-Jun-13	3.942	13.77	8.94	64
Tiedman South Dam	28-Jun-13	1.581	13.69	8.66	72.6
Tiedman East Dam	28-Jun-13	1.133	13.8	8.93	60.8
Catch dam 1 (east)	28-Jun-13	0.581	13.55	8.36	95.6
Catch dam 2 (west)	28-Jun-13	0.749	13.64	7.95	106.5

Appendix B

Water quality graphs

Figure B.1: Field measured pH





Notes:

~ANZECC 2000 - Water Quality Guidelines: 95% protection levels (threshold values) for the protection of freshwater aquatic ecosystems are adopted when maximum analyte concentration is lower than applicable ANZECC (2000) guideline value

*ANZECC 2000. pH range of water for long-term irrigation and general water use

Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester Basin, NSW

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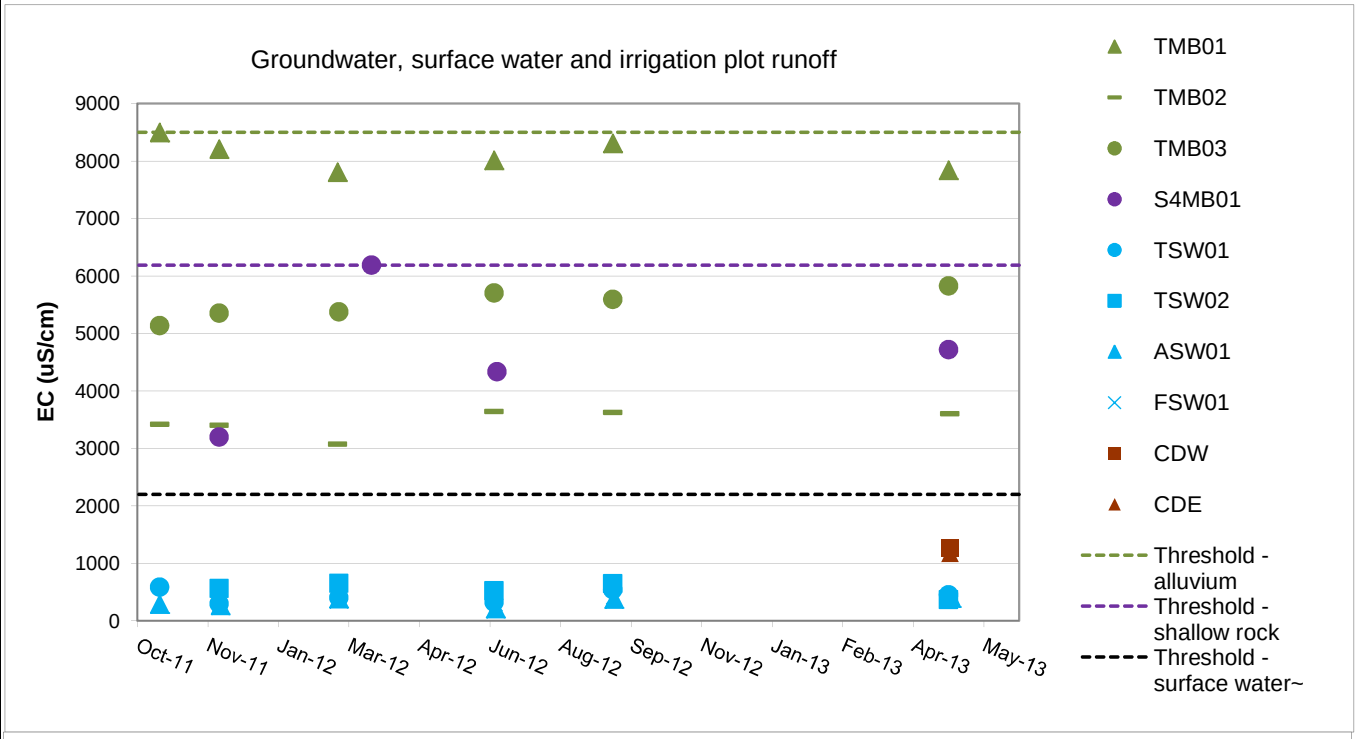
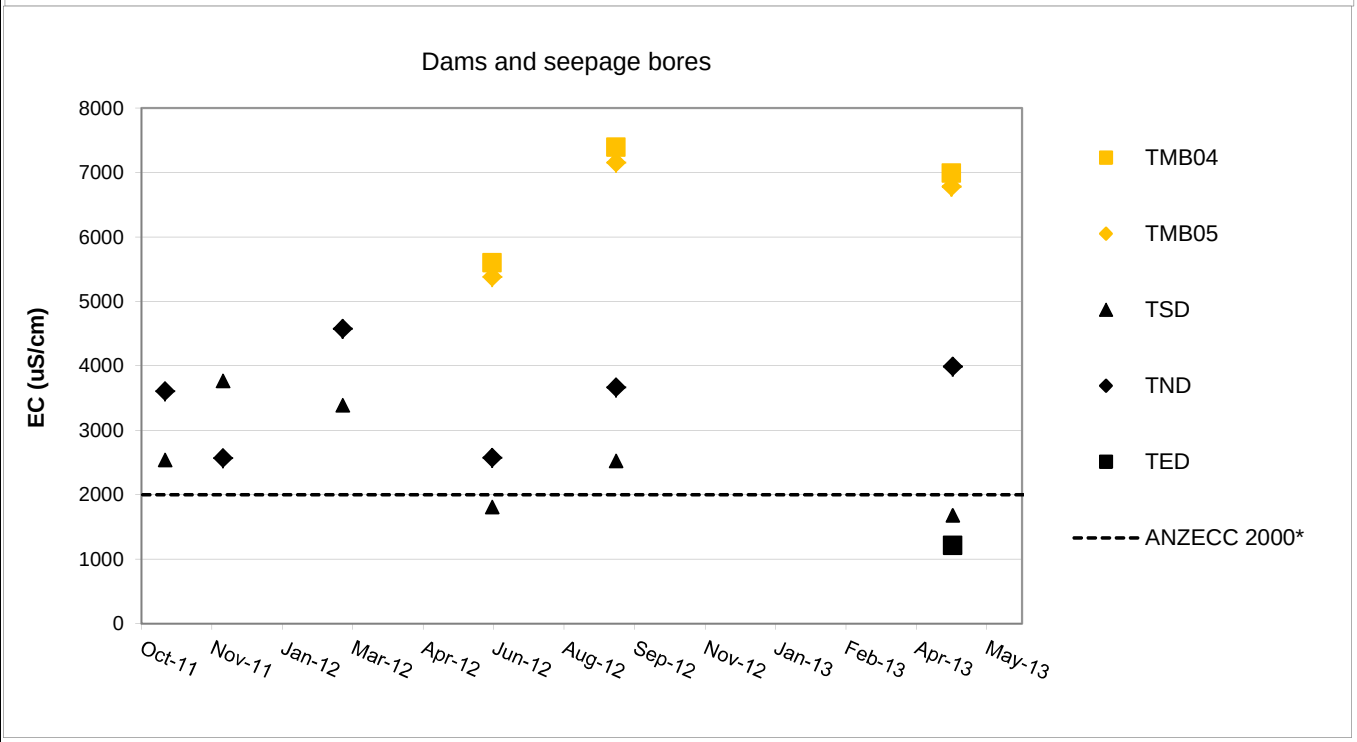
Figure B.2: Field measured EC





Note:
~ANZECC 2000 – Water Quality Guideline: 95% protection levels for aquatic ecosystems, South-East Australia, low lying river ecosystems.
*ANZECC 2000. EC range of water for long-term irrigation and general water use

Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester Basin, NSW

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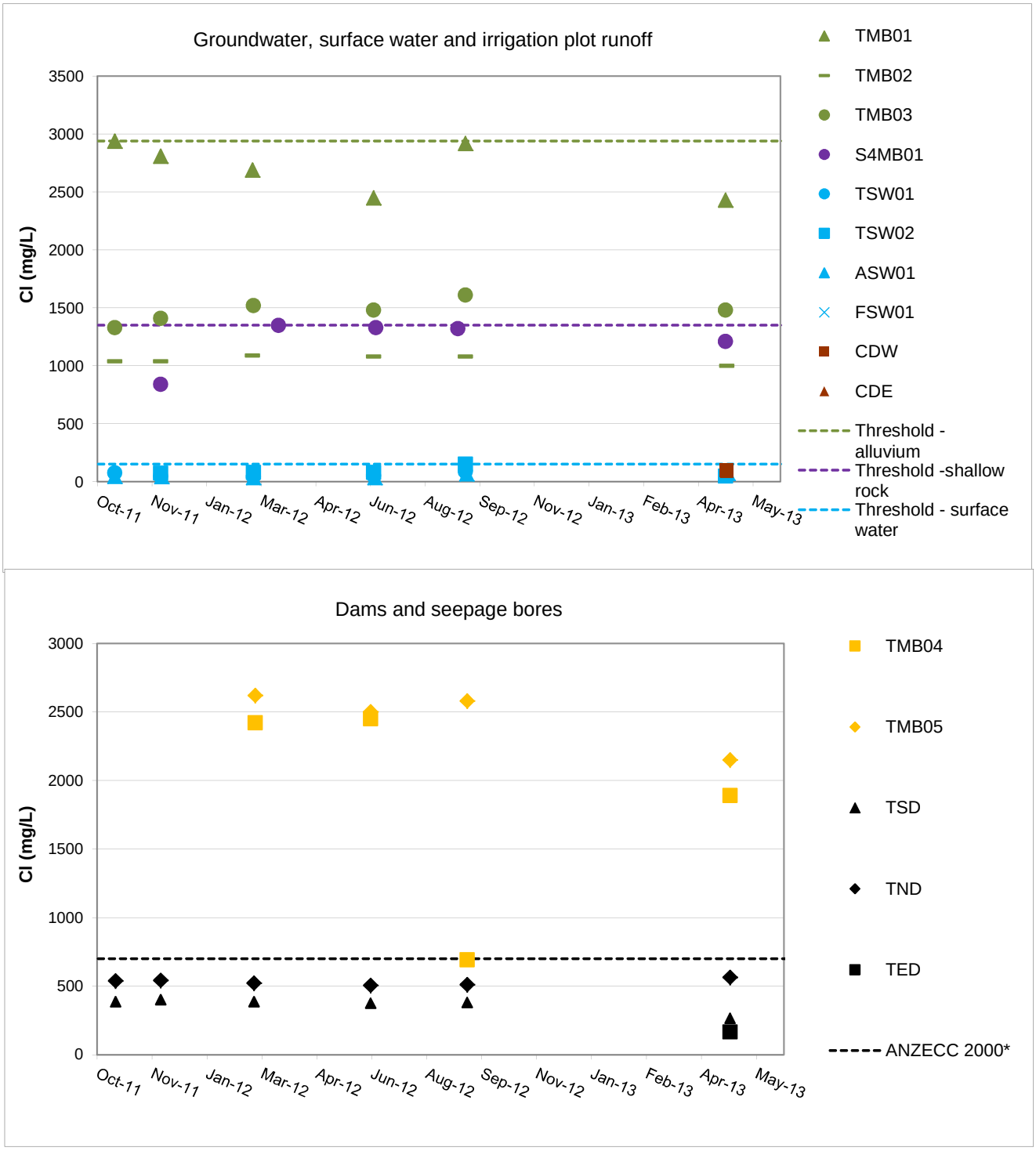
Figure B.3: Chloride concentrations



Note:
*ANZECC 2000. Water for irrigation and general water use. Moderately tolerant plants.

Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester Basin, NSW

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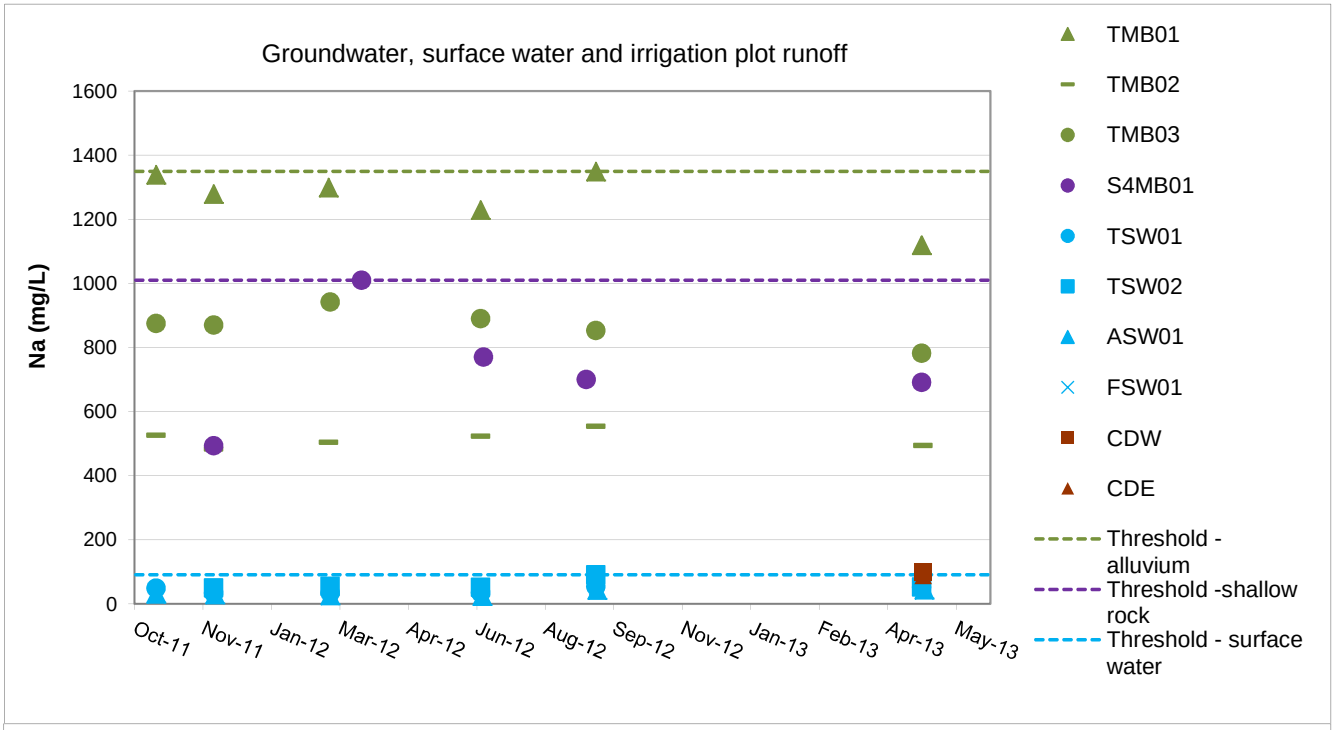
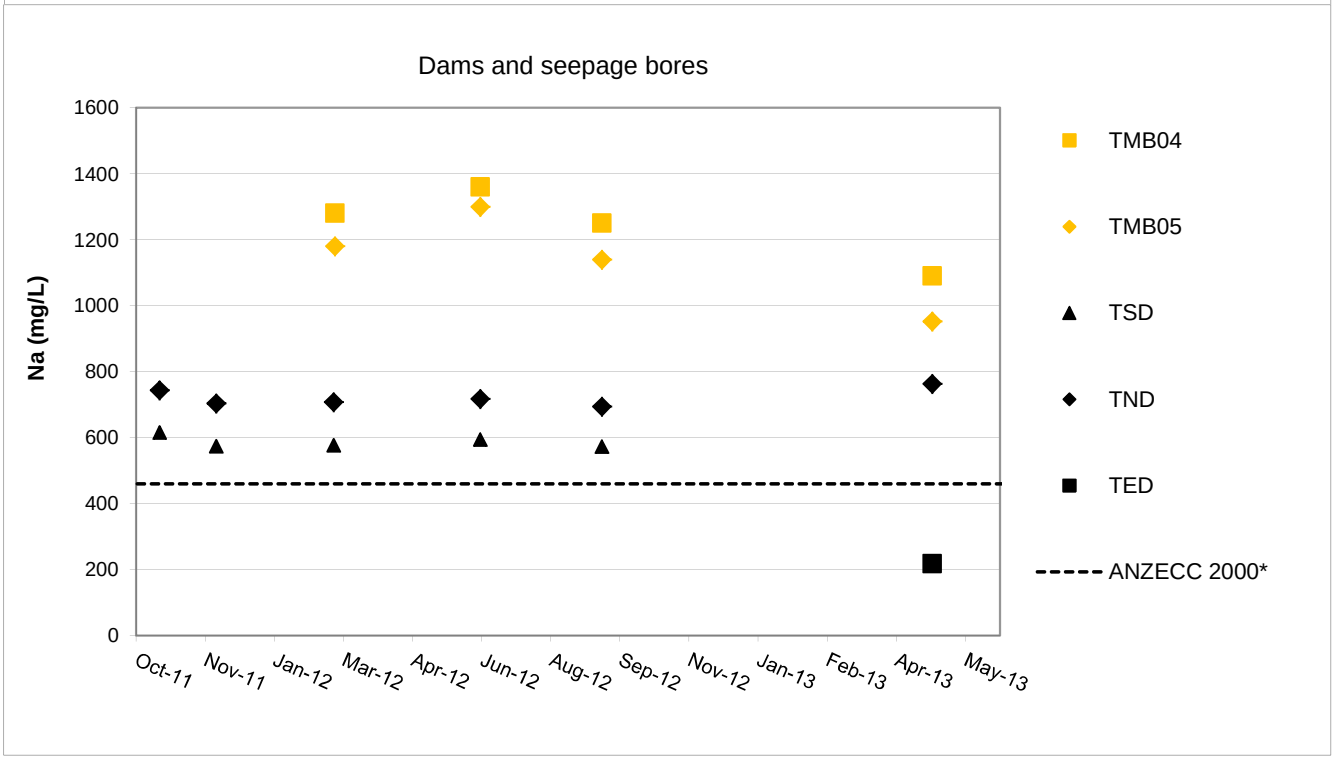
Figure B.4: Sodium concentrations





Note:
*ANZECC 2000. Water for irrigation and general water use. Moderately tolerant plants.

Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester Basin, NSW

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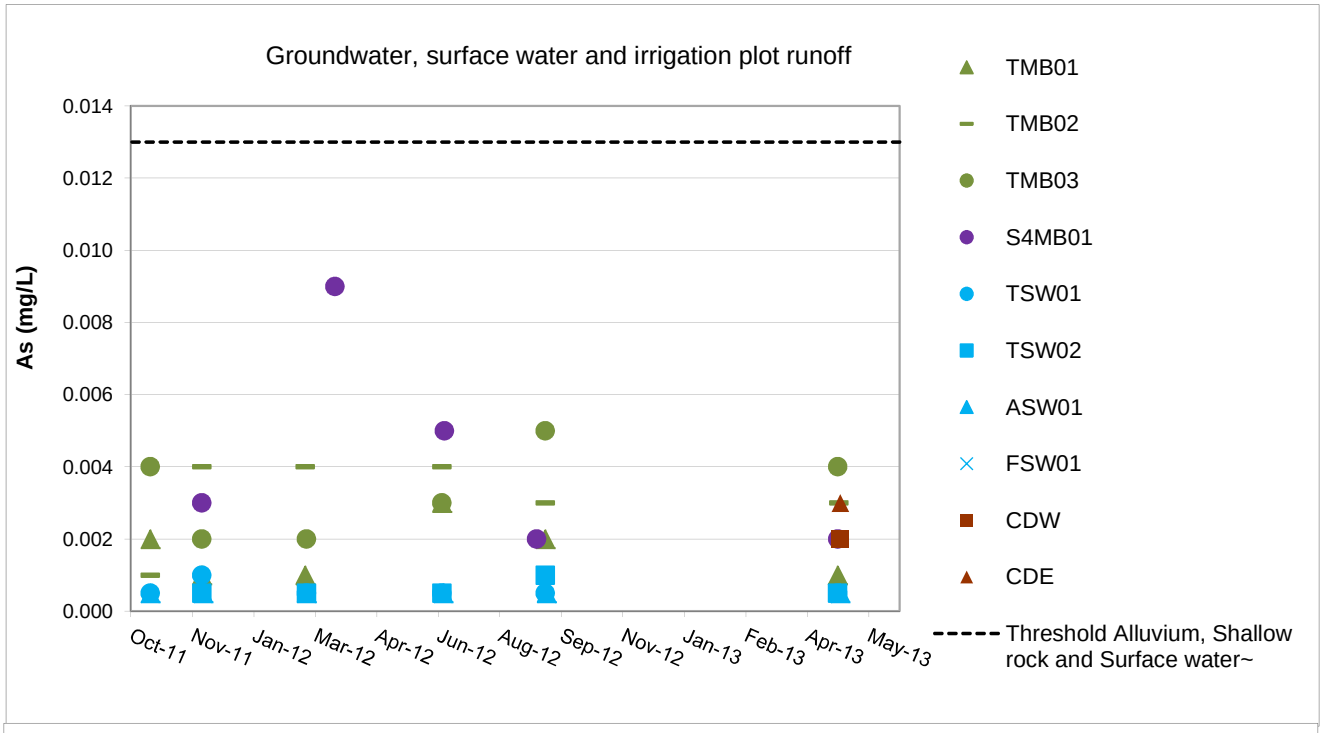
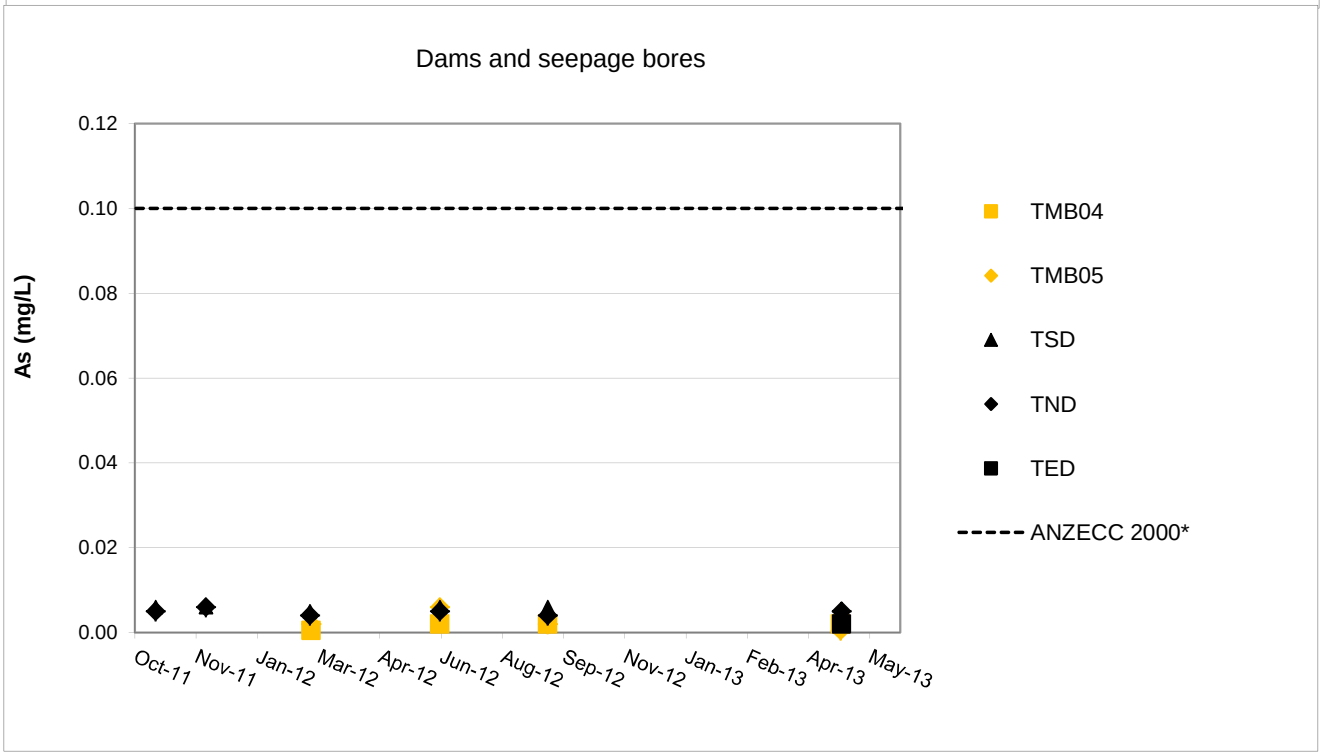
Figure B.5: Arsenic concentrations





Note:
~ANZECC 2000 - Water Quality Guidelines: 95% protection levels (threshold values) for the protection of freshwater aquatic ecosystems are adopted when maximum analyte concentration is lower than applicable ANZECC (2000) guideline value
*ANZECC 2000. Water for long term irrigation and general water use

Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester Basin, NSW

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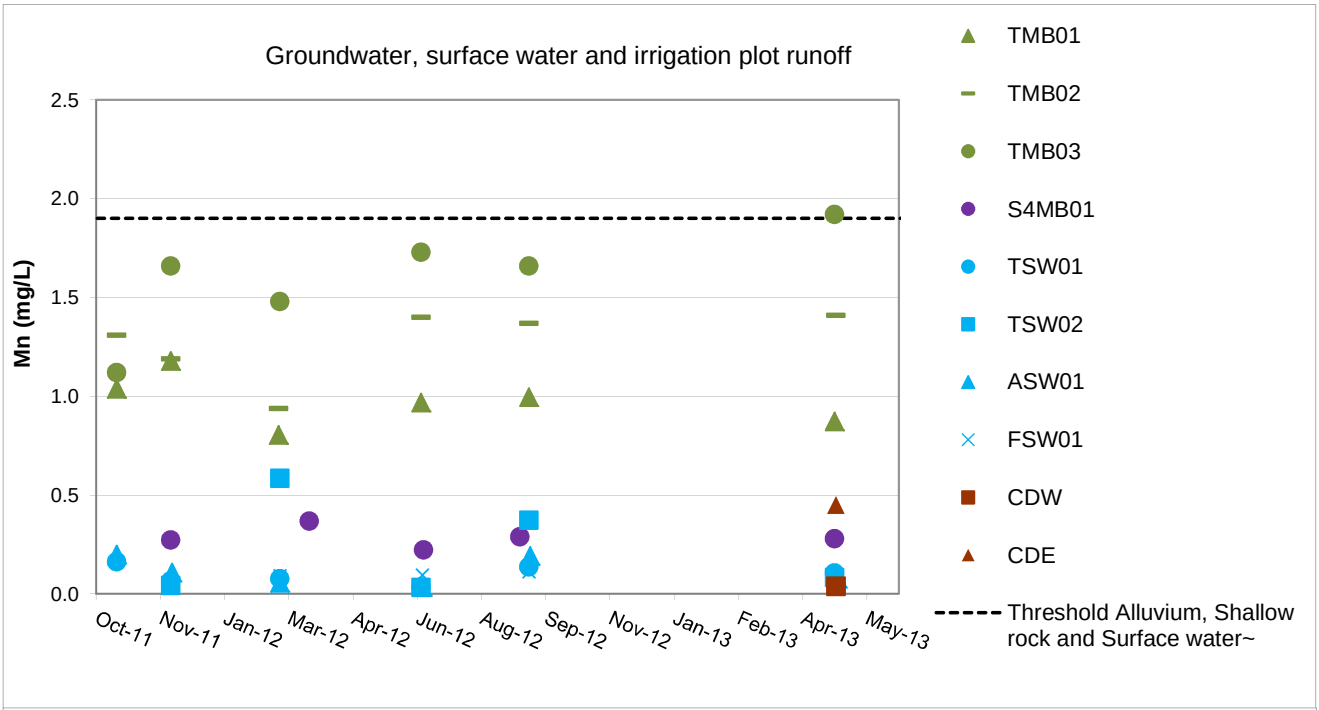
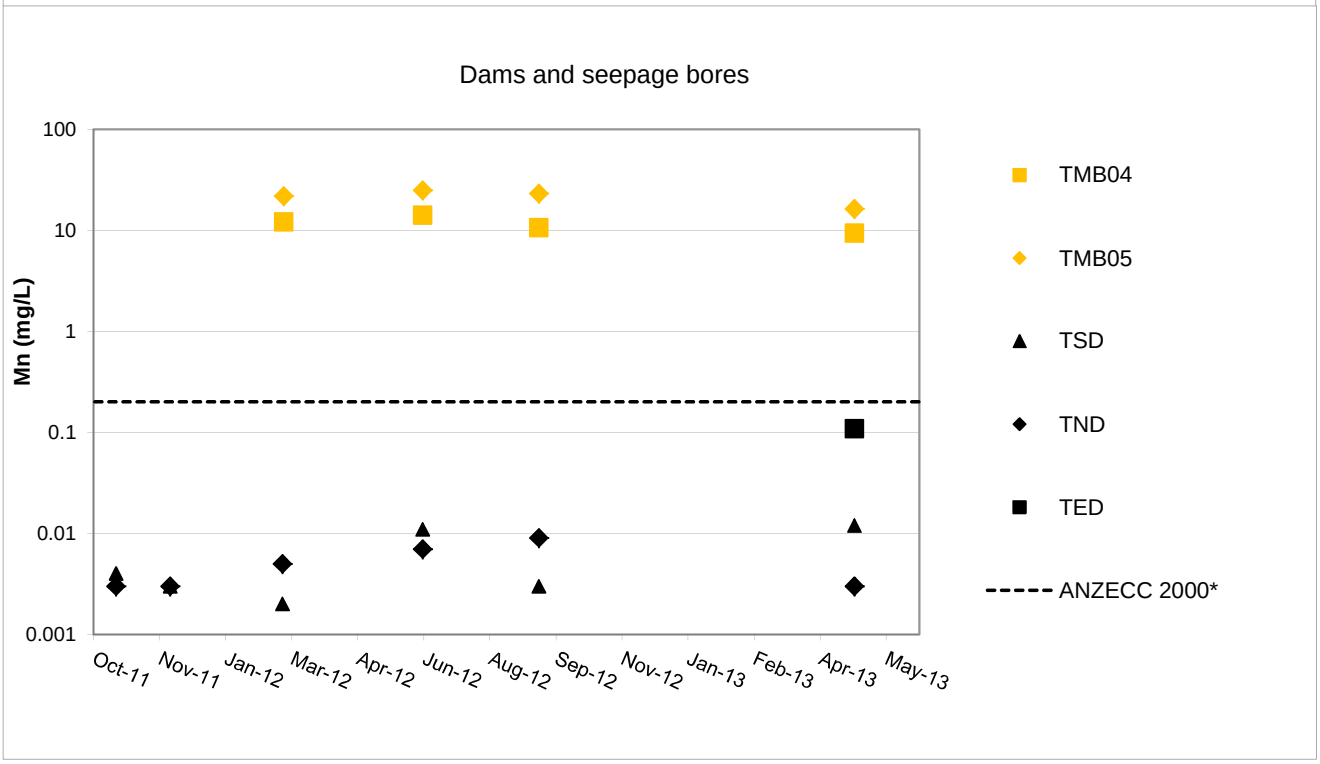
Figure B.6: Manganese concentrations





Note:
~ANZECC 2000 - Water Quality Guidelines: 95% protection levels (threshold values) for the protection of freshwater aquatic ecosystems are adopted when maximum analyte concentration is lower than applicable ANZECC (2000) guideline value
*ANZECC 2000. Water for long term irrigation and general water use

Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester Basin, NSW

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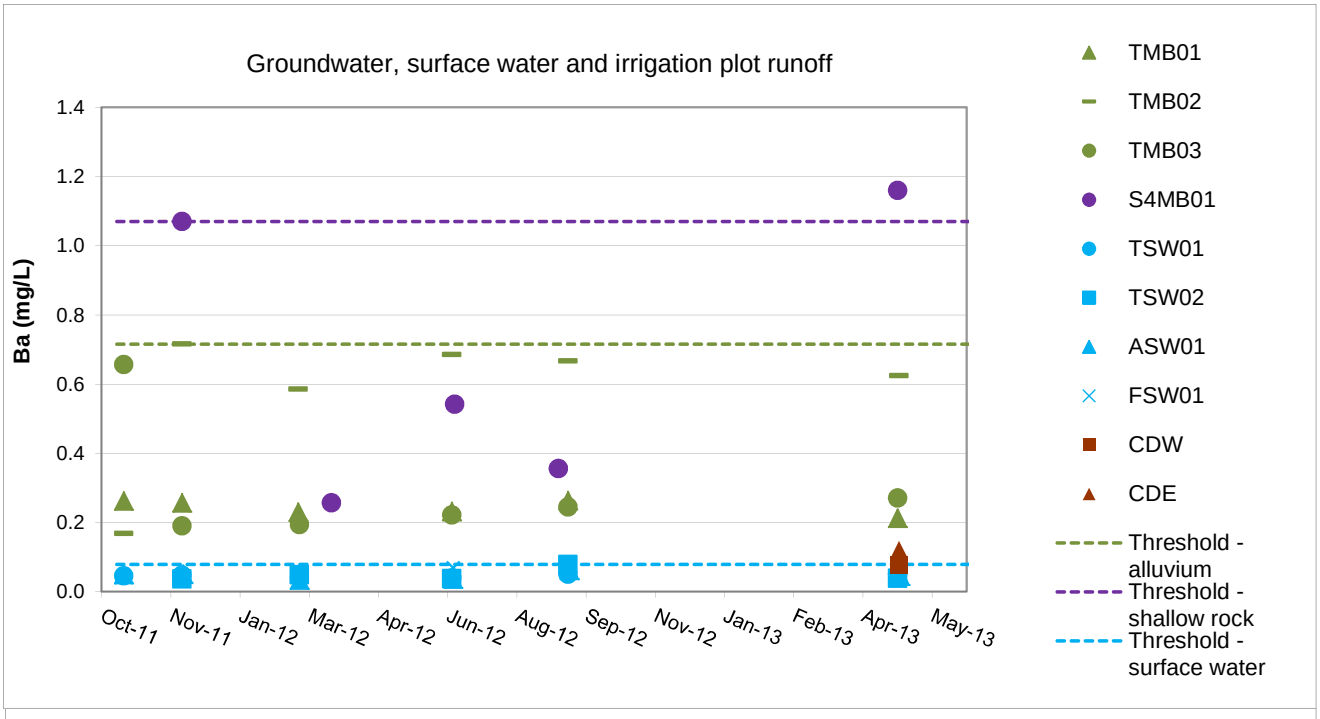
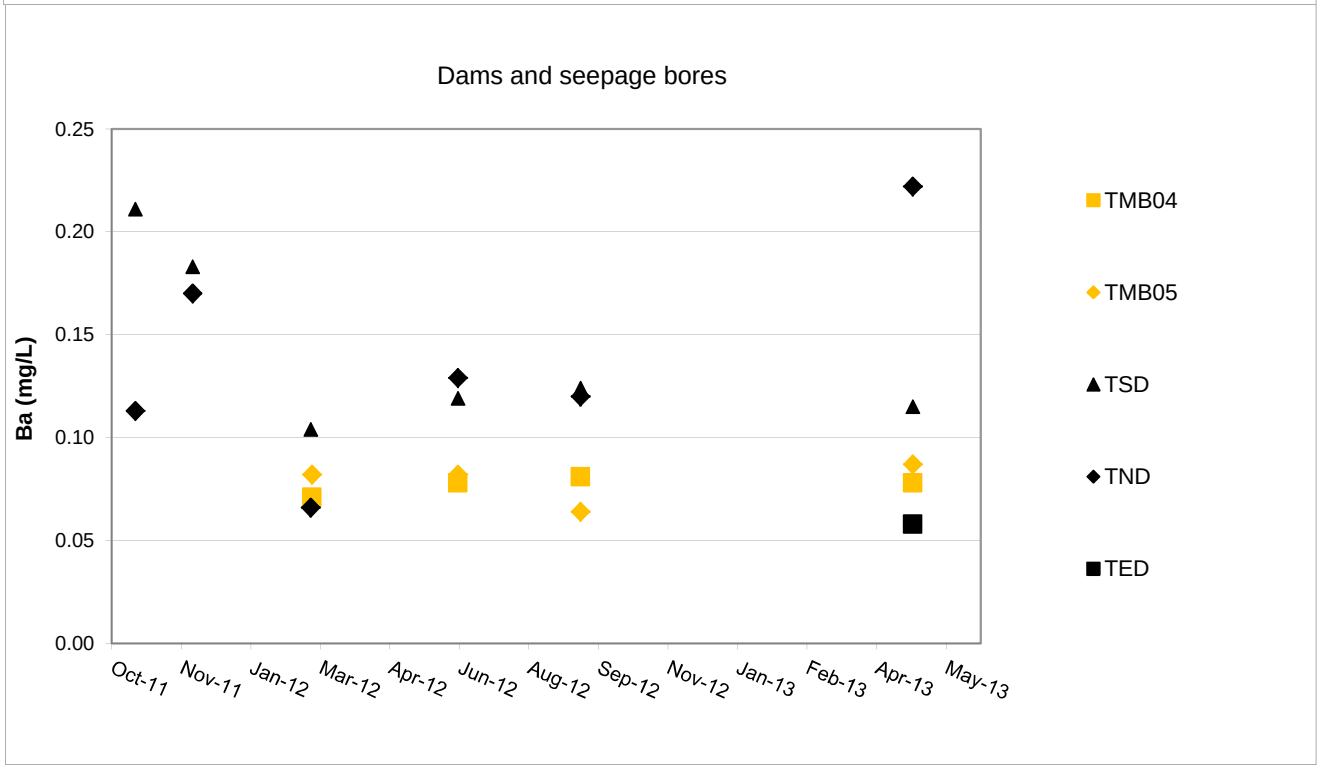
Figure B.7: Barium concentrations





Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester Basin, NSW

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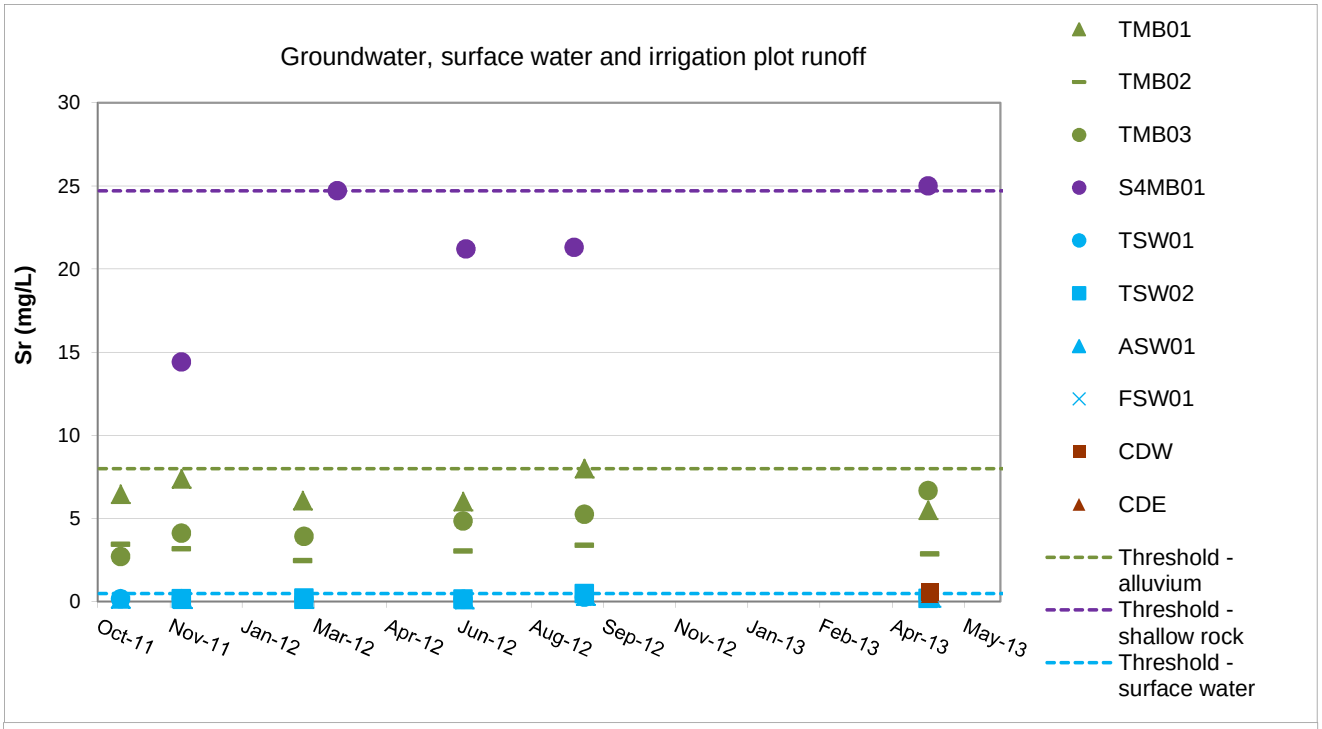
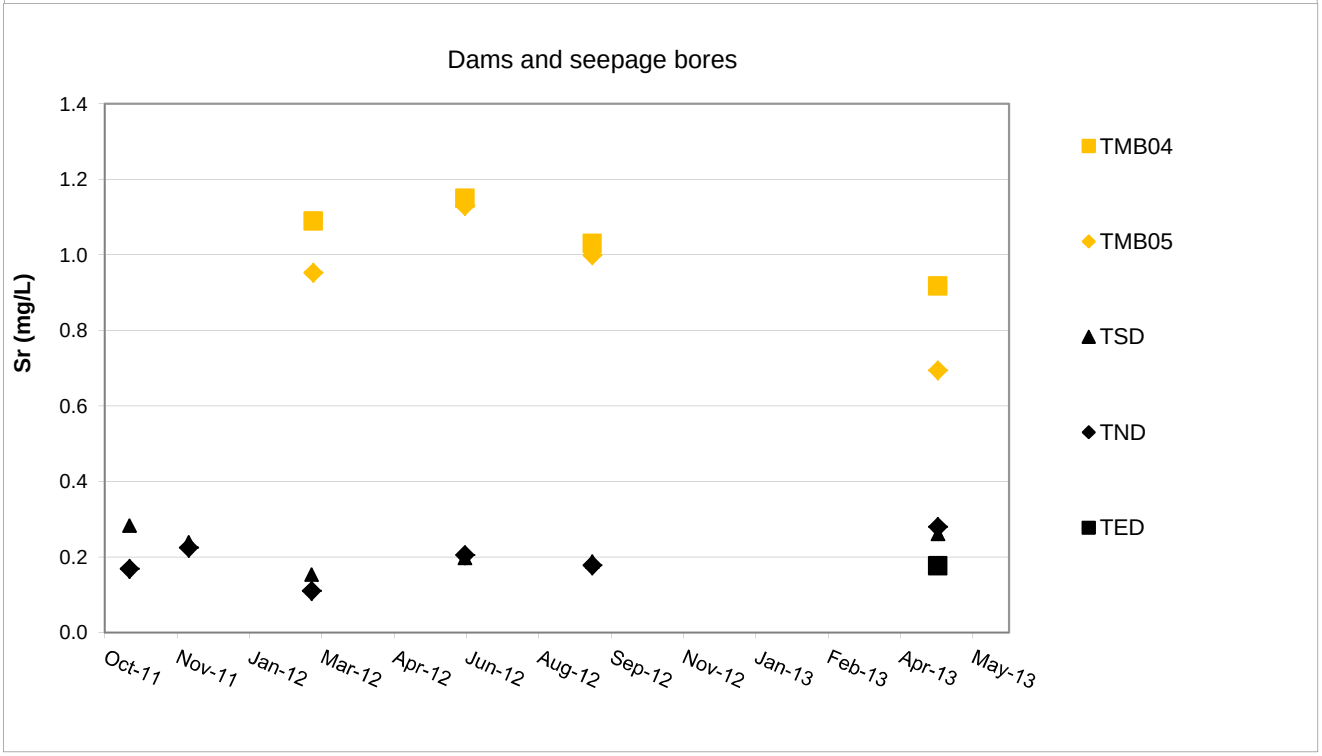
Figure B.8: Strontium concentrations





Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester Basin, NSW

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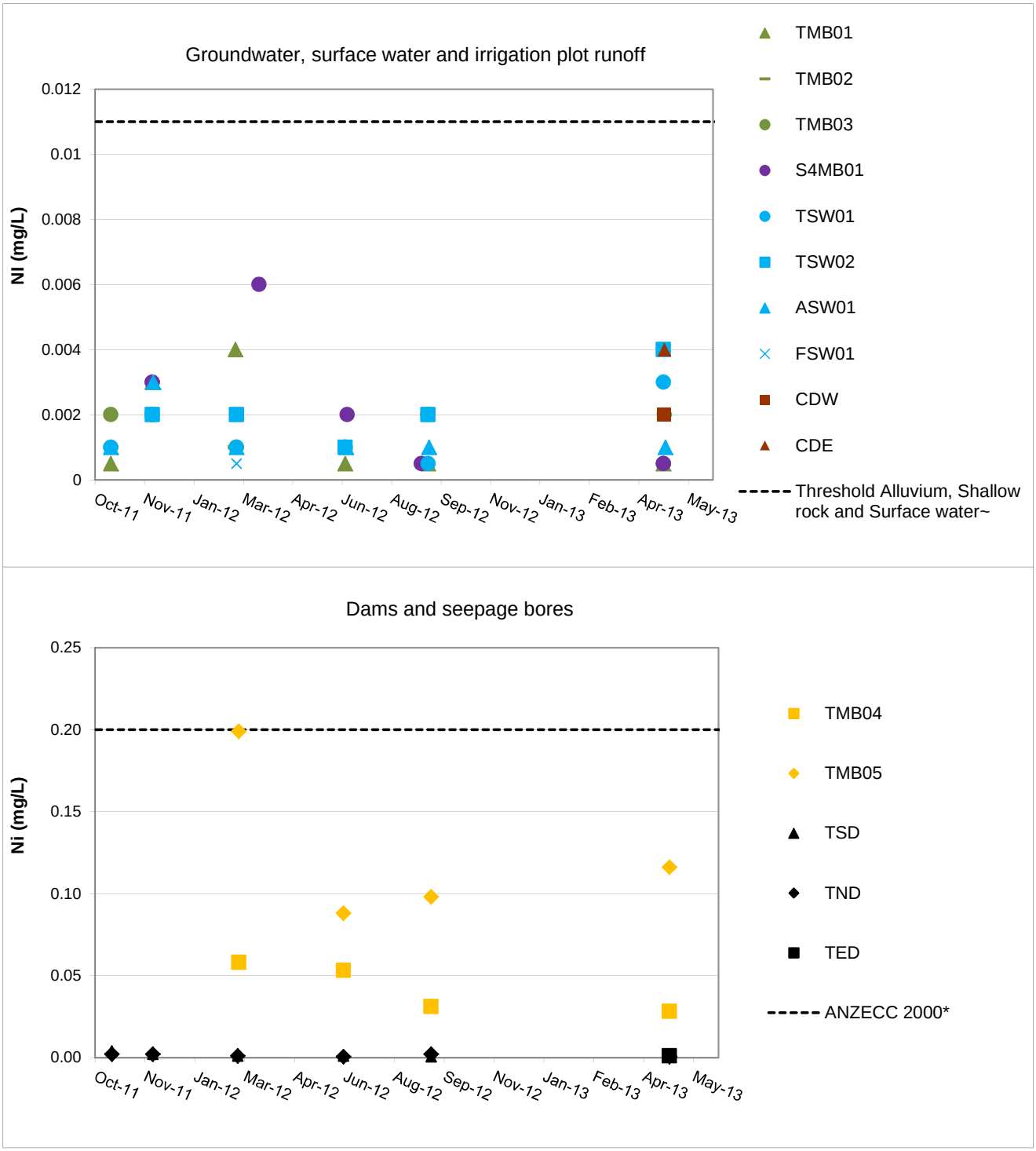
Figure B.9: Nickel concentrations



Notes:

~ANZECC 2000 - Water Quality Guidelines: 95% protection levels (threshold values) for the protection of freshwater aquatic ecosystems are adopted when maximum analyte concentration is lower than applicable ANZECC (2000) guideline value

*ANZECC 2000. Water for long term irrigation and general water use

Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester Basin, NSW

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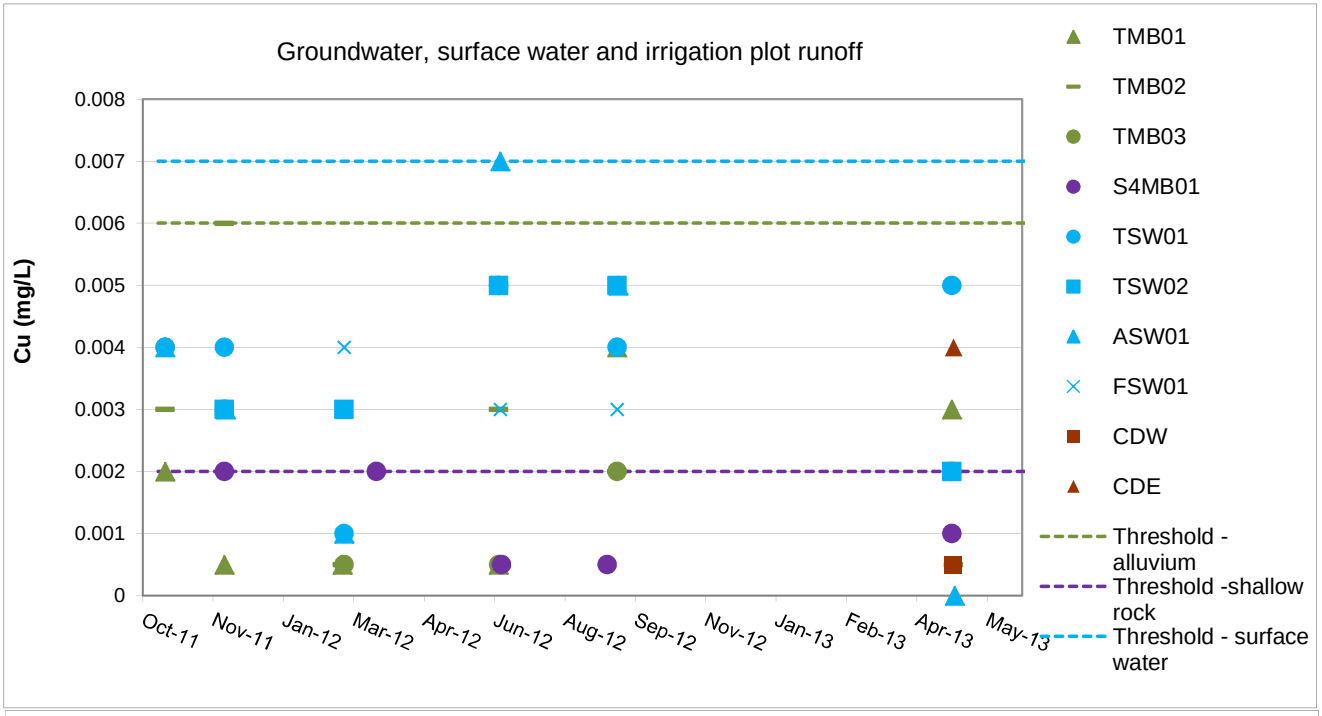
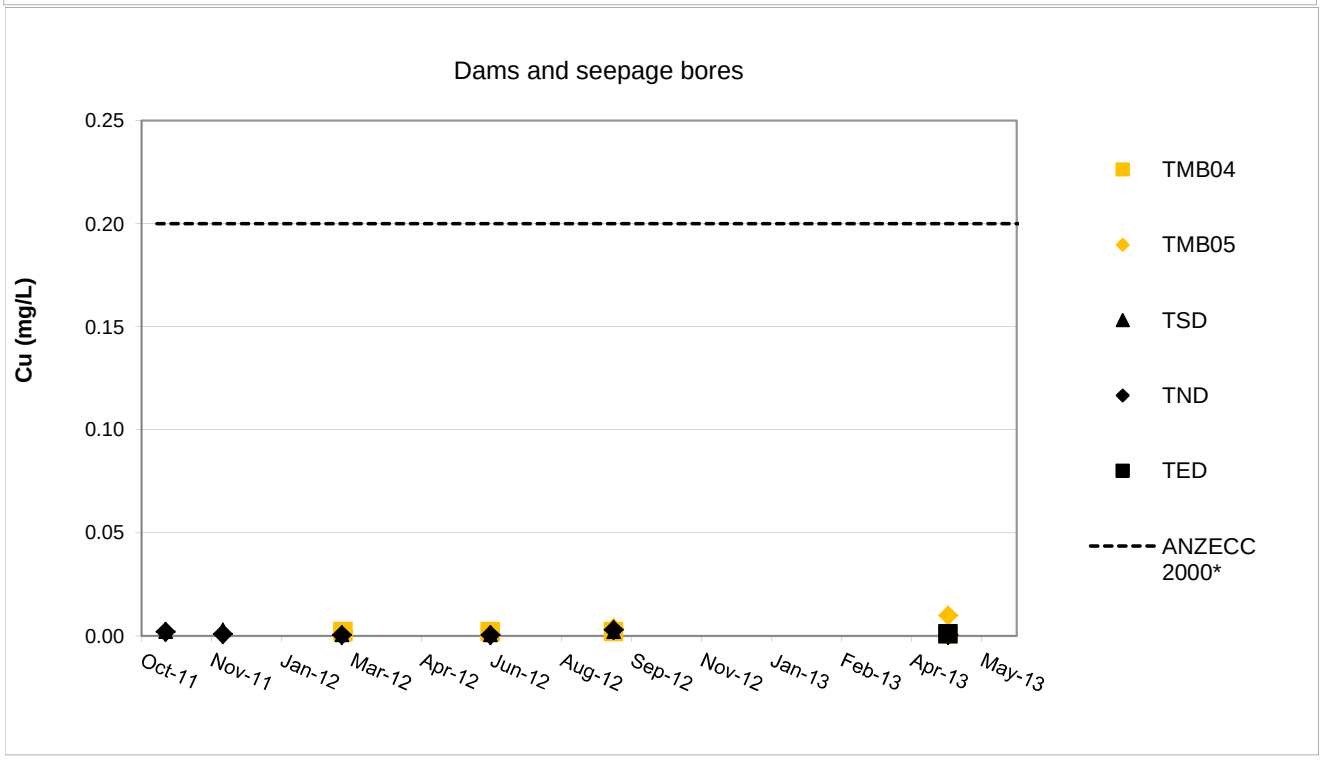
Figure B.10: Copper concentrations





Note:
*ANZECC 2000. Water for long term irrigation and general water use

Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester Basin, NSW

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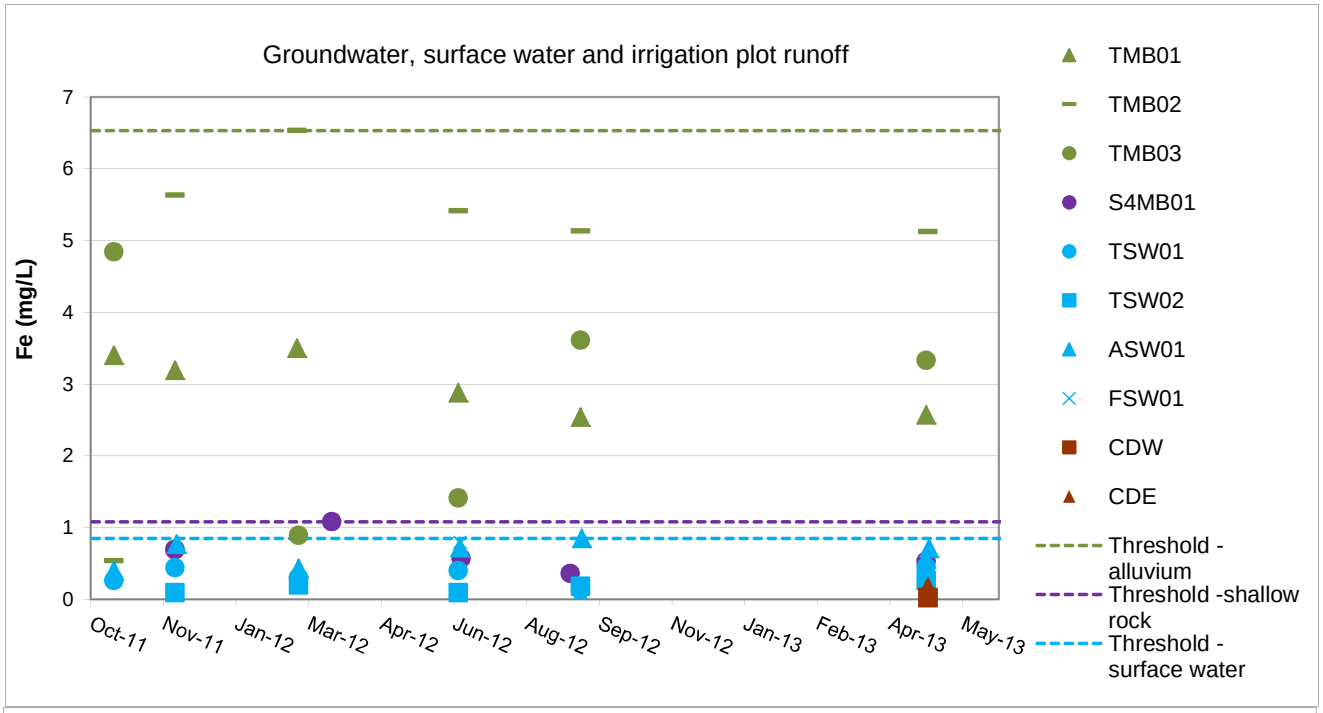
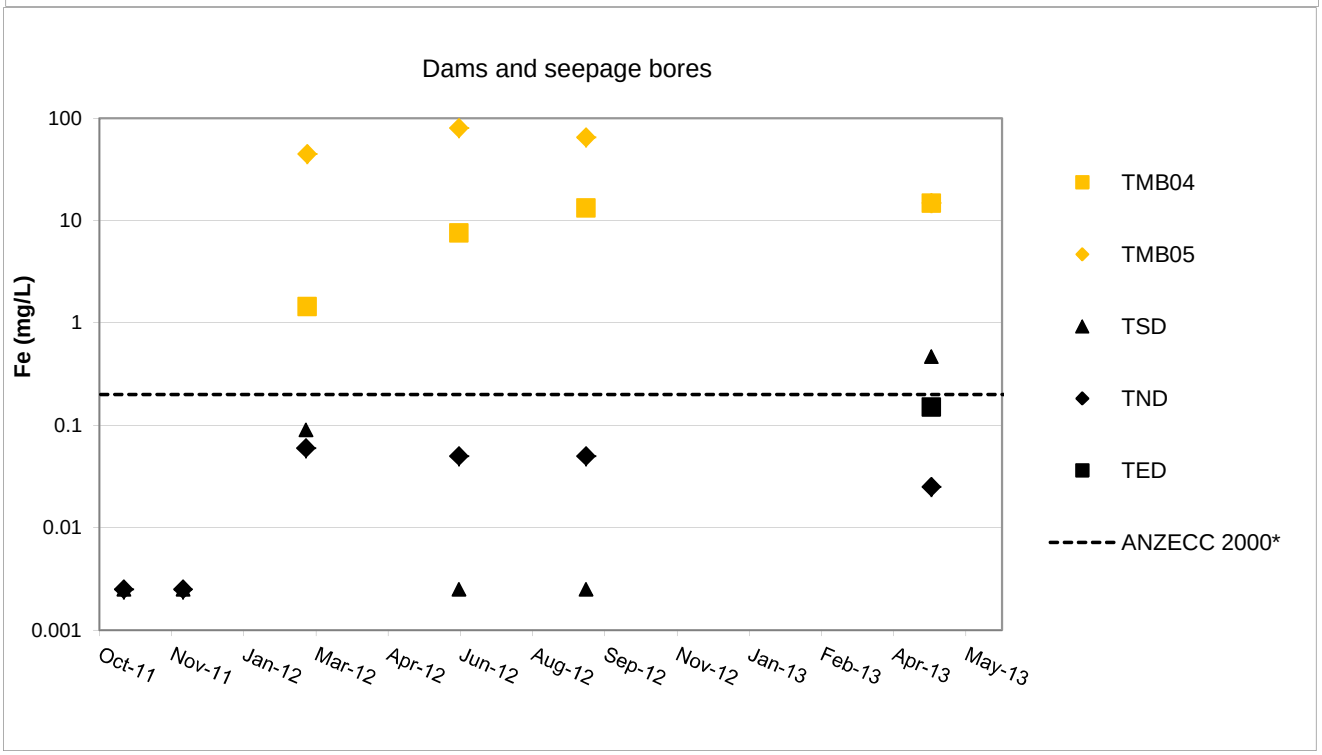
Figure B.11: Iron concentrations





Note:
*ANZECC 2000. Water for long term irrigation and general water use

Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester Basin, NSW

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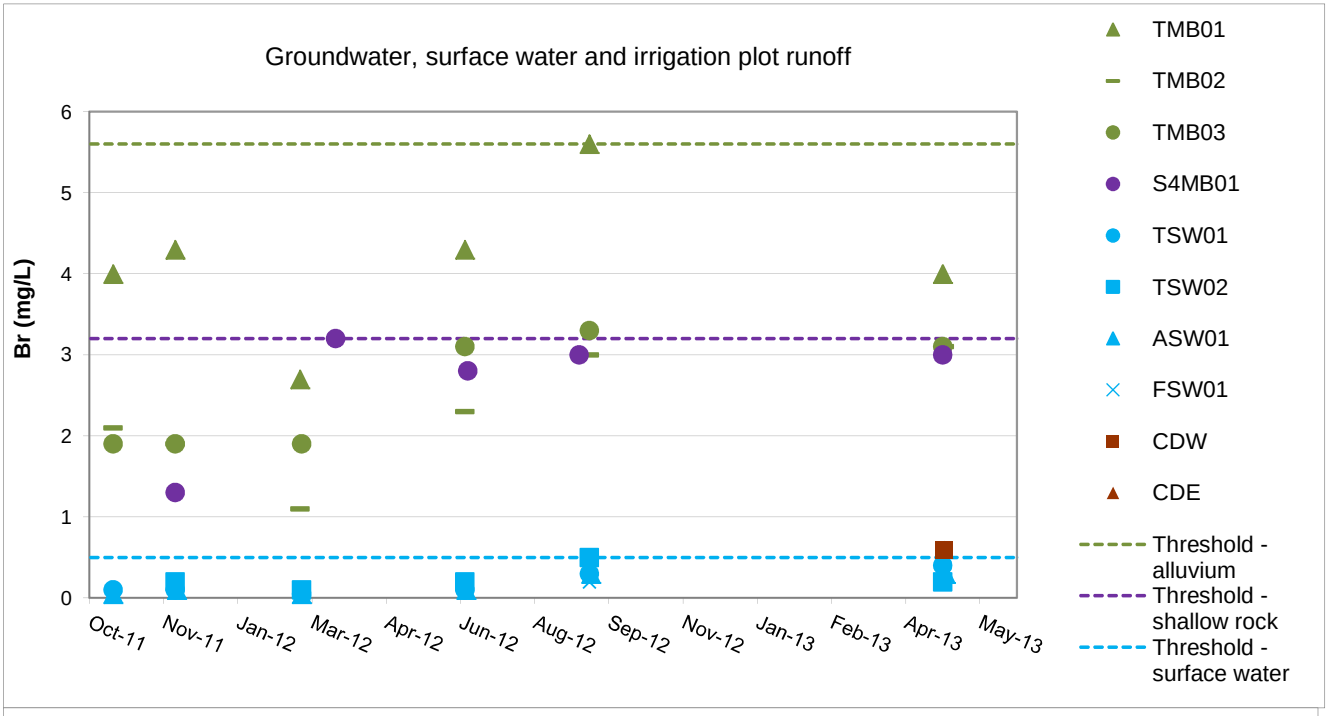
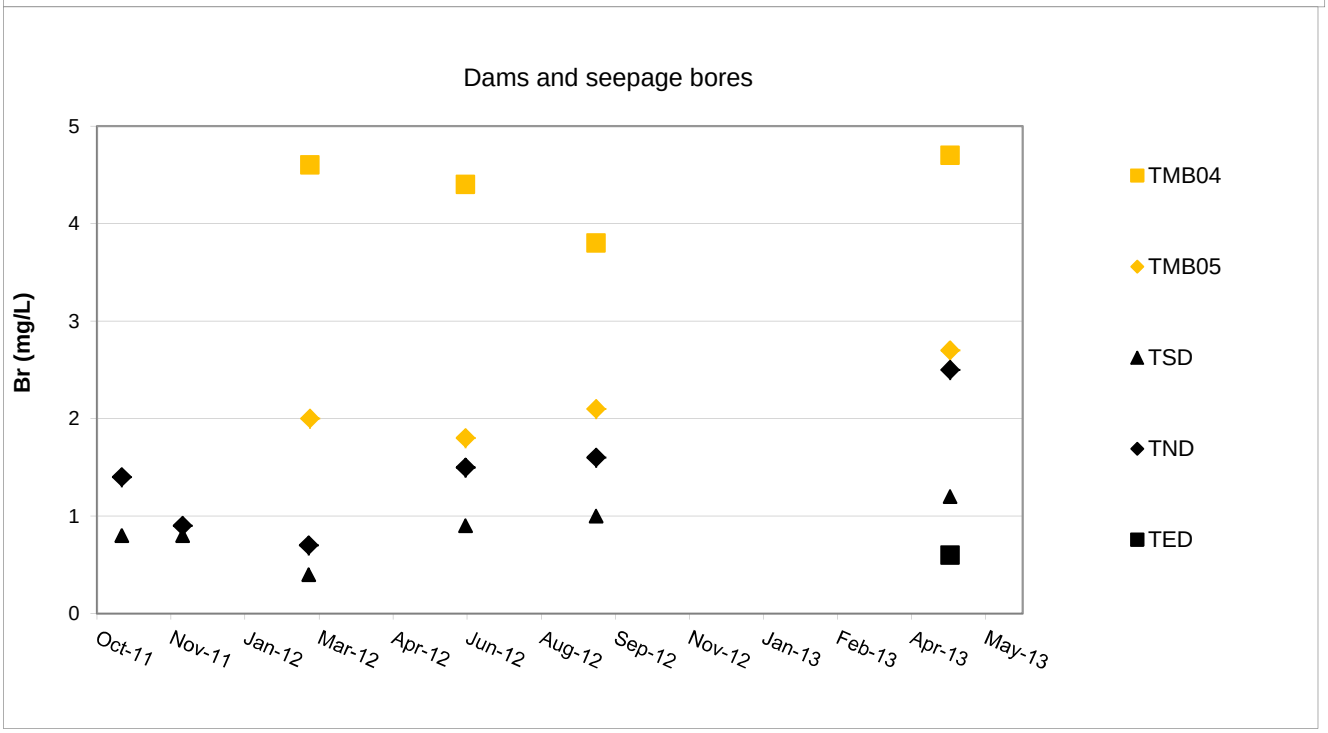
Figure B.12: Bromine concentrations





Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester Basin, NSW

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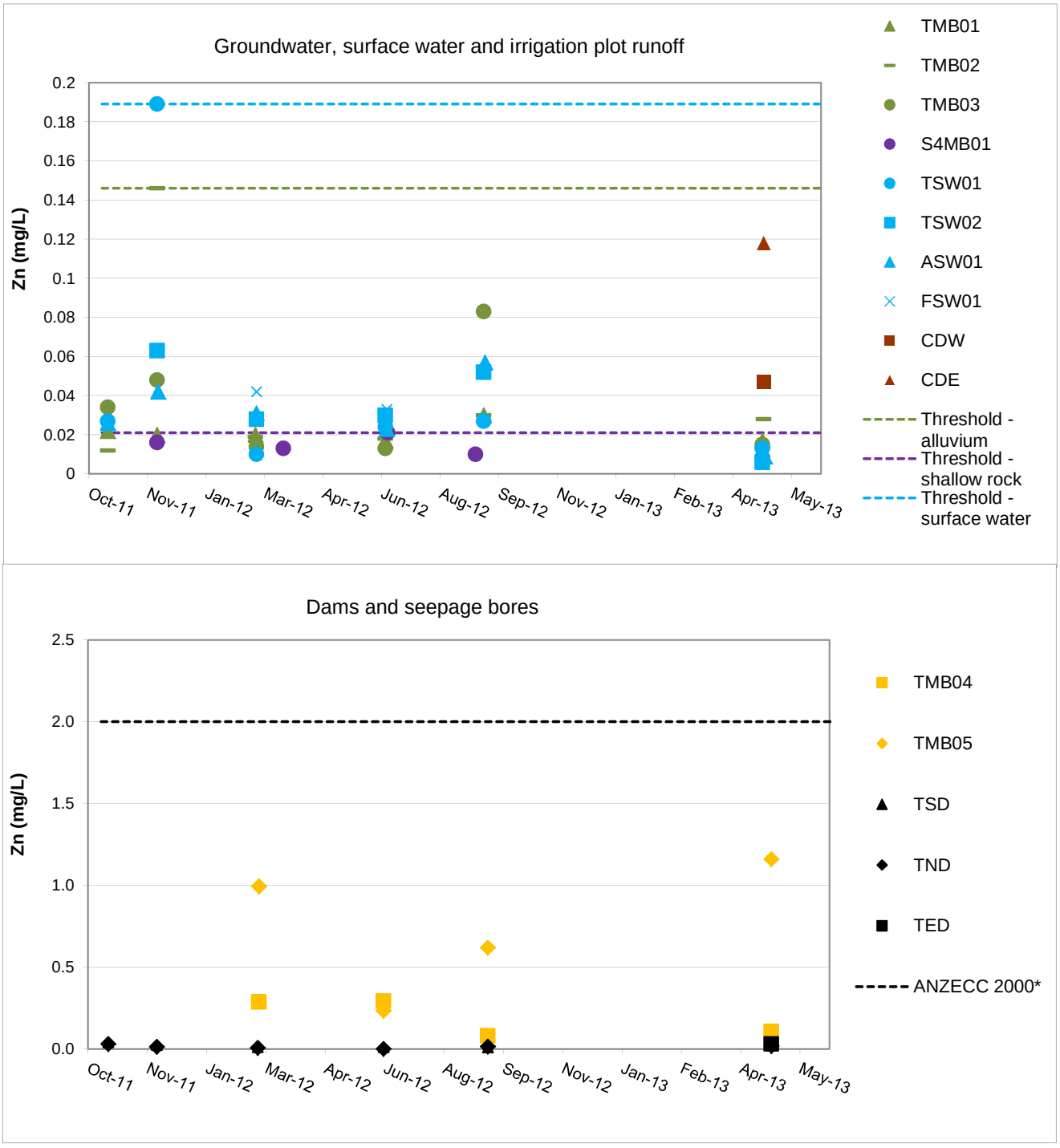
Figure B.13: Zinc concentrations



Note:
*ANZECC 2000. Water for long term irrigation and general water use

Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester Basin, NSW

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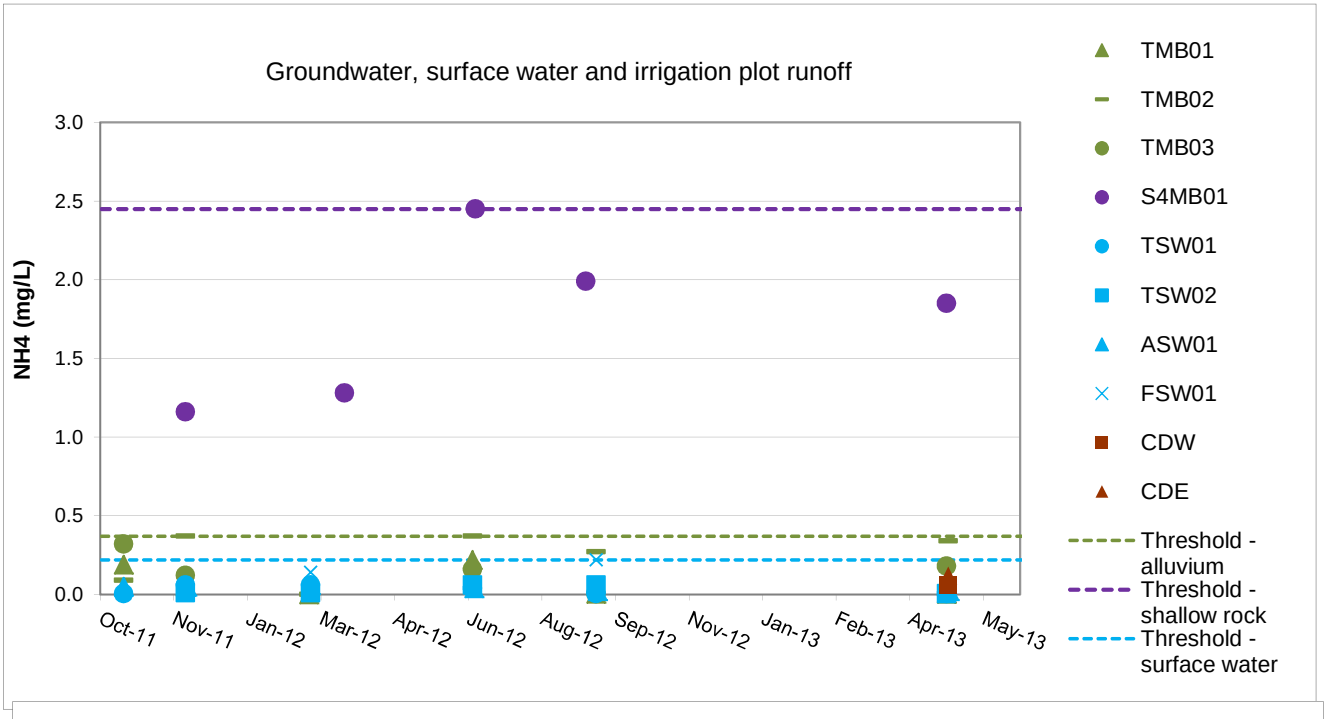
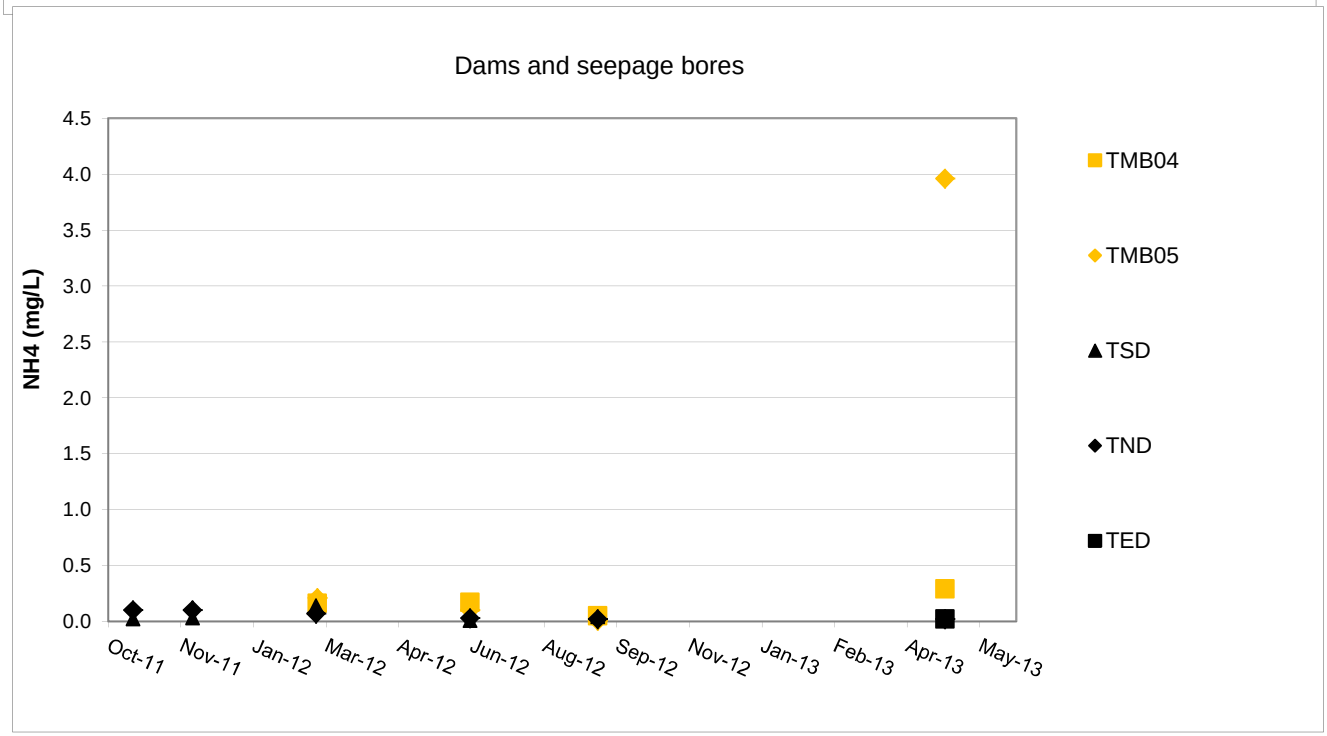
Figure B.14: Ammonia concentrations





Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester Basin, NSW

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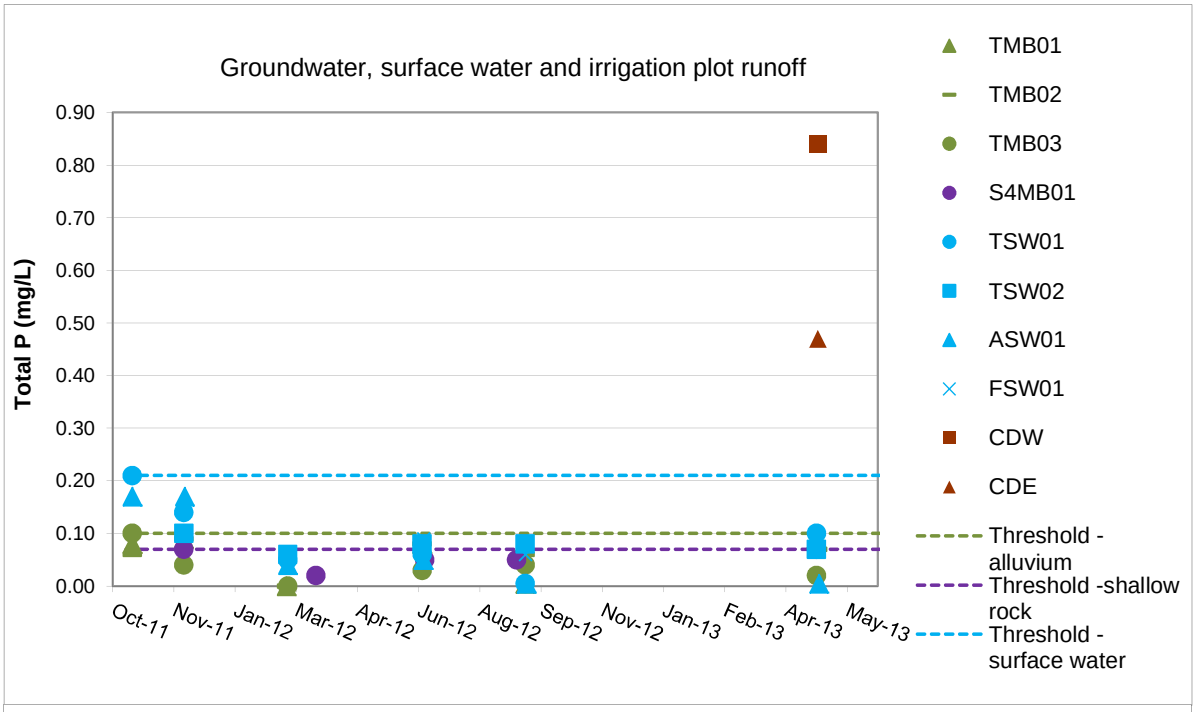
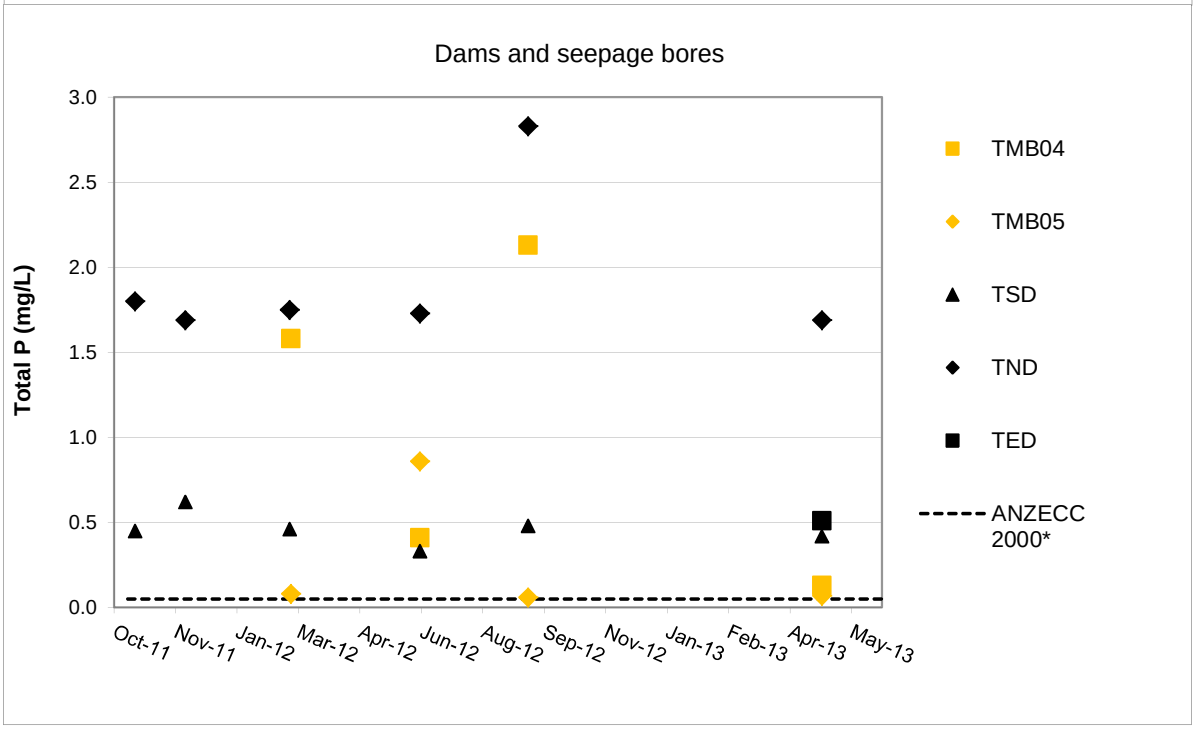
Figure B.15: Total Phosphorus





Note:
*ANZECC 2000. Water for long term irrigation and general water use

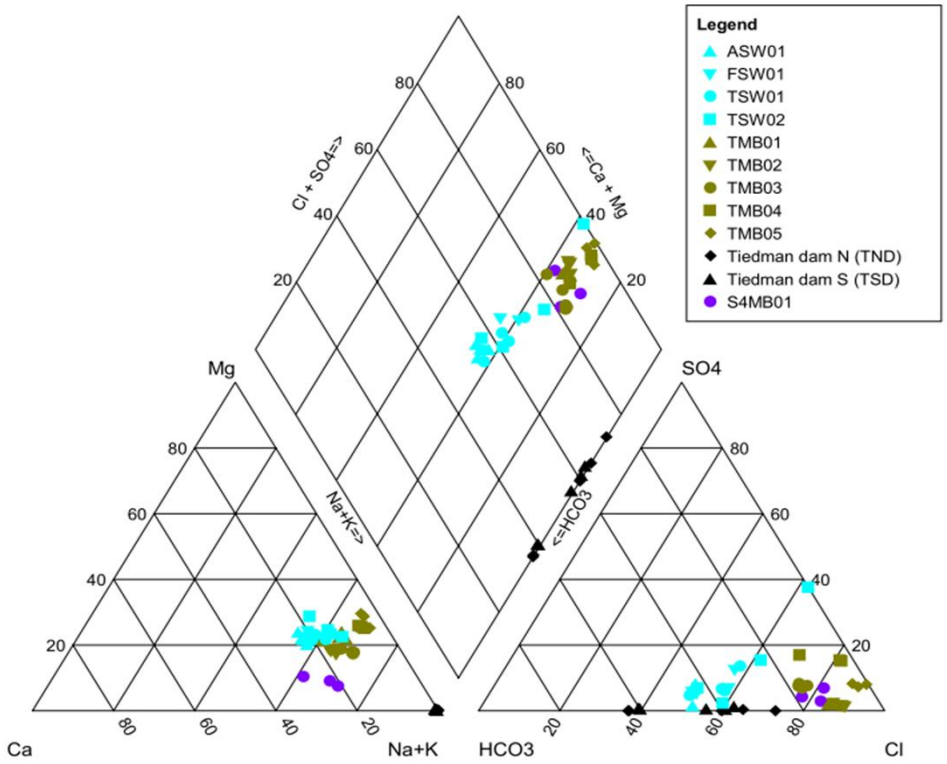
Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester Basin, NSW

PARSONS BRINCKERHOFF

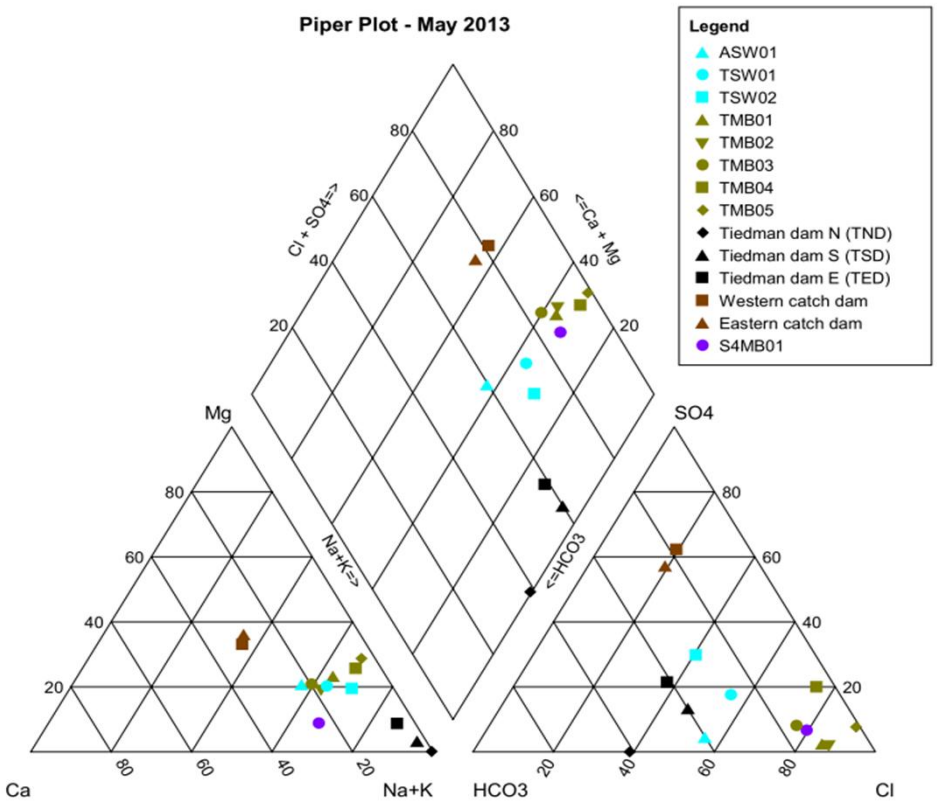
Appendix C

Piper diagrams

Piper Plot - Baseline (October 2011 - September 2012)



Piper Plot - May 2013



Note: Blue - surface water; Olive - shallow groundwater; Black - storage dams; Brown - irrigation plot runoff; and Purple - interburden unit

Client: AGL Upstream Investment Pty Ltd
Project: Tiedmans Irrigation Trial - Gloucester Gas Project
Location: Gloucester, NSW

PARSONS BRINCKERHOFF

Appendix D

Laboratory reports

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES1309676**	Page	: 1 of 4
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: MR JAMES DUGGLEBY	Contact	: Loren Schiavon
Address	: GPO BOX 5394 SYDNEY NSW, AUSTRALIA 2001	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: jduggleby@pb.com.au	E-mail	: loren.schiavon@alsglobal.com
Telephone	: +61 02 9272 5100	Telephone	: +61 2 8784 8503
Facsimile	: +61 02 9272 5101	Facsimile	: +61 2 8784 8500
Project	: 2162406F - AGL	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 26-APR-2013
Sampler	: ----	Issue Date	: 02-MAY-2013
Site	: ----		
		No. of samples received	: 1
Quote number	: SY/394/09	No. of samples analysed	: 1

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

NATA Accredited Laboratory 825

Accredited for compliance with ISO/IEC 17025.

Signatories

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

Signatories	*Position*	*Accreditation Category*
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Hoa Nguyen	Senior Inorganic Chemist	Sydney Inorganics

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **ALS Sydney is not NATA accredited for CCPP, but holds accreditation for the analysis of conductivity, pH, calcium and alkalinity which the parameters used for CCPP calculation (Accreditation # 825);**
- **EG020: Bromine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	TIEDMAN S DAM	----	----	----	----
			Client sampling date / time	24-APR-2013 10:48	----	----	----	----
Compound	CAS Number	LOR	Unit	ES1309676-001	----	----	----	----
EA005P: pH by PC Titrator								
pH Value	----	0.01	pH Unit	**9.28**	----	----	----	----
EA010P: Conductivity by PC Titrator								
Electrical Conductivity @ 25°C	----	1	µS/cm	**1380**	----	----	----	----
EA015: Total Dissolved Solids								
Total Dissolved Solids @180°C	----	10	mg/L	**924**	----	----	----	----
EA065: Total Hardness as CaCO3								
Total Hardness as CaCO3	----	1	mg/L	**36**	----	----	----	----
EA072: Calcium Carbonate Precipitation Potential								
CCPP	----	0.1	--	**9.4**	----	----	----	----
ED037P: Alkalinity by PC Titrator								
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L	<1	----	----	----	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L	**109**	----	----	----	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L	**194**	----	----	----	----
Total Alkalinity as CaCO3	----	1	mg/L	**303**	----	----	----	----
ED040F: Dissolved Major Anions								
Sulfur as S	63705-05-5	1	mg/L	**27**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA								
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L	**87**	----	----	----	----
ED045G: Chloride Discrete analyser								
Chloride	16887-00-6	1	mg/L	**218**	----	----	----	----
ED093F: Dissolved Major Cations								
Calcium	7440-70-2	1	mg/L	**6**	----	----	----	----
Magnesium	7439-95-4	1	mg/L	**5**	----	----	----	----
Sodium	7440-23-5	1	mg/L	**200**	----	----	----	----
Potassium	7440-09-7	1	mg/L	**160**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS								
Aluminium	7429-90-5	0.01	mg/L	**0.04**	----	----	----	----
Arsenic	7440-38-2	0.001	mg/L	**0.002**	----	----	----	----
Beryllium	7440-41-7	0.001	mg/L	<0.001	----	----	----	----
Barium	7440-39-3	0.001	mg/L	**0.110**	----	----	----	----
Cadmium	7440-43-9	0.0001	mg/L	<0.0001	----	----	----	----
Cobalt	7440-48-4	0.001	mg/L	<0.001	----	----	----	----
Copper	7440-50-8	0.001	mg/L	**0.002**	----	----	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)			Client sample ID	TIEDMAN S DAM	----	----	----	----
			Client sampling date / time	24-APR-2013 10:48	----	----	----	----
Compound	CAS Number	LOR	Unit	ES1309676-001	----	----	----	----
EG020F: Dissolved Metals by ICP-MS - Continued								
Lead	7439-92-1	0.001	mg/L	<0.001	----	----	----	----
Manganese	7439-96-5	0.001	mg/L	**0.009**	----	----	----	----
Molybdenum	7439-98-7	0.001	mg/L	**0.009**	----	----	----	----
Nickel	7440-02-0	0.001	mg/L	<0.001	----	----	----	----
Selenium	7782-49-2	0.01	mg/L	<0.01	----	----	----	----
Strontium	7440-24-6	0.001	mg/L	**0.218**	----	----	----	----
Uranium	7440-61-1	0.001	mg/L	<0.001	----	----	----	----
Vanadium	7440-62-2	0.01	mg/L	<0.01	----	----	----	----
Zinc	7440-66-6	0.005	mg/L	**0.012**	----	----	----	----
Boron	7440-42-8	0.05	mg/L	**0.16**	----	----	----	----
Iron	7439-89-6	0.05	mg/L	**0.54**	----	----	----	----
Bromine	7726-95-6	0.1	mg/L	**0.6**	----	----	----	----
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	**0.2**	----	----	----	----
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	**0.06**	----	----	----	----
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	----	----	----	----
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	----	----	----	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	----	----	----	----
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.39**	----	----	----	----
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	<0.01	----	----	----	----
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**14.0**	----	----	----	----
Total Cations	----	0.01	meq/L	**13.5**	----	----	----	----
Ionic Balance	----	0.01	%	**1.86**	----	----	----	----
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**14**	----	----	----	----

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES1310491**	Page	: 1 of 7
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: ELLEN KWANTES	Contact	: Loren Schiavon
Address	: GPO BOX 5394 SYDNEY NSW, AUSTRALIA 2001	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
E-mail	: ekwantes@pb.com.au	E-mail	: loren.schiavon@alsglobal.com
Telephone	: +61 02 9272 5100	Telephone	: +61 2 8784 8503
Facsimile	: +61 02 9272 5101	Facsimile	: +61 2 8784 8500
Project	: 2162406F-GGP IRRIGATION - ANNUAL	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 08-MAY-2013
Sampler	: SM, CR	Issue Date	: 14-MAY-2013
Site	: ----		
		No. of samples received	: 5
Quote number	: SY/394/09	No. of samples analysed	: 5

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EK055G: Spike failed for Ammonia due to matrix interferences (confirmed by re analysis).**
- **EP075(SIM) : Result of sample (ES1310491-3) has beeb confirmed by re extraction and re-analysis.**

Signatories

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

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Hoa Nguyen	Senior Inorganic Chemist	Sydney Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Organics
		Sydney Organics

Analytical Results

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

Compound	CAS Number	LOR	Unit	Client sample ID	STREAM LOCATION TSW02	STREAM GAUGE TSW01	TMB01	TMBO3	S4MB01
				Client sampling date / time	06-MAY-2013 15:00	06-MAY-2013 12:00	06-MAY-2013 12:00	06-MAY-2013 14:30	06-MAY-2013 12:30
					ES1310491-001	ES1310491-002	ES1310491-003	ES1310491-004	ES1310491-005
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**7.20**	**7.21**	**7.10**	**7.18**	**7.58**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**365**	**402**	**8170**	**5980**	**4850**
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		**150**	**168**	**4240**	**3420**	**2790**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	<1	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**40**	**50**	**483**	**427**	**298**
Total Alkalinity as CaCO3	----	1	mg/L		**50**	**50**	**483**	**427**	**298**
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**48**	**31**	**93**	**215**	**138**
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		**48**	**72**	**2430**	**1480**	**1210**
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**7**	**12**	**203**	**228**	**217**
Magnesium	7439-95-4	1	mg/L		**8**	**9**	**218**	**146**	**49**
Sodium	7440-23-5	1	mg/L		**53**	**52**	**1120**	**782**	**691**
Potassium	7440-09-7	1	mg/L		**2**	**2**	**3**	**3**	**7**
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.07**	**0.05**	<0.01	**0.04**	**0.02**
Arsenic	7440-38-2	0.001	mg/L		<0.001	<0.001	**0.001**	**0.004**	**0.002**
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	7440-39-3	0.001	mg/L		**0.038**	**0.050**	**0.212**	**0.270**	**1.16**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	<0.001	**0.003**	<0.001
Copper	7440-50-8	0.001	mg/L		**0.002**	**0.005**	**0.003**	**0.002**	**0.001**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.083**	**0.106**	**0.874**	**1.92**	**0.280**
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Nickel	7440-02-0	0.001	mg/L		**0.004**	**0.003**	<0.001	<0.001	<0.001
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	7440-24-6	0.001	mg/L		**0.191**	**0.249**	**5.49**	**6.67**	**25.0**

Analytical Results

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

Compound	CAS Number	LOR	Unit	Client sample ID: STREAM LOCATION TSW02	STREAM GAUGE TSW01	TMB01	TMBO3	S4MB01
			Client sampling date / time	06-MAY-2013 15:00	06-MAY-2013 12:00	06-MAY-2013 12:00	06-MAY-2013 14:30	06-MAY-2013 12:30
				ES1310491-001	ES1310491-002	ES1310491-003	ES1310491-004	ES1310491-005
EG020F: Dissolved Metals by ICP-MS - Continued								
Uranium	7440-61-1	0.001	mg/L	<0.001	<0.001	**0.002**	**0.007**	**0.002**
Vanadium	7440-62-2	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L	**0.006**	**0.013**	**0.017**	**0.015**	**0.008**
Boron	7440-42-8	0.05	mg/L	<0.05	**0.06**	<0.05	<0.05	**0.16**
Iron	7439-89-6	0.05	mg/L	**0.26**	**0.45**	**2.57**	**3.33**	**0.53**
Bromine	7726-95-6	0.1	mg/L	**0.2**	**0.4**	**4.0**	**3.1**	**3.0**
EK040P: Fluoride by PC Titrator								
Fluoride	16984-48-8	0.1	mg/L	<0.1	<0.1	**0.2**	**0.2**	**0.5**
EK055G: Ammonia as N by Discrete Analyser								
Ammonia as N	7664-41-7	0.01	mg/L	<0.01	<0.01	<0.01	**0.18**	**1.85**
EK057G: Nitrite as N by Discrete Analyser								
Nitrite as N	----	0.01	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01
EK058G: Nitrate as N by Discrete Analyser								
Nitrate as N	14797-55-8	0.01	mg/L	<0.01	**0.02**	<0.01	**0.01**	**0.02**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser								
Nitrite + Nitrate as N	----	0.01	mg/L	<0.01	**0.02**	<0.01	**0.01**	**0.02**
EK067G: Total Phosphorus as P by Discrete Analyser								
Total Phosphorus as P	----	0.01	mg/L	**0.07**	**0.10**	**0.09**	**0.02**	**0.07**
EK071G: Reactive Phosphorus as P by discrete analyser								
Reactive Phosphorus as P	14265-44-2	0.01	mg/L	**0.01**	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance								
Total Anions	----	0.01	meq/L	**3.35**	**3.68**	**80.1**	**54.8**	**43.0**
Total Cations	----	0.01	meq/L	**3.36**	**3.65**	**76.9**	**57.5**	**45.1**
Ionic Balance	----	0.01	%	**0.15**	**0.33**	**2.09**	**2.43**	**2.43**
EP005: Total Organic Carbon (TOC)								
Total Organic Carbon	----	1	mg/L	**12**	**9**	**4**	**2**	**33**
EP033: C1 - C4 Hydrocarbon Gases								
Methane	74-82-8	10	µg/L	<10	<10	----	----	----
EP075(SIM)A: Phenolic Compounds								
Phenol	108-95-2	1.0	µg/L	<1.0	<1.0	**1.0**	<1.0	<1.0
2-Chlorophenol	95-57-8	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2-Methylphenol	95-48-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
3- & 4-Methylphenol	1319-77-3	2.0	µg/L	<2.0	<2.0	**102**	<2.0	<2.0

Analytical Results

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

Compound	CAS Number	LOR	Unit	Client sample ID: STREAM LOCATION TSW02	STREAM GAUGE TSW01	TMB01	TMBO3	S4MB01
				Client sampling date / time: 06-MAY-2013 15:00	06-MAY-2013 12:00	06-MAY-2013 12:00	06-MAY-2013 14:30	06-MAY-2013 12:30
				ES1310491-001	ES1310491-002	ES1310491-003	ES1310491-004	ES1310491-005
EP075(SIM)A: Phenolic Compounds - Continued								
2-Nitrophenol	88-75-5	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2.4-Dimethylphenol	105-67-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2.4-Dichlorophenol	120-83-2	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2.6-Dichlorophenol	87-65-0	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
4-Chloro-3-Methylphenol	59-50-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2.4.6-Trichlorophenol	88-06-2	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
2.4.5-Trichlorophenol	95-95-4	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Pentachlorophenol	87-86-5	2.0	µg/L	<2.0	<2.0	<2.0	<2.0	<2.0
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Acenaphthene	83-32-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Fluorene	86-73-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Phenanthrene	85-01-8	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Anthracene	120-12-7	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Fluoranthene	206-44-0	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Pyrene	129-00-0	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Chrysene	218-01-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(b)fluoranthene	205-99-2	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
^ Sum of polycyclic aromatic hydrocarbons	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
^ Benzo(a)pyrene TEQ (WHO)	----	0.5	µg/L	<0.5	<0.5	<0.5	<0.5	<0.5
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	<20	<20	<20
C10 - C14 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
C15 - C28 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
C29 - C36 Fraction	----	50	µg/L	<50	<50	<50	<50	<50
^ C10 - C36 Fraction (sum)	----	50	µg/L	<50	<50	<50	<50	<50

Analytical Results

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

	Compound	CAS Number	LOR	Unit	Client sample ID: STREAM LOCATION TSW02	STREAM GAUGE TSW01	TMB01	TMBO3	S4MB01
	Client sampling date / time				06-MAY-2013 15:00	06-MAY-2013 12:00	06-MAY-2013 12:00	06-MAY-2013 14:30	06-MAY-2013 12:30
					ES1310491-001	ES1310491-002	ES1310491-003	ES1310491-004	ES1310491-005
	EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft								
	C6 - C10 Fraction	----	20	µg/L	<20	<20	<20	<20	<20
^	C6 - C10 Fraction minus BTEX (F1)	----	20	µg/L	<20	<20	<20	<20	<20
	>C10 - C16 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
	>C16 - C34 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
	>C34 - C40 Fraction	----	100	µg/L	<100	<100	<100	<100	<100
^	>C10 - C40 Fraction (sum)	----	100	µg/L	<100	<100	<100	<100	<100
	EP080: BTEXN								
	Benzene	71-43-2	1	µg/L	<1	<1	<1	<1	<1
	Toluene	108-88-3	2	µg/L	<2	<2	<2	<2	<2
	Ethylbenzene	100-41-4	2	µg/L	<2	<2	<2	<2	<2
	meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	<2	<2	<2
	ortho-Xylene	95-47-6	2	µg/L	<2	<2	<2	<2	<2
^	Total Xylenes	1330-20-7	2	µg/L	<2	<2	<2	<2	<2
^	Sum of BTEX	----	1	µg/L	<1	<1	<1	<1	<1
	Naphthalene	91-20-3	5	µg/L	<5	<5	<5	<5	<5
	EP075(SIM)S: Phenolic Compound Surrogates								
	Phenol-d6	13127-88-3	0.1	%	**28.6**	**33.4**	**37.6**	**32.0**	**30.0**
	2-Chlorophenol-D4	93951-73-6	0.1	%	**85.7**	**86.2**	**88.0**	**84.8**	**82.7**
	2.4.6-Tribromophenol	118-79-6	0.1	%	**95.0**	**93.9**	**93.0**	**91.6**	**93.5**
	EP075(SIM)T: PAH Surrogates								
	2-Fluorobiphenyl	321-60-8	0.1	%	**82.8**	**89.4**	**88.4**	**88.6**	**87.1**
	Anthracene-d10	1719-06-8	0.1	%	**83.6**	**84.2**	**82.2**	**83.3**	**79.9**
	4-Terphenyl-d14	1718-51-0	0.1	%	**81.8**	**80.1**	**78.3**	**80.2**	**75.7**
	EP080S: TPH(V)/BTEX Surrogates								
	1.2-Dichloroethane-D4	17060-07-0	0.1	%	**114**	**122**	**120**	**123**	**124**
	Toluene-D8	2037-26-5	0.1	%	**105**	**119**	**119**	**121**	**117**
	4-Bromofluorobenzene	460-00-4	0.1	%	**78.8**	**101**	**89.2**	**94.7**	**87.9**

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10.0	44
2-Chlorophenol-D4	93951-73-6	15.9	102
2.4.6-Tribromophenol	118-79-6	17	125
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	20.4	112
Anthracene-d10	1719-06-8	29.6	118
4-Terphenyl-d14	1718-51-0	21.5	126
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128

Environmental Division

CERTIFICATE OF ANALYSIS

Work Order	: **ES1310624**	Page	: 1 of 11
Client	: **PARSONS BRINCKERHOFF AUST P/L**	Laboratory	: Environmental Division Sydney
Contact	: ELLEN KWANTES	Contact	: Loren Schiavon
Address	: GPO BOX 5394 SYDNEY NSW, AUSTRALIA 2001	Address	: 277-289 Woodpark Road Smithfield NSW Australia 2164
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Telephone	: +61 02 9272 5100	Telephone	: +61 2 8784 8503
Facsimile	: +61 02 9272 5101	Facsimile	: +61 2 8784 8500
Project	: 2162406F- GGP IRRIGATION - ANNUAL	QC Level	: NEPM 1999 Schedule B(3) and ALS QCS3 requirement
Order number	: ----		
C-O-C number	: ----	Date Samples Received	: 09-MAY-2013
Sampler	: ----	Issue Date	: 15-MAY-2013
Site	: ----		
		No. of samples received	: 9
Quote number	: SY/394/09	No. of samples analysed	: 9

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. All pages of this report have been checked and approved for release.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results
- Surrogate Control Limits

General Comments

The analytical procedures used by the Environmental Division have been developed from established internationally recognized procedures such as those published by the USEPA, APHA, AS and NEPM. In house developed procedures are employed in the absence of documented standards or by client request.

Where moisture determination has been performed, results are reported on a dry weight basis.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

When sampling time information is not provided by the client, sampling dates are shown without a time component. In these instances, the time component has been assumed by the laboratory for processing purposes.

Key : CAS Number = CAS registry number from database maintained by Chemical Abstracts Services. The Chemical Abstracts Service is a division of the American Chemical Society.
LOR = Limit of reporting
^ = This result is computed from individual analyte detections at or above the level of reporting

- **EG020: Bromine quantification may be unreliable due to its low solubility in acid, leading to variable volatility during measurement by ICPMS.**
- **EK067G: Spike failed for Total P due to matrix interferences(confirmed by re-digestion and re-analysis).**

Signatories

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

Signatories	Position	Accreditation Category
Ankit Joshi	Inorganic Chemist	Sydney Inorganics
Ashesh Patel	Inorganic Chemist	Sydney Inorganics
Celine Conceicao	Senior Spectroscopist	Sydney Inorganics
Hoa Nguyen	Senior Inorganic Chemist	Sydney Inorganics
Pabi Subba	Senior Organic Chemist	Sydney Organics
		Sydney Organics

Analytical Results

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

Compound	CAS Number	LOR	Unit	Client sample ID	TIEDMAN SOUTH DAM	TIEDMAN NORTH DAM	TIEDAM EAST DAM	TMB04	TMB05
				Client sampling date / time	07-MAY-2013 10:00	07-MAY-2013 10:30	07-MAY-2013 15:30	07-MAY-2013 15:00	07-MAY-2013 12:30
					ES1310624-001	ES1310624-002	ES1310624-003	ES1310624-004	ES1310624-005
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		**9.24**	**9.54**	**9.84**	**6.54**	**5.98**
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		**1730**	**4080**	**1220**	**7220**	**6770**
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		**914**	**2430**	**720**	**3910**	**3930**
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	<1
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		**109**	**586**	**180**	<1	<1
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		**213**	**669**	**74**	**166**	**37**
Total Alkalinity as CaCO3	----	1	mg/L		**321**	**1260**	**254**	**166**	**37**
ED040F: Dissolved Major Anions									
Sulfur as S	63705-05-5	1	mg/L		**29**	----	----	----	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		**103**	<1	**128**	**683**	**245**
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		**266**	**536**	**164**	**1890**	**2150**
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		**7**	**3**	**11**	**90**	**44**
Magnesium	7439-95-4	1	mg/L		**6**	**1**	**13**	**221**	**218**
Sodium	7440-23-5	1	mg/L		**214**	**763**	**218**	**1090**	**952**
Potassium	7440-09-7	1	mg/L		**195**	**266**	**40**	**26**	**33**
ED093F: SAR and Hardness Calculations									
Total Hardness as CaCO3	----	1	mg/L		**42**	----	----	----	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		**0.05**	**0.12**	**0.08**	**0.04**	**0.38**
Arsenic	7440-38-2	0.001	mg/L		**0.002**	**0.005**	**0.002**	**0.002**	<0.001
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	**0.003**
Barium	7440-39-3	0.001	mg/L		**0.115**	**0.222**	**0.058**	**0.078**	**0.087**
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	**0.0002**	**0.0025**
Cobalt	7440-48-4	0.001	mg/L		<0.001	<0.001	**0.001**	**0.055**	**0.248**
Copper	7440-50-8	0.001	mg/L		**0.001**	<0.001	**0.001**	**0.001**	**0.010**
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Manganese	7439-96-5	0.001	mg/L		**0.012**	**0.003**	**0.108**	**9.34**	**16.2**

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)

Compound	CAS Number	LOR	Unit	Client sample ID	TIEDMAN SOUTH DAM	TIEDMAN NORTH DAM	TIEDAM EAST DAM	TMB04	TMB05
				Client sampling date / time	07-MAY-2013 10:00	07-MAY-2013 10:30	07-MAY-2013 15:30	07-MAY-2013 15:00	07-MAY-2013 12:30
					ES1310624-001	ES1310624-002	ES1310624-003	ES1310624-004	ES1310624-005
EG020F: Dissolved Metals by ICP-MS - Continued									
Molybdenum	7439-98-7	0.001	mg/L		**0.007**	**0.019**	**0.006**	<0.001	**0.001**
Nickel	7440-02-0	0.001	mg/L		<0.001	<0.001	**0.001**	**0.028**	**0.116**
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Strontium	7440-24-6	0.001	mg/L		**0.262**	**0.280**	**0.177**	**0.918**	**0.695**
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	<0.001
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
Zinc	7440-66-6	0.005	mg/L		**0.022**	**0.018**	**0.030**	**0.107**	**1.16**
Boron	7440-42-8	0.05	mg/L		**0.19**	**0.76**	**0.19**	<0.05	<0.05
Iron	7439-89-6	0.05	mg/L		**0.47**	<0.05	**0.15**	**14.7**	**14.9**
Bromine	7726-95-6	0.1	mg/L		**1.2**	**2.5**	**0.6**	**4.7**	**2.7**
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.2**	**0.6**	**0.2**	**0.8**	**0.7**
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.03**	**0.02**	**0.02**	**0.29**	**3.96**
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.01**
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.23**
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	**0.24**
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		**0.42**	**1.69**	**0.51**	**0.13**	**0.07**
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	<0.01
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**16.1**	**40.3**	**12.4**	**70.8**	**66.5**
Total Cations	----	0.01	meq/L		**15.1**	**40.2**	**12.1**	**70.8**	**62.4**
Ionic Balance	----	0.01	%		**2.95**	**0.12**	**1.02**	**0.08**	**3.19**
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**15**	**29**	**21**	**7**	**9**
EP033: C1 - C4 Hydrocarbon Gases									
Methane	74-82-8	10	µg/L		**26**	<10	<10	----	----
EP075(SIM)A: Phenolic Compounds									

Analytical Results

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

Compound	CAS Number	LOR	Unit	Client sample ID	TIEDMAN SOUTH DAM	TIEDMAN NORTH DAM	TIEDAM EAST DAM	TMB04	TMB05
				Client sampling date / time	07-MAY-2013 10:00	07-MAY-2013 10:30	07-MAY-2013 15:30	07-MAY-2013 15:00	07-MAY-2013 12:30
					ES1310624-001	ES1310624-002	ES1310624-003	ES1310624-004	ES1310624-005
EP075(SIM)A: Phenolic Compounds - Continued									
Phenol	108-95-2	1.0	µg/L		<1.0	<1.0	<1.0	----	----
2-Chlorophenol	95-57-8	1.0	µg/L		<1.0	<1.0	<1.0	----	----
2-Methylphenol	95-48-7	1.0	µg/L		<1.0	<1.0	<1.0	----	----
3- & 4-Methylphenol	1319-77-3	2.0	µg/L		<2.0	<2.0	<2.0	----	----
2-Nitrophenol	88-75-5	1.0	µg/L		<1.0	<1.0	<1.0	----	----
2.4-Dimethylphenol	105-67-9	1.0	µg/L		<1.0	<1.0	<1.0	----	----
2.4-Dichlorophenol	120-83-2	1.0	µg/L		<1.0	<1.0	<1.0	----	----
2.6-Dichlorophenol	87-65-0	1.0	µg/L		<1.0	<1.0	<1.0	----	----
4-Chloro-3-Methylphenol	59-50-7	1.0	µg/L		<1.0	<1.0	<1.0	----	----
2.4.6-Trichlorophenol	88-06-2	1.0	µg/L		<1.0	<1.0	<1.0	----	----
2.4.5-Trichlorophenol	95-95-4	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Pentachlorophenol	87-86-5	2.0	µg/L		<2.0	<2.0	<2.0	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons									
Naphthalene	91-20-3	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Acenaphthylene	208-96-8	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Acenaphthene	83-32-9	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Fluorene	86-73-7	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Phenanthrene	85-01-8	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Anthracene	120-12-7	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Fluoranthene	206-44-0	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Pyrene	129-00-0	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Chrysene	218-01-9	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Benzo(b)fluoranthene	205-99-2	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L		<0.5	<0.5	<0.5	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L		<1.0	<1.0	<1.0	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L		<1.0	<1.0	<1.0	----	----
^ **Sum of polycyclic aromatic hydrocarbons**	----	0.5	µg/L		<0.5	<0.5	<0.5	----	----
^ **Benzo(a)pyrene TEQ (WHO)**	----	0.5	µg/L		<0.5	<0.5	<0.5	----	----
EP080/071: Total Petroleum Hydrocarbons									
C6 - C9 Fraction	----	20	µg/L		<20	<20	<20	----	----
C10 - C14 Fraction	----	50	µg/L		<50	**70**	<50	----	----

Analytical Results

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

Compound	CAS Number	LOR	Unit	Client sample ID	TIEDMAN SOUTH DAM	TIEDMAN NORTH DAM	TIEDAM EAST DAM	TMB04	TMB05
				Client sampling date / time	07-MAY-2013 10:00	07-MAY-2013 10:30	07-MAY-2013 15:30	07-MAY-2013 15:00	07-MAY-2013 12:30
					ES1310624-001	ES1310624-002	ES1310624-003	ES1310624-004	ES1310624-005
EP080/071: Total Petroleum Hydrocarbons - Continued									
C15 - C28 Fraction	----	100	µg/L		<100	**270**	**310**	----	----
C29 - C36 Fraction	----	50	µg/L		<50	**50**	**70**	----	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L		<50	**390**	**380**	----	----
EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft									
C6 - C10 Fraction	----	20	µg/L		<20	<20	<20	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	----	20	µg/L		<20	<20	<20	----	----
>C10 - C16 Fraction	----	100	µg/L		<100	**110**	<100	----	----
>C16 - C34 Fraction	----	100	µg/L		<100	**270**	**340**	----	----
>C34 - C40 Fraction	----	100	µg/L		<100	<100	<100	----	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L		<100	**380**	**340**	----	----
EP080: BTEXN									
Benzene	71-43-2	1	µg/L		<1	<1	<1	----	----
Toluene	108-88-3	2	µg/L		<2	<2	<2	----	----
Ethylbenzene	100-41-4	2	µg/L		<2	<2	<2	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L		<2	<2	<2	----	----
ortho-Xylene	95-47-6	2	µg/L		<2	<2	<2	----	----
^ **Total Xylenes**	1330-20-7	2	µg/L		<2	<2	<2	----	----
^ **Sum of BTEX**	----	1	µg/L		<1	<1	<1	----	----
Naphthalene	91-20-3	5	µg/L		<5	<5	<5	----	----
EP075(SIM)S: Phenolic Compound Surrogates									
Phenol-d6	13127-88-3	0.1	%		**22.0**	**26.6**	**25.2**	----	----
2-Chlorophenol-D4	93951-73-6	0.1	%		**60.0**	**66.2**	**62.4**	----	----
2.4.6-Tribromophenol	118-79-6	0.1	%		**68.4**	**74.6**	**70.9**	----	----
EP075(SIM)T: PAH Surrogates									
2-Fluorobiphenyl	321-60-8	0.1	%		**71.0**	**81.3**	**73.9**	----	----
Anthracene-d10	1719-06-8	0.1	%		**72.7**	**80.7**	**74.2**	----	----
4-Terphenyl-d14	1718-51-0	0.1	%		**60.9**	**66.8**	**61.7**	----	----
EP080S: TPH(V)/BTEX Surrogates									
1.2-Dichloroethane-D4	17060-07-0	0.1	%		**119**	**120**	**102**	----	----
Toluene-D8	2037-26-5	0.1	%		**114**	**120**	**120**	----	----
4-Bromofluorobenzene	460-00-4	0.1	%		**89.2**	**94.1**	**83.9**	----	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	TREAM GAUGE ASW01	TMB02	WESTERN CATCH DAM	EASTERN CATCH DAM	----
				Client sampling date / time	08-MAY-2013 07:00	07-MAY-2013 13:00	07-MAY-2013 14:00	07-MAY-2013 15:00	----
Compound	CAS Number	LOR	Unit		ES1310624-006	ES1310624-007	ES1310624-008	ES1310624-009	----
EA005P: pH by PC Titrator									
pH Value	----	0.01	pH Unit		7.49	6.98	9.26	9.18	----
EA010P: Conductivity by PC Titrator									
Electrical Conductivity @ 25°C	----	1	µS/cm		397	3690	1330	1210	----
EA015: Total Dissolved Solids									
Total Dissolved Solids @180°C	----	10	mg/L		161	2150	958	865	----
ED037P: Alkalinity by PC Titrator									
Hydroxide Alkalinity as CaCO3	DMO-210-001	1	mg/L		<1	<1	<1	<1	----
Carbonate Alkalinity as CaCO3	3812-32-6	1	mg/L		<1	<1	55	62	----
Bicarbonate Alkalinity as CaCO3	71-52-3	1	mg/L		74	170	82	102	----
Total Alkalinity as CaCO3	----	1	mg/L		74	170	136	164	----
ED041G: Sulfate (Turbidimetric) as SO4 2- by DA									
Sulfate as SO4 - Turbidimetric	14808-79-8	1	mg/L		8	37	443	380	----
ED045G: Chloride Discrete analyser									
Chloride	16887-00-6	1	mg/L		72	1000	102	94	----
ED093F: Dissolved Major Cations									
Calcium	7440-70-2	1	mg/L		16	126	89	78	----
Magnesium	7439-95-4	1	mg/L		9	82	58	59	----
Sodium	7440-23-5	1	mg/L		45	495	100	90	----
Potassium	7440-09-7	1	mg/L		3	4	32	30	----
EG020F: Dissolved Metals by ICP-MS									
Aluminium	7429-90-5	0.01	mg/L		0.02	0.01	0.02	0.11	----
Arsenic	7440-38-2	0.001	mg/L		<0.001	0.003	0.002	0.003	----
Beryllium	7440-41-7	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Barium	7440-39-3	0.001	mg/L		0.044	0.624	0.077	0.121	----
Cadmium	7440-43-9	0.0001	mg/L		<0.0001	<0.0001	<0.0001	0.0001	----
Cobalt	7440-48-4	0.001	mg/L		0.002	0.006	0.002	0.004	----
Copper	7440-50-8	0.001	mg/L		<0.001	<0.001	<0.001	0.004	----
Lead	7439-92-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Manganese	7439-96-5	0.001	mg/L		0.078	1.41	0.039	0.106	----
Molybdenum	7439-98-7	0.001	mg/L		<0.001	<0.001	0.001	0.001	----
Nickel	7440-02-0	0.001	mg/L		0.001	0.002	0.002	0.004	----
Selenium	7782-49-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Strontium	7440-24-6	0.001	mg/L		0.234	2.87	0.559	0.452	----

Analytical Results

Sub-Matrix: WATER (Matrix: WATER)				Client sample ID	TREAM GAUGE ASW01	TMB02	WESTERN CATCH DAM	EASTERN CATCH DAM	----
				Client sampling date / time	08-MAY-2013 07:00	07-MAY-2013 13:00	07-MAY-2013 14:00	07-MAY-2013 15:00	----
Compound	CAS Number	LOR	Unit		ES1310624-006	ES1310624-007	ES1310624-008	ES1310624-009	----
EG020F: Dissolved Metals by ICP-MS - Continued									
Uranium	7440-61-1	0.001	mg/L		<0.001	<0.001	<0.001	<0.001	----
Vanadium	7440-62-2	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
Zinc	7440-66-6	0.005	mg/L		**0.009**	**0.028**	**0.047**	**0.118**	----
Boron	7440-42-8	0.05	mg/L		<0.05	<0.05	**0.05**	<0.05	----
Iron	7439-89-6	0.05	mg/L		**0.71**	**5.12**	<0.05	**0.20**	----
Bromine	7726-95-6	0.1	mg/L		**0.3**	**3.1**	**0.6**	**0.6**	----
EK040P: Fluoride by PC Titrator									
Fluoride	16984-48-8	0.1	mg/L		**0.1**	**0.1**	**0.3**	**0.2**	----
EK055G: Ammonia as N by Discrete Analyser									
Ammonia as N	7664-41-7	0.01	mg/L		**0.02**	**0.34**	**0.06**	**0.12**	----
EK057G: Nitrite as N by Discrete Analyser									
Nitrite as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
EK058G: Nitrate as N by Discrete Analyser									
Nitrate as N	14797-55-8	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
EK059G: Nitrite plus Nitrate as N (NOx) by Discrete Analyser									
Nitrite + Nitrate as N	----	0.01	mg/L		<0.01	<0.01	<0.01	<0.01	----
EK067G: Total Phosphorus as P by Discrete Analyser									
Total Phosphorus as P	----	0.01	mg/L		<0.01	**0.07**	**0.84**	**0.47**	----
EK071G: Reactive Phosphorus as P by discrete analyser									
Reactive Phosphorus as P	14265-44-2	0.01	mg/L		<0.01	**0.01**	**0.02**	<0.01	----
EN055: Ionic Balance									
Total Anions	----	0.01	meq/L		**3.68**	**32.4**	**14.8**	**13.8**	----
Total Cations	----	0.01	meq/L		**3.57**	**34.7**	**14.4**	**13.4**	----
Ionic Balance	----	0.01	%		**1.43**	**3.42**	**1.49**	**1.50**	----
EP005: Total Organic Carbon (TOC)									
Total Organic Carbon	----	1	mg/L		**3**	**1**	**57**	**44**	----
EP033: C1 - C4 Hydrocarbon Gases									
Methane	74-82-8	10	µg/L		**14**	----	----	----	----
EP075(SIM)A: Phenolic Compounds									
Phenol	108-95-2	1.0	µg/L		<1.0	<1.0	----	----	----
2-Chlorophenol	95-57-8	1.0	µg/L		<1.0	<1.0	----	----	----
2-Methylphenol	95-48-7	1.0	µg/L		<1.0	<1.0	----	----	----
3- & 4-Methylphenol	1319-77-3	2.0	µg/L		<2.0	<2.0	----	----	----

Analytical Results

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

Compound	CAS Number	LOR	Unit	Client sample ID: TREAM GAUGE ASW01	TMB02	WESTERN CATCH DAM	EASTERN CATCH DAM	----
				Client sampling date / time: 08-MAY-2013 07:00	07-MAY-2013 13:00	07-MAY-2013 14:00	07-MAY-2013 15:00	----
				ES1310624-006	ES1310624-007	ES1310624-008	ES1310624-009	----
EP075(SIM)A: Phenolic Compounds - Continued								
2-Nitrophenol	88-75-5	1.0	µg/L	<1.0	<1.0	----	----	----
2.4-Dimethylphenol	105-67-9	1.0	µg/L	<1.0	<1.0	----	----	----
2.4-Dichlorophenol	120-83-2	1.0	µg/L	<1.0	<1.0	----	----	----
2.6-Dichlorophenol	87-65-0	1.0	µg/L	<1.0	<1.0	----	----	----
4-Chloro-3-Methylphenol	59-50-7	1.0	µg/L	<1.0	<1.0	----	----	----
2.4.6-Trichlorophenol	88-06-2	1.0	µg/L	<1.0	<1.0	----	----	----
2.4.5-Trichlorophenol	95-95-4	1.0	µg/L	<1.0	<1.0	----	----	----
Pentachlorophenol	87-86-5	2.0	µg/L	<2.0	<2.0	----	----	----
EP075(SIM)B: Polynuclear Aromatic Hydrocarbons								
Naphthalene	91-20-3	1.0	µg/L	<1.0	<1.0	----	----	----
Acenaphthylene	208-96-8	1.0	µg/L	<1.0	<1.0	----	----	----
Acenaphthene	83-32-9	1.0	µg/L	<1.0	<1.0	----	----	----
Fluorene	86-73-7	1.0	µg/L	<1.0	<1.0	----	----	----
Phenanthrene	85-01-8	1.0	µg/L	<1.0	<1.0	----	----	----
Anthracene	120-12-7	1.0	µg/L	<1.0	<1.0	----	----	----
Fluoranthene	206-44-0	1.0	µg/L	<1.0	<1.0	----	----	----
Pyrene	129-00-0	1.0	µg/L	<1.0	<1.0	----	----	----
Benz(a)anthracene	56-55-3	1.0	µg/L	<1.0	<1.0	----	----	----
Chrysene	218-01-9	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(b)fluoranthene	205-99-2	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(k)fluoranthene	207-08-9	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(a)pyrene	50-32-8	0.5	µg/L	<0.5	<0.5	----	----	----
Indeno(1.2.3.cd)pyrene	193-39-5	1.0	µg/L	<1.0	<1.0	----	----	----
Dibenz(a.h)anthracene	53-70-3	1.0	µg/L	<1.0	<1.0	----	----	----
Benzo(g.h.i)perylene	191-24-2	1.0	µg/L	<1.0	<1.0	----	----	----
^ **Sum of polycyclic aromatic hydrocarbons**	----	0.5	µg/L	<0.5	<0.5	----	----	----
^ **Benzo(a)pyrene TEQ (WHO)**	----	0.5	µg/L	<0.5	<0.5	----	----	----
EP080/071: Total Petroleum Hydrocarbons								
C6 - C9 Fraction	----	20	µg/L	<20	<20	----	----	----
C10 - C14 Fraction	----	50	µg/L	<50	<50	----	----	----
C15 - C28 Fraction	----	100	µg/L	<100	<100	----	----	----
C29 - C36 Fraction	----	50	µg/L	<50	<50	----	----	----
^ **C10 - C36 Fraction (sum)**	----	50	µg/L	<50	<50	----	----	----

Analytical Results

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

Compound	CAS Number	LOR	Unit	Client sample ID: TREAM GAUGE ASW01	TMB02	WESTERN CATCH DAM	EASTERN CATCH DAM	----
				Client sampling date / time: 08-MAY-2013 07:00	07-MAY-2013 13:00	07-MAY-2013 14:00	07-MAY-2013 15:00	----
				ES1310624-006	**ES1310624-007**	**ES1310624-008**	**ES1310624-009**	**----**
EP080/071: Total Recoverable Hydrocarbons - NEPM 2010 Draft								
C6 - C10 Fraction	----	20	µg/L	<20	<20	----	----	----
^ **C6 - C10 Fraction minus BTEX (F1)**	----	20	µg/L	<20	<20	----	----	----
>C10 - C16 Fraction	----	100	µg/L	<100	<100	----	----	----
>C16 - C34 Fraction	----	100	µg/L	<100	<100	----	----	----
>C34 - C40 Fraction	----	100	µg/L	<100	<100	----	----	----
^ **>C10 - C40 Fraction (sum)**	----	100	µg/L	<100	<100	----	----	----
EP080: BTEXN								
Benzene	71-43-2	1	µg/L	<1	<1	----	----	----
Toluene	108-88-3	2	µg/L	<2	<2	----	----	----
Ethylbenzene	100-41-4	2	µg/L	<2	<2	----	----	----
meta- & para-Xylene	108-38-3 106-42-3	2	µg/L	<2	<2	----	----	----
ortho-Xylene	95-47-6	2	µg/L	<2	<2	----	----	----
^ **Total Xylenes**	1330-20-7	2	µg/L	<2	<2	----	----	----
^ **Sum of BTEX**	----	1	µg/L	<1	<1	----	----	----
Naphthalene	91-20-3	5	µg/L	<5	<5	----	----	----
EP075(SIM)S: Phenolic Compound Surrogates								
Phenol-d6	13127-88-3	0.1	%	**27.7**	**30.0**	----	----	----
2-Chlorophenol-D4	93951-73-6	0.1	%	**77.7**	**83.0**	----	----	----
2.4.6-Tribromophenol	118-79-6	0.1	%	**83.4**	**86.9**	----	----	----
EP075(SIM)T: PAH Surrogates								
2-Fluorobiphenyl	321-60-8	0.1	%	**81.3**	**85.8**	----	----	----
Anthracene-d10	1719-06-8	0.1	%	**81.2**	**86.7**	----	----	----
4-Terphenyl-d14	1718-51-0	0.1	%	**67.9**	**71.7**	----	----	----
EP080S: TPH(V)/BTEX Surrogates								
1.2-Dichloroethane-D4	17060-07-0	0.1	%	**119**	**133**	----	----	----
Toluene-D8	2037-26-5	0.1	%	**121**	**129**	----	----	----
4-Bromofluorobenzene	460-00-4	0.1	%	**95.6**	**101**	----	----	----

Surrogate Control Limits

Sub-Matrix: **WATER**

Compound	CAS Number	Recovery Limits (%) Low	High
EP075(SIM)S: Phenolic Compound Surrogates			
Phenol-d6	13127-88-3	10.0	44
2-Chlorophenol-D4	93951-73-6	15.9	102
2.4.6-Tribromophenol	118-79-6	17	125
EP075(SIM)T: PAH Surrogates			
2-Fluorobiphenyl	321-60-8	20.4	112
Anthracene-d10	1719-06-8	29.6	118
4-Terphenyl-d14	1718-51-0	21.5	126
EP080S: TPH(V)/BTEX Surrogates			
1.2-Dichloroethane-D4	17060-07-0	71	137
Toluene-D8	2037-26-5	79	131
4-Bromofluorobenzene	460-00-4	70	128