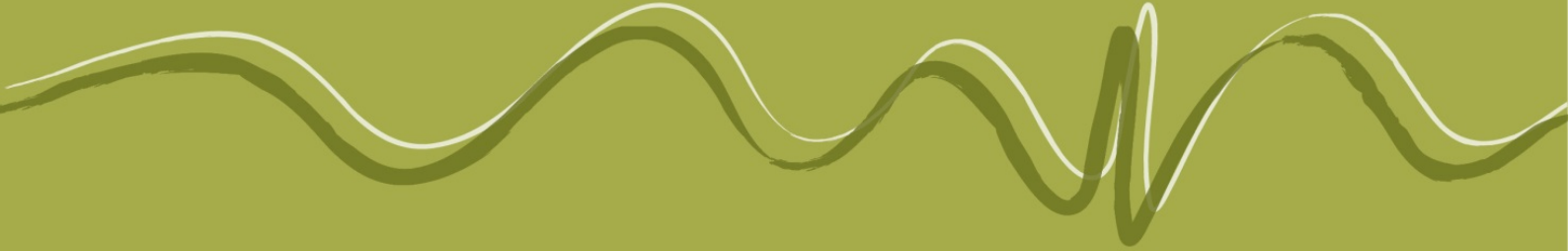


Annual Water Monitoring Report: Construction Phase

Pacific Highway Upgrade: Woolgoolga to Ballina -
Wells Crossing to Glenugie (Nov 2019 - Feb 2021)



GeoLINK
environmental management and design

PO Box 119
Lennox Head NSW 2478
T 02 6687 7666

PO Box 1446
Coffs Harbour NSW 2450
T 02 6651 7666

PO Box 1267
Armidale NSW 2350
T 02 6772 0454

PO Box 229
Lismore NSW 2480
T 02 6621 6677

info@geolink.net.au

Prepared for: Transport for NSW (TfNSW)
© GeoLINK, 2022

UPR	Description	Date Issued	Issued By
2683-1230	First issue – draft for review by TfNSW	09/09/2021	Duncan Thomson
2683-1245	Second issue	25/01/2022	Patrick Sloan
2683-1248	Third issue	16/02/2022	Patrick Sloan
2683-1252	Fourth issue	10/03/2022	Gemma Quick



Table of Contents

1.	Introduction	1
1.1	Background	1
1.2	Overview of Monitoring Program	1
1.2.1	Objectives	1
2.	Monitoring Methodology	2
2.1	Surface Water Quality	2
2.1.1	Monitoring Locations	2
2.1.2	Sampling Regime and Parameters	2
2.1.3	Sample and Data Collection	3
2.2	Groundwater Quality	3
2.2.1	Monitoring Locations	3
2.2.2	Sampling Regime and Parameters	3
2.2.3	Sample and Data Collection	4
2.3	Groundwater Levels	4
2.3.1	Monitoring Locations	4
2.3.2	Sampling Regime	4
2.3.3	Sample and Data Collection	4
3.	Results	5
3.1	Climatic Conditions	5
3.2	Data Analysis Approach	6
3.2.1	Surface Water Quality	6
3.2.2	Groundwater Quality	6
3.2.3	Groundwater Levels	7
3.3	Surface Water Quality	7
3.3.1	Discussion	7
3.4	Groundwater Quality	10
3.4.1	Discussion	10
3.5	Groundwater Levels	10
3.5.1	Discussion	10
4.	Project Response to Results	11
4.1	General	11
4.2	Surface Water Quality	11
4.3	Groundwater Quality	12
4.4	Groundwater Levels	12

5. Recommendations	13
5.1 Monitoring Program	13

Tables

Table 2.1 Surface Water Sampling Parameters	2
Table 2.2 Groundwater Quality Sampling Parameters	3

Figures

Figure 3.1 Grafton Monthly Rainfall over the Reporting Period Versus Long-Term Average	5
--	---

Appendices

<u>Appendix A Surface Water Quality: Results of Interest</u>
<u>Appendix B Surface Water Quality: Data</u>
<u>Appendix C Groundwater Quality: Results of Interest</u>
<u>Appendix D Groundwater Quality: Data</u>
<u>Appendix E Groundwater Levels: Results of Interest</u>
<u>Appendix F Groundwater Levels: Charts</u>
<u>Appendix G Maps of Water Monitoring Sites</u>



Executive Summary

This is the water monitoring report for the construction phase of the Wells Crossing to Glenugie project (WC2G), which is within Sections 1 and 2 of the Woolgoolga to Ballina (W2B) Pacific Highway upgrade. The reporting period for this report is 1 November 2019 to 28 February 2021. The monitoring undertaken during the reporting period includes surface water quality, groundwater quality and groundwater levels.

The water quality monitoring program is described in the Pacific Highway Upgrade – Woolgoolga to Glenugie: Water Quality Monitoring Program (WQMP) (dated 27 September 2019, GeoLINK ref: 2134-1121). The purpose of the WQMP is to monitor the construction and operation impacts of the highway upgrade on surface water bodies and groundwater resources and provide input to the environmental management of the project.

In this report, a ‘result of interest’ is a result that exceeds relevant criteria and has been identified as being potentially influenced by project activities.

The WQMP proposes that water quality monitoring results be assessed by comparing sampling results to the corresponding 80th percentile (P80) figure and/or 20th percentile (P20) figure (as relevant) from the baseline data. Baseline data comprises the original baseline data set (collected during the pre-construction phase) which is progressively supplemented with the data collected from upstream monitoring sites during the construction and operational phases of the project. This process provides a more robust set of baseline P80/P20 data over the course of the project.

The P80 is applicable to parameters where high values are potentially an issue (e.g., turbidity), while the P20 is applicable to parameters where low values are potentially an issue (e.g., dissolved oxygen), and both figures are relevant for parameters where either a high value or a low value are potentially an issue (e.g., pH).

For surface water monitoring, where a downstream result is greater than the P80 baseline value (or is less than the P20 baseline value, where relevant) then further comparison with the upstream result collected at the same time is undertaken to determine whether the result is of interest. During the reporting period, results of interest were identified at both sites. A review was undertaken of the environmental incidents that occurred during the reporting period and have the potential to impact water quality. During the reporting period, there were no environmental incidents associated with the project that had the potential to impact water quality.

For groundwater quality monitoring, bores have been classified as either ‘up-gradient’ or ‘down-gradient’. For a pair of bores, the down-gradient bore is the one that typically has the lower groundwater level, indicating that the direction of groundwater flow is from the up-gradient bore to the down-gradient bore. Where the down-gradient result is greater than the P80 value (or is less than the P20 value, where relevant), it is considered to be a result of interest. During the reporting period, results of interest were identified at the single down-gradient site.

For groundwater level monitoring, the construction phase groundwater level data has been assessed by comparing the difference in groundwater levels between a pair of bores to the P80 of the difference in groundwater levels between the same pairs of bores during the pre-construction monitoring period. During the reporting period, results of interest were identified at one of the two sites.



The project responds to the water monitoring results as follows:

1. The water monitoring data is reviewed, with particular focus on the results of interest that have been identified.
2. The results assist with setting the focus for the project's environmental management inspections.
3. During these inspections, environmental controls are checked and reviewed for adequacy, and any required actions (e.g., maintenance, replacement, and upgrade) are identified.
4. The aforementioned actions are tracked and implemented.

The surface water quality results of interest have been adequately closed out as part of the regular environmental inspections and meetings that occurred during the reporting period.

With regard to the groundwater quality results of interest, road construction activities in the vicinity of the monitoring locations have been reviewed with regard to the noted results. No construction activities were identified that have the potential to influence the results.

With regard to the groundwater level results of interest, the nature and extent of works associated with the relevant highway cuttings have been reviewed and it has been determined that it is unlikely that the cuttings have influenced the noted results.

On the basis of the above, no further action is recommended with respect to the surface water quality, groundwater quality and groundwater level monitoring results.

It is recommended that the monitoring program continue in accordance with the WQMP for the operational phase of the WC2G project.



1. Introduction

1.1 Background

This is the water monitoring report for the construction phase of the Wells Crossing to Glenugie project (WC2G), which is within Sections 1 and 2 of the Woolgoolga to Ballina (W2B) Pacific Highway upgrade. The reporting period for this report is 1 November 2019 to 28 February 2021.

Water monitoring reports are typically prepared on an annual basis. However, given that the duration of the construction phase of the WC2G project was sixteen months, TfNSW discussed and agreed with the Environmental Representative that it was appropriate to prepare a single water monitoring report covering the construction phase.

Construction recommenced within the WC2G section of the W2B upgrade in November 2019. Therefore, surface water and groundwater monitoring sites within this section (i.e., SW10, SW11, GWB28 to GWB31) were not monitored as part of the broader Sections 1 and 2 operational phase monitoring. Monitoring of these sites was undertaken as part of the WC2G construction phase and is included within this report.

1.2 Overview of Monitoring Program

The water quality monitoring program is described in the Pacific Highway Upgrade – Woolgoolga to Glenugie: Water Quality Monitoring Program (WQMP) (dated 27 September 2019, GeoLINK ref: 2134-1121).

1.2.1 Objectives

The purpose of the WQMP is to monitor and manage the construction and operation impacts of the highway upgrade on surface water bodies and groundwater resources.

The key surface water quality objective of the broader W2B project is to protect downstream environments from the potential impacts of surface runoff during the construction and operational phases of the project (RMS, Aurecon, SKM, 2012a). Similarly, the key groundwater objective of the W2B project is to protect environmental receivers of groundwater flows and groundwater users from the potential impacts on groundwater levels and quality during the construction and operational phases of the project (RMS, Aurecon, SKM, 2012b).

The outcomes of the WQMP will assist with achieving water quality and hydrology related management objectives for the WC2G project including:

- Mitigating impacts to surface water quality in order to protect aquatic ecology and ecosystem characteristics in adjacent catchments.
- Mitigating impacts to groundwater hydrology in order to protect licensed bores and dams, water bodies and groundwater dependant ecosystems.

2. Monitoring Methodology

2.1 Surface Water Quality

2.1.1 Monitoring Locations

The surface water monitoring locations for the broader Woolgoolga to Glenugie (W2G) project are described in Section 2.1 and Appendix C of the WQMP. Surface water monitoring locations SW10 and SW11 are the only sites located within the WC2G section and therefore covered by this report. These monitoring locations are shown in **Appendix G** of this report.

2.1.2 Sampling Regime and Parameters

As per Section 4.2.1 of the WQMP, the required frequency of sampling and the sampling parameters for the construction phase were as follows:

- Two wet event sampling rounds per month:
 - Assess Type A parameters every round (refer to **Table 2.1**); and
 - Assess Type B parameters every second round (refer to **Table 2.1**).
- One dry event sampling round per month:
 - Assess Type A parameters every month; and
 - Assess Type B parameters every second month.

Table 2.1 Surface Water Sampling Parameters

Parameter	Type A Parameters	Type B Parameters
pH	X	
Temperature	X	
Electrical Conductivity (EC)	X	
Dissolved Oxygen (DO)	X	
Turbidity	X	
Total Suspended Solids (TSS)	X	
Total Oils and Grease	X	
Total Phosphorous, Total Nitrogen	X	
Phosphate, Ammonia, Nitrate, Nitrite		X
Total Recoverable Hydrocarbons (TRH)	*	X

* Note: TRH is to be included as a Type A parameter if oil / grease is visible at sampling location

Wet events are defined as 10 mm or more of rain within 24 hours. Wet event sampling was undertaken within 24 hours of the rain event. In some months, two rounds of wet event sampling were not undertaken due to the rainfall trigger not being exceeded.

Surface water monitoring was undertaken by the construction contractor. The monitoring undertaken during the reporting period complied with the above requirements, except that some parameters were not monitored at some sites during the reporting period.

A summary is provided below

- TSS was not analysed at SW10US or SW11US during wet event monitoring in March 2020.
- Total oil and grease was not analysed at any site during the reporting period.
- TN was not analysed at SW10DS or SW11DS during wet event monitoring in November 2019.

The following changes had previously been agreed by the Environmental Review Group (ERG) and approved by the Environmental Representative:

- TRH was discontinued as a routine sampling parameter in April 2016. A visual check for oils/grease was undertaken and TRH monitoring was undertaken if required.
- Analysis of nutrients was discontinued in October 2016.

Surface water quality monitoring could not be undertaken at some sites on some occasions because there was insufficient water. Field notes are included in **Appendix B**.

2.1.3 Sample and Data Collection

The collection of in-situ water quality data and the collection of water samples for laboratory analysis were undertaken in accordance with the methodology described in Sections 5.1 and 5.2 of the WQMP.

2.2 Groundwater Quality

2.2.1 Monitoring Locations


The groundwater quality monitoring locations for the broader W2G project are described in Section 2.2 and Appendix C of the WQMP. Groundwater quality monitoring locations GWB30 and GWB31 are the only sites located within the WC2G section and therefore covered by this report. These monitoring locations are shown in **Appendix G** of this report.

2.2.2 Sampling Regime and Parameters

As per Section 4.3.2.1 of the WQMP, the required frequency of sampling for the construction phase is quarterly, and the sampling parameters are as per **Table 2.2**.

Table 2.2 Groundwater Quality Sampling Parameters

<i>Parameter Group</i>	<i>Parameter</i>	<i>Field Analysis</i>	<i>Laboratory Analysis</i>
Physical and Chemical Properties	pH	X	
	Temperature	X	
	Electrical Conductivity (EC)	X	
	Dissolved Oxygen (DO)	X	
	Turbidity	X	
	Total Dissolved Solids (TDS)		X
Hydrocarbons	Total Recoverable Hydrocarbons (TRH)		X
Nutrients	Total Phosphorous, Total Nitrogen		X
Major Cations	Sodium (Na+), Potassium (K+), Calcium (Ca2+), Magnesium (Mg2+)		X



<i>Parameter Group</i>	<i>Parameter</i>	<i>Field Analysis</i>	<i>Laboratory Analysis</i>
Major Anions	Chloride (Cl-), Sulfate (SO42-), Bicarbonate (HCO3-)		X
Heavy Metals (Dissolved)	Aluminium, Cadmium, Copper, Lead, Zinc		X

The monitoring undertaken during the reporting period complied with the above requirements. Groundwater quality monitoring could not be undertaken at some bores on some occasions because there was insufficient water in the bore. Field notes are provided in **Appendix D**.

2.2.3 Sample and Data Collection

The collection of in-situ water quality data and the collection of water samples for laboratory analysis were undertaken in accordance with the methodology described in Sections 5.1 and 5.3 of the WQMP. A passive sampling approach was used to collect groundwater samples.

2.3 Groundwater Levels

2.3.1 Monitoring Locations

The groundwater level monitoring locations for the broader W2G project are described in Section 2.2 and Appendix C of the WQMP. Groundwater level monitoring locations GWB28 to GWB31 are the only sites located within the WC2G section and therefore covered by this report. These monitoring locations are shown in **Appendix G** of this report.

2.3.2 Sampling Regime

As per Section 4.3.1.1 of the WQMP, the required frequency of monitoring for the construction phase is for the automatic water level recorders to be downloaded quarterly, with physical measurement of the depth to standing water level taken at the same time.

The monitoring undertaken during the reporting period complied with the above requirements.

2.3.3 Sample and Data Collection

The collection of groundwater level data was undertaken in accordance with the methodology described in Sections 5.1 and 5.3 of the WQMP.

3. Results

3.1 Climatic Conditions

The climatic conditions recorded at the Bureau of Meteorology (BoM) Grafton Airport weather station provide an indication of the conditions experienced at the project site during the reporting period.

Figure 3.1 presents monthly rainfall totals for the reporting period compared to long-term averages (data sourced from BoM website). From July 2020 to November 2020 there were gaps in the BoM data at Grafton Airport, so data and averages from the Grafton South weather station have been substituted for this period. Total rainfall for the reporting period was 1,830 mm, which is higher than the long-term average rainfall of 1,538 mm.

Rainfall was significantly higher than the long-term monthly averages for January, February, and December 2020, as well as February 2021. In July 2020, rainfall was slightly above average, with lower-than-average rainfall recorded during all other months in the reporting period.

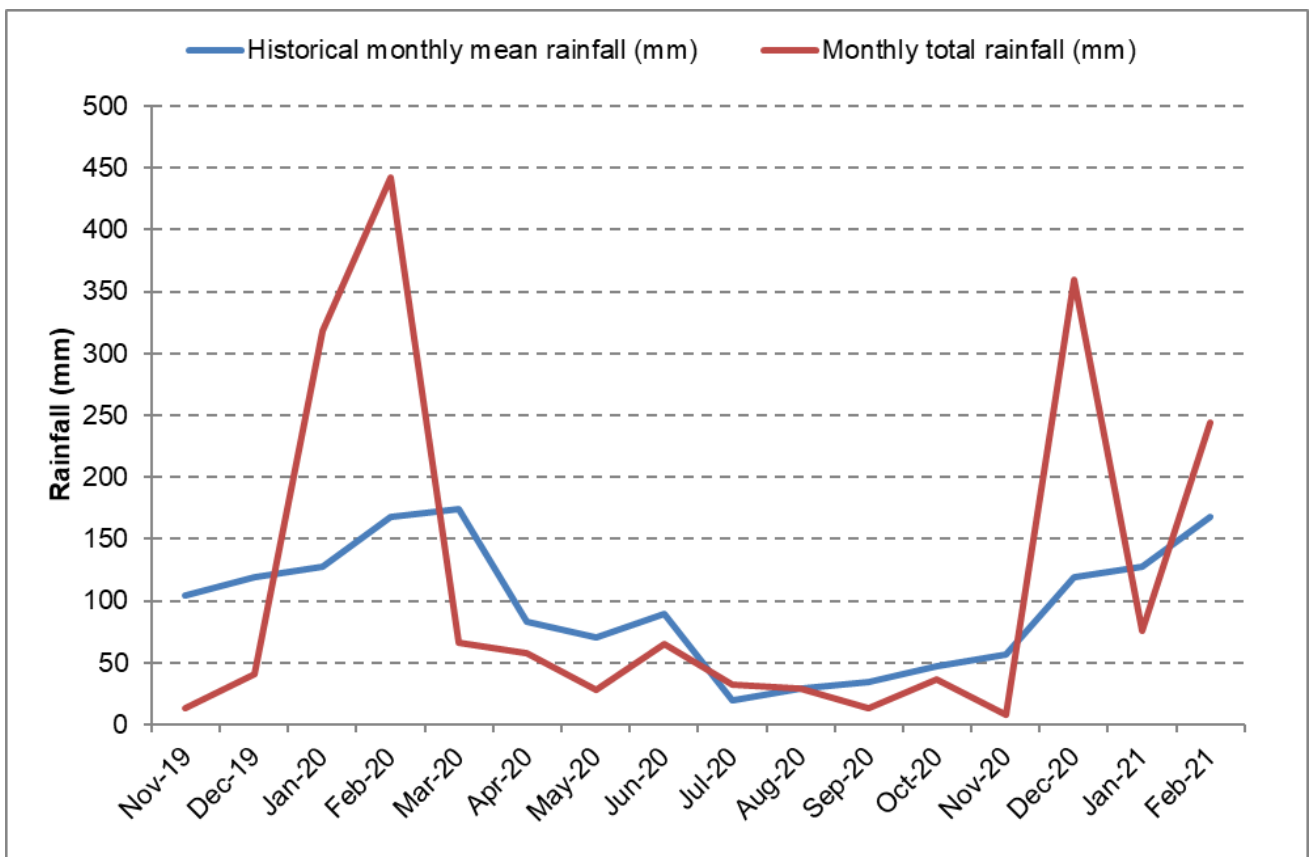


Figure 3.1 Grafton Monthly Rainfall over the Reporting Period Versus Long-Term Average



3.2 Data Analysis Approach

3.2.1 Surface Water Quality

The WQMP proposes that surface water quality monitoring results be assessed by comparing sampling results to the corresponding 80th percentile (P80) figure and/or 20th percentile (P20) figure (as relevant) from the baseline data (which is the pre-construction baseline data that is progressively supplemented with the construction and operational phase data as discussed below).

The P80 is applicable to parameters where high values are potentially an issue (e.g., turbidity), while the P20 is applicable to parameters where low values are potentially an issue (e.g., dissolved oxygen), and both figures are relevant for parameters where either a high value or a low value are potentially an issue (e.g., pH).

Where a downstream result is greater than the P80 value (or is less than the P20 value, where relevant) a further comparison with the upstream result collected at the same time is undertaken. Where the downstream result is then also greater than (or less than, where relevant) the corresponding upstream result, it is considered to be a 'result of interest'. That is, the result has potentially been influenced by project activities and further investigation is undertaken.

The original baseline data set is the pre-construction data collected between May 2013 and April 2014. As per Section 7.1.2 of the WQMP, the baseline data is progressively supplemented with the data collected from upstream monitoring sites during the construction and operational phases of the project. The upstream monitoring sites represent sites not impacted by the highway upgrade and therefore reflect 'baseline' data. This process provides a more robust set of baseline P80/P20 data over the course of the monitoring program.

3.2.2 Groundwater Quality

The WQMP proposes that groundwater quality monitoring results be assessed using comparisons to the P80 and P20 values from the baseline data, similar to the surface water quality approach described above.

The baseline data set is the pre-construction data collected between November 2013 and April 2014. For one of the two sites, three rounds of pre-construction data were collected during this six-month period. At the remaining site, one round of data was collected. This was due to insufficient water in the piezometers at the time of sampling.

Three sets of data (or less) collected over a six-month period are unlikely to capture the full range of natural variability of each parameter at each site. Therefore, an alternative approach has been adopted. Each bore has been classified as either 'up-gradient' or 'down-gradient'. For a pair of bores, the down-gradient bore is the one that typically has the lower groundwater level, indicating that the direction of groundwater flow is from the up-gradient bore to the down-gradient bore. P80 values (and P20 values, where relevant) have been calculated using any available pre-construction data, as well as the construction and operational phase data for the up-gradient bore. These P80 and P20 values are then used to assess the groundwater quality results for the corresponding down-gradient bore.

Where the down-gradient result is greater than the P80 value (or is less than the P20 value, where relevant), it is considered to be a result of interest. That is, the result has potentially been influenced by project activities and further investigation is undertaken.



3.2.3 Groundwater Levels

The WQMP proposes that the groundwater level data be assessed by comparing the difference in groundwater levels between a pair of bores to the P80 of the difference in groundwater levels between the same pair of bores during the pre-construction monitoring period. This has been implemented in the following manner:

- The difference in the groundwater levels between a pair of bores is calculated at each time interval for the pre-construction monitoring period.
- The 80th percentile (P80) of these groundwater level differences is calculated to determine the baseline P80.
- During the construction and operational phases, the difference in the groundwater levels between a pair of bores is calculated at each time interval.
- If the difference in the groundwater levels exceeds the baseline P80, it is considered to be a result of interest. That is, the result has potentially been influenced by project activities and further investigation is undertaken.

It is noted that the groundwater levels could be impacted by other 'natural' factors, such as climatic conditions that are different to those experienced during the baseline period.

3.3 Surface Water Quality

A compilation of the results of interest for the reporting period is provided in **Appendix A** and the surface water quality monitoring results spreadsheet is provided in **Appendix B**. Results of interest are highlighted in bold red font in the spreadsheet.

During the reporting period, there were no environmental incidents associated with the project that had the potential to impact water quality.


3.3.1 Discussion

Both sites had results of interest for at least one parameter during most monitoring rounds. The following observations can be made:

- **Electrical Conductivity (EC):** Aside from the influence of tidal water, EC in a waterway may be influenced by inputs such as fertiliser (i.e., total phosphorous (TP) and total nitrogen (TN) concentrations) and soils with high salt content. Fertiliser runoff and erosion associated with the project may cause increases in EC levels at monitoring sites.

Results of interest for EC levels were recorded at SW10 on eight occasions and SW11 on 18 occasions, including during both wet and dry sampling events (refer to **Appendix A**). All eight results of interest at SW10 were below the relevant P20 values. These results may indicate a higher influx of fresh water into the system which is unlikely to be as a result of construction activities. The more likely explanation is the wetter than average conditions experienced during the reporting period. These results do not appear to indicate point source pollution from the construction works influencing the EC. Seventeen of the eighteen results of interest at SW11 were above the relevant P80 values. It is of note that all seventeen results were recorded when the upstream and downstream sites were not connected. In this situation it is difficult to infer impacts resulting from construction works.

The impacts from the recorded EC levels are considered likely to be negligible.

- 
- **Dissolved Oxygen (DO):** Low DO concentrations in a waterway may be a result of:
 - inputs of tannin leachates (which increases biological oxygen demand);
 - inputs of nutrients (which cause elevated algal growth that in turn depletes DO); or
 - a change in flow regime which can lead to stagnation and in turn depleted DO concentrations.

Another potential cause of low DO concentrations, which is unrelated to highway construction or operation, is long periods of floodplain inundation due to flood events.

Results of interest for DO were recorded at SW10 on one occasion, during a dry sampling event, and at SW11 on three occasions, including during both wet and dry sampling events (refer to **Appendix A**). The result of interest at SW10 was during a period where there was no connection between the upstream and downstream sites. For each result of interest incident at SW11 the upstream site had insufficient water to sample and the downstream site was experiencing low water and no visible flow conditions. Under these conditions, low DO is considered a natural outcome and unlikely to be as a result of construction activities.

- **Turbidity and Total Suspended Solids:** Elevated turbidity and / or suspended solids can result from the direct disturbance and subsequent mobilisation of sediments within waterways as well as inputs of sediment laden run-off during rain. Construction activities including clearing, grubbing and earthworks typically increase the area of exposed soil and without appropriate management this can lead to erosion and transport of fine material into waterways. Direct disturbance of river and creek beds during activities such as temporary rock platform construction, creek crossings and piling associated with bridge works can also mobilise sediments and lead to increased turbidity/ suspended soils.

Results of interest for turbidity and/or suspended solids were not recorded at SW10, but were recorded at SW11 on nine occasions including during both wet and dry sampling events (refer to **Appendix A**). A result of particular note was recorded on 27/03/2020 (wet event) where turbidity (482 NTU) and suspended solids (260 mg/L) were significantly higher than both the corresponding upstream result (202 NTU, 156 mg/L) and the P80 (125 NTU, 71 mg/L). It is of note that upstream and downstream sites were not connected during this monitoring event or for all but two of the other turbidity and / or suspended solids results of interest monitoring. All results of interest were recorded under low or no visible flow conditions.

- **Hydrocarbons (including Oil and Grease):** Hydrocarbons are widely used in construction plant and equipment in the form of fuels and oils. Spills and leaks from plant, equipment and storage vessels, and during transport and refuelling, can lead to contamination of waterways. Run-off from contaminated soil and asphalt works is also a potential pathway for hydrocarbons to enter aquatic systems.

Results of interest for hydrocarbons were recorded at SW10 and SW11 on one occasion, during a wet sampling event on 19/01/2021. It is noted that works were undertaken adjacent to the operational highway. Wet event sampling was undertaken in conjunction with post rainfall inspections and no issues associated with handling, storage or use of hydrocarbons were identified. It is reasonable to assume that the hydrocarbons identified may have been as a result of runoff from the operational portion of the highway. In addition, at SW10 hydrocarbons at the upstream site were identified in similar concentrations to hydrocarbons at the downstream site. This suggests that at SW10 another unknown source of hydrocarbons, upstream of the highway alignment may have contributed to the downstream result.

▪ **Nutrients:** Nutrients can enter waterways via:

- soil erosion and off-site movement of eroded soils, particularly soils that have had fertiliser added; or
- changes to flow regimes, which can change the volumes and flow rates of water, leading to stagnation and subsequent increases in nutrients.

Results of interest for nutrient concentrations were recorded at SW10 on nine occasions and SW11 on 30 occasions, including during both wet and dry sampling events (refer to **Appendix A**). Five of the results obtained at SW10 and twenty-four at SW11 were under no flow conditions with the upstream and downstream monitoring points not connected. Results of particular note where upstream and downstream points were connected and where nutrients were higher than both the corresponding upstream result and the P80, are as follows:

- Ammonia (0.240 mg/L) at SW10 on 20/01/2020 (wet event);
- Phosphate (0.080 mg/L), ammonia (0.220 mg/L), nitrate (0.130 mg/L) and nitrite (0.041 mg/L) at SW10 on 10/04/2020 (wet event);
- Nitrate (0.060 mg/L) at SW10 on 08/01/2021 (wet event);
- Nitrate (0.330 mg/L) at SW11 on 26/07/2020 (wet event);
- TP (0.05 mg/L) and Ammonia (0.270 mg/L) at SW11 on 14/02/2021.

It is of note that hydromulching activities do not correspond with any of these monitoring events and that at SW10 construction works did not commence until late 2020.

▪ **pH:** The pH of a waterway can be affected by acidification due to exposure of acid sulfate soils, the leaching of tannins and from spills/ run-off during concreting and lime stabilisation works.

Results of interest for pH levels (both high and low) were recorded at SW10 on 18 occasions and SW11 on 14 occasions during both wet and dry sampling events (refer to **Appendix A**). Results of particular note, where the pH was significantly higher than both the corresponding upstream result and the P80/P20, are as follows:

- pH 7.90 at SW10 on 25/03/2020 (dry event);
- pH 8.16 at SW10 on 10/05/2020 (wet event);
- pH 8.17 at SW10 on 08/08/2020 (wet event);
- pH 7.66 at SW10 on 15/08/2020 (wet event);
- pH 8.03 at SW10 on 07/12/2020 (wet event); and
- pH 7.98 at SW11 on 20/01/2020 (wet event).

It is noted that at SW10 construction works did not commence until late 2020.

With regard to surface water monitoring, regularly the downstream monitoring site is not connected by continuous water to the upstream monitoring site. In such instances, the waterway may be a series of isolated pools. Stagnant, isolated pools can have water quality characteristics that are significantly different to those of a flowing creek or stream. For example, dissolved oxygen levels can decline in stagnant pools and nutrient levels can increase. Such changes in water quality may not have been influenced by project activities but are likely to be significantly different to the typical water quality of the connected and flowing waterway and therefore may be flagged as a result of interest.



3.4 Groundwater Quality

A compilation of the results of interest for the reporting period is provided in **Appendix C** and the groundwater quality monitoring results spreadsheet is provided in **Appendix D**. Results of interest are highlighted in bold red font in the spreadsheet.

3.4.1 Discussion

The discussion provided in **Section 3.3.1** regarding potential impacts of the project on specific water quality parameters and potential management responses to results of interest is also applicable to groundwater quality.

During the reporting period, results of interest were identified at the down-gradient bore (GWB31) on one occasion. It is noted that there was sufficient water to sample the bore on only one occasion during the monitoring period. The following results of particular note, where parameters were significantly higher than both the corresponding upstream result and the P80, were recorded:

- Sodium (492 mg/L) and Chloride (638 mg/L) on 23/12/2020.

Salts are soluble and have the potential to infiltrate groundwater via the soil. Management responses to elevated salt levels can include the inspection of controls designed to avoid the seepage of water from sediment basins and other water pollution controls.

3.5 Groundwater Levels

A compilation of the results of interest for the reporting period is provided in **Appendix E** and charts of the groundwater levels are presented in **Appendix F**.

3.5.1 Discussion

Results of interest were recorded at one of the two down-gradient bores (GWB29). Further investigation to determine the likelihood of project activities being a contributing factor to these results include:

- The timing of the cutting and/or excavation works at the specific sites.
- Site observations that include interception of groundwater levels.

Potential management responses to the results of interest can include measures to collect and transfer groundwater seepage from the up-gradient side of the cut to the down-gradient side of the cut. No observations of the interception of groundwater were made by the contractor or Transport for NSW during the reporting period.



4. Project Response to Results

4.1 General

The project responds to the water monitoring results as follows:

1. The water monitoring data is reviewed, with particular focus on the results of interest that have been identified.
2. The results assist with setting the focus for the project's environmental management inspections.
3. During these inspections, environmental controls are checked and reviewed for adequacy and any required actions (e.g., maintenance, replacement, or upgrade) are identified.
4. The aforementioned actions are tracked and implemented.

The project's environmental management inspections include the following:

- Daily pre-work inspection by the contractor's staff, including a check of relevant environmental controls and resources required to ensure effective operation and maintenance.
- Weekly and post rainfall inspections of the work sites by the construction contractor environmental personnel to evaluate the effectiveness of environmental controls.
- Fortnightly inspections by the Environmental Representative and / or TfNSW environmental personnel.
- Inspections by the Soil Conservationist focusing on erosion and sediment controls.

When reviewing a result of interest, the first step is to determine whether project activities with the potential to influence the result were underway at the time of (or prior to) the monitoring event. Where project activities are considered a potential contributor to the result of interest, existing management measures are reviewed and, where appropriate, additional management measures are considered. If it is determined that additional management measures are warranted, they are implemented and monitored for efficacy.

As previously discussed, at surface water monitoring sites some results of interest may have been a result of water quality characteristics being significantly different due to the waterway not being connected by flowing water. As such, the review of the results of interest and consideration of the adequacy of the management measures takes into account the lack of connectivity at the time of the monitoring event.

In addition to the above, Transport for NSW are notified immediately if a potential pollution incident is observed in the field.

4.2 Surface Water Quality

The results of interest were closed out as part of regular contractor and TfNSW environmental inspections and meetings that occurred during the reporting period. The monthly water quality results were provided to TfNSW and the Environmental Representative. The EPA were also notified and provided water quality results as required under the approved Water Quality Monitoring Program. No further action is recommended.



4.3 Groundwater Quality

Road construction activities in the vicinity of the monitoring locations have been reviewed with regard to the noted results. No construction activities were identified that have the potential to influence the results. No further action is recommended.

4.4 Groundwater Levels

The results of interest indicate a possibility of highway cuttings impacting on groundwater flows. The nature and extent of works associated with these highway cuttings have been reviewed. Visual inspections of cuttings by Transport for NSW have not identified interception of groundwater. In addition, no engineering solutions have been required to manage any groundwater inflows. Finally, the project is aligned on the catchment divide, which further reduces the potential for interception of directional groundwater flows.

On the basis of the above, it has been determined that it is unlikely that the cuttings have influenced the noted exceedances. No further action is recommended.



5. Recommendations

5.1 Monitoring Program

The WQMP requires water monitoring to be undertaken for the first three years of the operational phase. This is consistent with the relevant Minister's Condition of Approval (D12.(f)), which states that the WQMP shall include *"a minimum monitoring period of three years following the completion of construction"*.

It is recommended that the monitoring program continue in accordance with the WQMP for the operational phase of the WC2G project.



References

ANZECC ARMCANZ (1995). *Guidelines for groundwater protection in Australia*. Australian and New Zealand Environment and Conservation Council (ANZECC), Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

ANZECC ARMCANZ (2000a). *Australian and New Zealand guidelines for fresh and marine water quality. Volume 1, The Guidelines*. Australian and New Zealand Environment and Conservation Council (ANZECC), Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

ANZECC ARMCANZ (2000b). *Australian guidelines for water quality monitoring and reporting*. Australian and New Zealand Environment and Conservation Council (ANZECC), Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ).

GeoLINK (2019). *Pacific Highway Upgrade – Woolgoolga to Glenugie – Water Quality Monitoring Program*. 27 September 2019 for NSW Road and Maritime Services.

RMS, Aurecon, SKM (2012a). *Upgrading the Pacific Highway. Woolgoolga to Ballina. Working Paper – Water Quality*. November 2012.

RMS, Aurecon, SKM (2012b). *Upgrading the Pacific Highway. Woolgoolga to Ballina. Working Paper – Groundwater*. November 2012.



Copyright and Usage

©GeoLINK, 2022

This document, including associated illustrations and drawings, was prepared for the exclusive use of Transport for NSW to support construction of the Woolgoolga to Ballina Pacific Highway upgrade. It is not to be used for any other purpose or by any other person, corporation or organisation without the prior consent of GeoLINK. GeoLINK accepts no responsibility for any loss or damage suffered howsoever arising to any person or corporation who may use or rely on this document for a purpose other than that described above.

This document, including associated illustrations and drawings, may not be reproduced, stored, or transmitted in any form without the prior consent of GeoLINK. This includes extracts of texts or parts of illustrations and drawings.



Appendix A

Surface Water Quality: Results of Interest

Surface Water Quality Table of Results of Interest

Site	Date	Wet or Dry Event	Results of Interest	U/S Results	P20 / P80	Field Notes / Comments	Design 5 Day Rainfall Depth Exceeded?
SW10	13/11/2019	Dry	pH = 7.27	N/A	7.24	Upstream and downstream not connected. No visible flow, standing water. Weather fine. Upstream insufficient water to sample.	No
SW10	18/12/2019	Dry	pH = 7.50	N/A	7.24	Upstream and downstream not connected. No visible flow, standing water. Weather fine. Upstream insufficient water to sample.	Yes
SW10	24/12/2019	Wet	pH = 7.54 Ammonia = 0.057 mg/L	N/A	7.31 0.044	Upstream and downstream sites not connected. No visible flow, low water level. Weather fine. Upstream insufficient water to sample.	No
SW10	26/12/2019	Wet	Ammonia = 0.120 mg/L	0.07	0.044	Upstream and downstream sites not connected. No visible flow, low water level. Weather fine.	No
SW10	15/01/2020	Wet	pH = 7.49	N/A	7.31	Upstream and downstream not connected. No visible flow, standing water. Weather fine. Upstream insufficient water to sample.	No
SW10	20/01/2020	Wet	pH = 7.60 EC = 0.11 mS/cm TN = 1.30 mg/L Ammonia = 0.240 mg/L	7.29 0.24 1.10 0.059	7.31 0.12 0.97 0.044	Upstream and downstream connected. Visible flow. Weather fine.	No
SW10	25/03/2020	Dry	pH = 7.90	7.05	7.24	Upstream and downstream connected. No visible flow. Weather fine.	No
SW10	27/03/2020	Wet	pH = 7.41	7.01	7.31	Upstream and downstream connected. No visible flow. Weather fine.	No
SW10	10/04/2020	Wet	pH = 7.38 Phosphate = 0.080 mg/L Ammonia = 0.220 mg/L Nitrate = 0.130 mg/L Nitrite = 0.041 mg/L	6.93 0.003 0.030 0.003 0.003	7.31 0.015 0.044 0.025 0.025	Upstream and downstream connected. No visible flow. Weather fine.	No
SW10	15/04/2020	Dry	DO = 2.22 mg/L	14.54	2.8	Upstream and downstream not connected. No visible flow. Weather fine.	No
SW10	08/05/2020	Dry	pH = 8.25 Ammonia = 0.037mg/L	7.40 0.017	7.24 0.026	Upstream and downstream not connected. No visible flow. Weather fine.	No

Site	Date	Wet or Dry Event	Results of Interest	U/S Results	P20 / P80	Field Notes / Comments	Design 5 Day Rainfall Depth Exceeded?
SW10	10/05/2020	Wet	pH = 8.16	7.36	7.31	Upstream and downstream connected. No visible flow. Weather fine.	No
SW10	05/08/2020	Dry	EC = 0.09 mS/cm	0.17	0.14	Upstream and downstream not connected. No visible flow. Weather fine.	No
SW10	08/08/2020	Wet	pH = 8.17	6.69	7.31	Upstream and downstream connected. No visible flow. Weather fine.	No
SW10	15/08/2020	Wet	pH = 7.66	7.03	7.31	Upstream and downstream connected. No visible flow. Weather fine.	No
SW10	02/09/2020	Dry	EC = 0.09 mS/cm	0.17	0.14	Upstream and downstream not connected. No visible flow. Weather partly cloudy.	No
SW10	09/10/2020	Dry	pH = 7.89 Ammonia = 0.110 mg/L Nitrate = 0.240 mg/L	7.86 0.015 0.010	7.24 0.026 0.025	Upstream and downstream not connected. No visible flow. Weather partly cloudy.	No
SW10	06/12/2020	Wet	pH = 7.45	7.13	7.31	Upstream and downstream connected. No visible flow. Weather overcast.	No
SW10	07/12/2020	Wet	pH = 8.03	6.42	7.31	Upstream and downstream connected. No visible flow. Weather overcast.	No
SW10	08/01/2021	Wet	pH = 5.09 EC = 0.08 mS/cm Nitrate = 0.060 mg/L	6.00 0.10 0.005	6.31 0.12 0.025	Upstream and downstream connected. No visible flow. Weather overcast.	Yes
SW10	15/01/2021	Dry	EC = 0.09 mS/cm	0.10	0.14	Upstream and downstream not connected. No visible flow. Weather partly cloudy.	No
SW10	19/01/2021	Wet	Ammonia = 0.087 mg/L TRH >C16-C34 Fraction = 120 µg/L	6.80 50	0.044 50	Upstream and downstream connected. No visible flow. Weather overcast.	No
SW10	01/02/2021	Dry	EC = 0.12 mS/cm	0.14	0.14	Upstream and downstream not connected. No visible flow.	No
SW10	22/02/2021	Wet	pH = 5.80 EC = 0.08 mS/cm	6.50 0.16	6.31 0.12	Upstream and downstream connected.	Yes
SW11	13/11/2019	Dry	EC = 0.25 mS/cm	N/A	0.26	Upstream and downstream sites not connected. No visible flow, low water level. Weather fine. Upstream insufficient water to sample.	No

Site	Date	Wet or Dry Event	Results of Interest	U/S Results	P20 / P80	Field Notes / Comments	Design 5 Day Rainfall Depth Exceeded?
SW11	30/11/2019	Wet	DO = 2.28 mg/L TP = 0.20 mg/L	N/A	3.48 0.04	Upstream and downstream sites not connected. No visible flow, low water level. Weather fine. Upstream insufficient water to sample.	No
SW11	26/12/2019	Wet	pH = 6.59 DO = 1.96 mg/L TP = 0.06 mg/L	N/A	6.72 3.48 0.04	Upstream and downstream sites not connected. No visible flow, low water level. Weather fine. Upstream insufficient water to sample.	No
SW11	08/01/2020	Dry	DO = 2.05 mg/L SS = 39 mg/L	N/A	3.00 23	Upstream and downstream sites not connected. No visible flow, low water level. Weather fine. Upstream insufficient water to sample.	No
SW11	15/01/2020	Wet	TP = 0.20 mg/L TN = 1.70 mg/L	N/A	0.04 1.19	Upstream and downstream sites not connected. No visible flow, low water level. Weather fine. Upstream insufficient water to sample.	No
SW11	20/01/2020	Wet	pH = 7.98 SS = 84 mg/L	7.36 56	7.77 75	Upstream and downstream sites connected. Low visible flow, low water level. Weather fine.	No
SW11	14/02/2020	Wet	pH = 7.82 SS = 147 mg/L Nitrite = 0.027 mg/L	7.68 131 0.003	7.77 75 0.025	Upstream and downstream sites connected. Low visible flow, low water level. Weather fine.	Yes
SW11	06/03/2020	Wet	EC = 0.37 mS/cm	0.28	0.35	Upstream and downstream sites connected. Low visible flow, low water level. Weather fine.	No
SW11	25/03/2020	Dry	TP = 0.06 mg/L Phosphate = 0.026 mg/L Ammonia = 0.240 mg/L Nitrate = 0.110 mg/L Nitrite = 0.042 mg/L	0.03 0.003 0.021 0.003 0.003	0.03 0.015 0.025 0.025 0.025	Upstream and downstream sites not connected. No visible flow. Weather fine.	No
SW11	27/03/2020	Wet	Turbidity = 482 NTU SS = 260 mg/L Ammonia = 0.093 mg/L Nitrate = 0.170 mg/L	202 156 0.016 0.003	131 75 0.036 0.070	Upstream and downstream sites not connected. No visible flow, low water level. Weather fine.	No

Site	Date	Wet or Dry Event	Results of Interest	U/S Results	P20 / P80	Field Notes / Comments	Design 5 Day Rainfall Depth Exceeded?
SW11	10/04/2020	Wet	EC = 0.41 mS/cm TP = 0.08 mg/L Ammonia = 0.220 mg/L Nitrate = 0.130 mg/L Nitrite = 0.041 mg/L	0.29 0.03 0.030 0.003 0.003	0.35 0.04 0.036 0.070 0.025	Upstream and downstream sites not connected. No visible flow, low water level. Weather fine.	No
SW11	15/04/2020	Dry	Ammonia = 0.049 mg/L Nitrate = 0.057 mg/L	0.014 0.003	0.025 0.025	Upstream and downstream sites not connected. No visible flow. Weather fine.	No
SW11	08/05/2020	Dry	EC = 1.35 mS/cm TP = 0.10 mg/L TN = 2.30 mg/L Phosphate = 0.072 mg/L Ammonia = 0.160 mg/L Nitrate = 1.300 mg/L Nitrite = 0.073 mg/L	0.35 0.03 0.50 0.003 0.003 0.005 0.005	0.41 0.03 0.80 0.015 0.025 0.025 0.025	Upstream and downstream sites not connected. No visible flow. Weather fine.	No
SW11	10/05/2020	Wet	EC = 1.32 mS/cm TP = 0.09 mg/L TN = 2.10 mg/L Phosphate = 0.083 mg/L Ammonia = 0.250 mg/L Nitrate = 1.200 mg/L Nitrite = 0.063 mg/L	0.35 0.03 0.50 0.003 0.015 0.003 0.003	0.35 0.04 1.19 0.015 0.036 0.070 0.025	Upstream and downstream sites not connected. No visible flow, low water level. Weather fine.	No
SW11	19/05/2020	Wet	EC = 1.38 mS/cm TP = 0.10 mg/L TN = 2.10 mg/L Phosphate = 0.072 mg/L Ammonia = 0.130 mg/L Nitrate = 1.500 mg/L Nitrite = 0.049 mg/L	0.35 0.03 0.50 0.003 0.024 0.003 0.003	0.35 0.04 1.19 0.015 0.036 0.070 0.025	Upstream and downstream sites not connected. No visible flow, low water level. Weather fine.	No
SW11	11/06/2020	Wet	pH = 8.64 Turbidity = 145 NTU Nitrate = 0.460 mg/L	8.20 82 0.003	7.77 131 0.070	Upstream and downstream sites not connected. No visible flow, low water level. Weather fine.	Yes
SW11	17/07/2020	Dry	EC = 0.65 mS/cm Nitrate = 0.420 mg/L	0.32 0.260	0.41 0.025	Upstream and downstream sites not connected. No visible flow. Weather fine.	No
SW11	26/07/2020	Wet	TP = 0.05 mg/L Nitrate = 0.330 mg/L	0.03 0.075	0.04 0.070	Upstream and downstream sites connected. Visible flow. Raining.	Yes

Site	Date	Wet or Dry Event	Results of Interest	U/S Results	P20 / P80	Field Notes / Comments	Design 5 Day Rainfall Depth Exceeded?
SW11	05/08/2020	Dry	pH = 7.86 EC = 0.42 mS/cm Turbidity = 80 NTU SS = 68 mg/L TN = 0.90 mg/L Ammonia = 0.036 mg/L Nitrate = 0.330 mg/L	7.61 0.24 61 37 0.80 0.021 0.095	7.80 0.41 70 23 0.80 0.025 0.025	Upstream and downstream sites not connected. No visible flow. Weather fine.	No
SW11	08/08/2020	Wet	SS = 89 mg/L Nitrate = 0.160 mg/L	47 0.069	75 0.070	Upstream and downstream sites not connected. No visible flow, low water level. Weather fine.	No
SW11	15/08/2020	Wet	SS = 76 mg/L Nitrate = 0.100 mg/L	45 0.050	75 0.070	Upstream and downstream sites not connected. No visible flow. Weather fine.	No
SW11	02/09/2020	Dry	EC = 0.44 mS/cm TN = 1.00 mg/L Ammonia = 0.028 mg/L Nitrate = 0.370 mg/L	0.34 0.70 0.003 0.010	0.41 0.80 0.025 0.025	Upstream and downstream sites not connected. No visible flow. Weather partly cloudy.	No
SW11	10/09/2020	Wet	EC = 0.43 mS/cm TP = 0.10 mg/L TN = 1.20 mg/L Phosphate = 0.030 mg/L Ammonia = 0.150 mg/L Nitrate = 0.660 mg/L Nitrite = 0.190 mg/L	0.33 0.08 0.60 0.003 0.027 0.007 0.003	0.35 0.04 1.19 0.015 0.036 0.070 0.025	Upstream and downstream sites not connected. No visible flow. Weather rain.	No
SW11	09/10/2020	Dry	EC = 0.48 mS/cm TP = 0.09 mg/L TN = 1.60 mg/L Phosphate = 0.040 mg/L Ammonia = 0.290 mg/L Nitrate = 0.590 mg/L Nitrite = 0.090 mg/L	0.37 0.03 0.60 0.003 0.013 0.010 0.003	0.41 0.03 0.80 0.015 0.025 0.025 0.025	Upstream and downstream sites not connected. No visible flow. Weather partly cloudy.	No

Site	Date	Wet or Dry Event	Results of Interest	U/S Results	P20 / P80	Field Notes / Comments	Design 5 Day Rainfall Depth Exceeded?
SW11	13/10/2020	Wet	EC = 0.49 mS/cm TP = 0.09 mg/L TN = 1.40 mg/L Phosphate = 0.020 mg/L Nitrate = 0.530 mg/L Nitrite = 0.063 mg/L	0.37 0.03 0.70 0.003 0.006 0.003	0.35 0.04 1.19 0.015 0.070 0.025	Upstream and downstream sites not connected. No visible flow. Weather fine.	No
SW11	20/10/2020	Wet	EC = 0.53 mS/cm TP = 0.08 mg/L Ammonia = 0.190 mg/L Nitrate = 0.150 mg/L Nitrite = 0.027 mg/L	0.37 0.03 0.018 0.003 0.003	0.35 0.04 0.036 0.070 0.025	Upstream and downstream sites not connected. No visible flow. Weather fine.	No
SW11	18/11/2020	Dry	pH = 8.26 EC = 0.84 mS/cm Ammonia = 0.120 mg/L Nitrate = 0.083 mg/L	8.02 0.41 0.013 0.003	7.80 0.41 0.025 0.025	Upstream and downstream sites not connected. No visible flow. Weather partly cloudy.	No
SW11	02/12/2020	Dry	pH = 8.98 EC = 0.85 mS/cm Ammonia = 0.110 mg/L	8.14 0.43 0.024	7.80 0.41 0.025	Upstream and downstream sites not connected. No visible flow. Weather partly cloudy.	No
SW11	06/12/2020	Wet	EC = 0.60 mS/cm Turbidity = 136 NTU SS = 94 mg/L Ammonia = 0.150 mg/L Nitrate = 0.580 mg/L Nitrite = 0.060 mg/L	0.42 35 22 0.071 0.003 0.003	0.35 131 75 0.036 0.070 0.025	Upstream and downstream sites not connected. No visible flow. Weather overcast.	No
SW11	07/12/2020	Wet	Turbidity = 175 NTU SS = 155 mg/L TP = 0.10 mg/L TN = 2.60 mg/L Ammonia = 0.093 mg/L Nitrate = 0.170 mg/L	42 20 0.03 0.60 0.059 0.003	131 75 0.04 1.19 0.036 0.070	Upstream and downstream sites not connected. No visible flow. Weather overcast.	No
SW11	08/01/2021	Wet	Nitrate = 0.080 mg/L	0.06	0.070	Upstream and downstream sites not connected. No visible flow. Weather overcast.	Yes

Site	Date	Wet or Dry Event	Results of Interest	U/S Results	P20 / P80	Field Notes / Comments	Design 5 Day Rainfall Depth Exceeded?
SW11	15/01/2021	Dry	TP = 0.06 mg/L TN = 1.40 mg/L Ammonia = 0.077 mg/L Nitrate = 0.040 mg/L	0.05 1.30 0.050 0.008	0.03 0.80 0.025 0.025	Upstream and downstream sites not connected. No visible flow. Weather partly cloudy.	No
SW11	19/01/2021	Wet	EC = 0.37 mS/cm TRH >C10-C16 Fraction = 53 µg/L TRH >C16-C34 Fraction = 160 µg/L	0.29 25 120	0.35 25 50	Upstream and downstream sites not connected. No visible flow. Weather overcast.	No
SW11	01/02/2021	Dry	TP = 0.06 mg/L TN = 1.20 mg/L Ammonia = 0.150 mg/L Nitrate = 0.110 mg/L	0.03 1.10 0.029 0.003	0.03 0.80 0.025 0.025	Upstream and downstream sites not connected. No visible flow. Weather partly cloudy.	No
SW11	14/02/2021	Wet	EC = 0.49 mS/cm TP = 0.05 mg/L Ammonia = 0.270 mg/L	0.43 0.03 0.003	0.35 0.04 0.036	Upstream and downstream sites not connected.	No



Appendix B

Surface Water Quality: Data

(Note: Italicised values in the following tables are below the practical quantification limit and have been halved to enable the calculation of statistics)

Monitoring Location	Field Notes	Date	pH (field)	Temperature (field)	Electrical Conductivity (field)	Dissolved Oxygen (field)	Turbidity (field)	Oil & Grease	Suspended Solids	Total Phosphorus	Total Nitrogen	Phosphate	Ammonia	Nitrate	Nitrite	TRH >C10-C16 Fraction	TRH >C16-C34 Fraction	TRH >C34-C40 Fraction	Aluminum	Arsenic	Cadmium	Calcium	Chromium	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Selenium	Silver	Zinc	
			pH unit	°C	mS/cm	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		
Wells Crossing D/S	pH (0.57) above P80. All other results compliant	3/08/2016	6.87	21.3	0.02	5.20	22		8	0.02	0.47	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	pH (1.03) and TN (0.02) above background. NTU and TSS above P80, results however, have been affected by upstream influences outside of the project. All other results compliant	4/08/2016	7.33	16.0	0.06	5.10	27		8	0.02	0.96	0.015	0.050	0.025	0.025																			
Wells Crossing D/S	pH (0.45) slightly above background but similar to upstream. All other results compliant	1/11/2016	6.85	24.1	0.19	4.00	8		5	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	pH (0.51) slightly above background but similar to upstream. All other results compliant	9/11/2016	6.81	24.3	0.20	3.10	23		8	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	All results compliant	3/12/2016	7.14	23.2	0.23	3.90	7		3	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	pH (0.99) above P80 with SD but similar to U/S results. All other results compliant.	3/01/2017	7.29	24.8	0.32	3.10	8		5	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	pH (1.15) above P80 SD but similar to U/S reading. All other results compliant	6/01/2017	7.45	22.5	0.41	4.10	8		5	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	pH (0.76) above P80 SD but similar to U/S all other results compliant	9/02/17	7.33	24.4	0.38	3.60	6		5	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	pH (0.97) above background but similar to up stream result. All other results compliant	15/02/2017	7.27	23.5	0.38	4.00	4		4	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	pH (0.56) TSS (6.4) and NTU (16.9) above P80 SD but within EPL guidelines. All other results compliant	1/03/2017	6.86	24.5	0.38	3.60	65		27	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	pH (0.09) and EC (0.214) above P80. All other results compliant	13/03/2017	6.39	23.4	0.61	3.20	12		6	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	pH (0.29) marginally above P80 SD. All other results compliant	27/04/2017	6.59	20.6	0.19	3.80	17		20	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	pH 0.53 above P80 all other results compliant	14/05/2017	6.63	14.4	0.39	4.80	19		5	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	All results compliant	19/05/2017	6.49	19.3	0.09	3.80	9		1	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	TSS 2.7mg/L above P80 SD all other results compliant	12/06/2017	5.90	21.7	0.04	4.30	32		23	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	All results compliant	17/06/2017	6.62	21.0	0.04	3.90	31		6	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	pH 1.2 above P80, all other results compliant	12/10/2017	7.16	24.0	0.25	4.30	6		5	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	pH 1.2 above P80, all other results compliant	24/10/2017	7.01	24.2	0.22	2.60	20		5	N/A	N/A	N/A	N/A	N/A	N/A																			
Wells Crossing D/S	pH 1.2 above P80, all other results compliant	7/11/2017	7.22	16.8	0.19	3.10	28		5	N/A	N/A	N/A	N/A	N/A	N/A																			
SW10 (Wells Crossing)	Upstream and downstream sites connected. High flow, high water level. Overcast.	2/01/2018	6.19	25.5	0.16	2.88	176	1	63	0.02	1.03																							
SW10 (Wells Crossing)	Upstream and downstream sites connected. No visible flow, high water level. Drizzle.	3/02/2018	6.24	21.4	0.28	1.41	25	1	21	0.03	0.98	0.015	0.025	0.025	0.025				0.380	0.009	0.001	17.0	0.002	0.002	4.130	0.005	6.2	0.650	0.0001	0.003	0.001	0.001	0.017	
SW10 (Wells Crossing)	Upstream and downstream sites connected. No visible flow, medium water level. Rain.	6/03/2018	6.72	23.6	0.22	4.60	4	4	15	0.02	0.55																							
SW10 (Wells Crossing)	Upstream and downstream sites connected. No visible flow, low water level. Rain.	24/04/2018	6.95	18.5	0.24	2.70	16	1	12	0.02	0.70	0.015	0.025	0.025	0.025	13	50	50	0.720	0.001	0.001	15.0	0.002	0.002	3.020	0.005	5.4	0.370	0.0001	0.003	0.001	0.001	0.019	
SW10 (Wells Crossing)	Upstream and downstream sites connected. No visible flow, very low water level. Overcast.	7/06/2018	7.30	14.6	0.18	6.29	119	1	45	0.02	0.44	0.015	0.025	0.025	0.025	13	50	50	6.600	0.001	0.001	12.0	0.003	0.002	2.780	0.005	3.6	0.025	0.0001	0.003	0.001	0.001	0.027	
SW10 (Wells Crossing)	Upstream and downstream sites connected. No visible flow, low water level. Overcast.	25/08/2018	7.32	12.5	0.29	6.47	15	1	9	0.02	0.44	0.015	0.025	0.060	0.025	13	50	50	0.250	0.001	0.001	18.0	0.002	0.002	0.240	0.005	5.3	0.014	0.0001	0.003	0.001	0.001	0.062	

Monitoring Location	Field Notes	Date	pH (field)	Temperature (field)	Electrical Conductivity (field)	Dissolved Oxygen (field)	Turbidity (field)	Oil & Grease	Suspended Solids	Total Phosphorus	Total Nitrogen	Phosphate	Ammonia	Nitrate	Nitrite	TRH >C10-C16 Fraction	TRH >C16-C34 Fraction	TRH >C34-C40 Fraction	Aluminum	Arsenic	Cadmium	Calcium	Chromium	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Selenium	Silver	Zinc		
			pH unit	°C	mS/cm	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		
Wells Crossing U/S	Wet type A	3/08/2016	6.84	21.9	0.02	3.60	21		10	0.02	0.29	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Wet type A ands B	4/08/2016	7.33	16.0	0.09	4.40	36		10	0.02	0.94	0.015	0.060	0.025	0.025																				
Wells Crossing U/S	Wet	9/11/2016	6.88	24.3	0.20	3.90	15		7	N/A	N/A	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Wet	3/12/2016	7.03	23.2	0.29	3.80	13		10	N/A	N/A	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Wet event (macrophyte particles in sample)	3/01/2017	7.42	24.3	0.55	3.00	29		16	N/A	N/A	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Wet event	6/01/2017	7.42	23.1	0.40	4.20	15		18	N/A	N/A	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Wet event	9/02/2017	7.16	24.3	0.49	3.10	7		4	N/A	N/A	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Wet event	15/02/2017	7.29	23.9	0.68	7.80	4		3	N/A	N/A	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Wet event	1/03/2017	6.82	24.6	0.57	3.60	4		3	N/A	N/A	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Wet event	13/03/2017	6.39	23.4	0.44	3.20	5		7	N/A	N/A	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Wet event: macrophyte particles in sample	27/04/2017	6.24	20.4	0.34	3.70	39		16	N/A	N/A	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Wet event Macrophyte particles in sample	14/05/2017	6.24	14.2	0.60	5.10	54		11	N/A	N/A	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Wet event	19/05/2017	6.27	20.1	0.27	4.10	102		130	N/A	N/A	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Wet event Macrophyte particles in sample	12/06/2017	6.03	21.4	0.03	4.10	27		5	N/A	N/A	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Wet event	17/06/2017	6.87	20.9	0.04	3.70	25		7	N/A	N/A	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Dry	12/10/2017								N/A	N/A	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Wet event	24/10/2017	7.31	24.1	0.18	2.50	17		3	N/A	N/A	N/A	N/A	N/A	N/A																				
Wells Crossing U/S	Wet event	7/11/2017	7.01	17.2	0.19	3.40	9		5	N/A	N/A	N/A	N/A	N/A	N/A																				
SW10-US	Upstream and downstream sites connected. High flow, high water level. Rain.	2/01/2018	6.12	25.6	0.28	2.16	23	1	17	0.02	1.01																								
SW-10 US	Upstream and downstream sites connected. No visible flow, medium water level. Drizzle.	3/02/2018	6.90	21.3	0.32	3.19	67	1	22	0.02	1.04	0.015	0.025	0.025	0.025				1.200	0.009	0.001	15.0	0.002	0.002	3.910	0.005	6.8	0.200	0.0001	0.003	0.001	0.001	0.001	0.006	
SW10-US	Upstream and downstream sites connected. No visible flow, low water level. Rain.	6/03/2018	7.07	23.6	0.25	4.50	15	4	14	0.03	0.75																								
SW10-US	Upstream and downstream sites connected. No visible flow, low water level. Rain.	24/04/2018	7.76	18.4	0.24	3.87	35	1	23	0.04	1.13	0.015	0.025	0.025	0.025	13	50	50	4.300	0.001	0.001	10.0	0.003	0.002	4.120	0.005	5.2	0.110	0.0001	0.003	0.001	0.001	0.001	0.063	
SW10-US	Upstream and downstream sites connected. No visible flow, very low water level. Weather fine.	7/06/2018	6.98	16.0	0.22	5.66	41	1	11	0.02	0.63	0.015	0.025	0.025	0.025	13	50	50	2.800	0.001	0.001	12.0	0.002	0.002	1.110	0.005	4.8	0.021	0.0001	0.003	0.001	0.001	0.001	0.069	
SW10-US	Upstream and downstream sites connected. No visible flow, very low water level. Overcast.	25/08/2018	7.69	13.5	0.29	6.52	39	1	19	0.02	0.50	0.015	0.025	0.080	0.025	13	50	50	0.570	0.001	0.001	22.0	0.002	0.002	0.230	0.005	5.4	0.020	0.0001	0.003	0.001	0.001	0.001	0.062	
SW10-US	Upstream and downstream sites connected. No visible flow, low water level. Drizzle.	4/09/2018	7.67	14.3	0.33	6.64	18	1	10	0.02	0.56	0.015	0.025	0.025	0.025	13	50	50	1.100	0.001	0.001	17.0	0.002	0.002	1.050	0.005	6.1	0.071	0.0001	0.003	0.001	0.001	0.001	0.065	
SW10-US	Upstream and downstream sites connected. No visible flow, low water level. Rain.	5/10/2018	7.29	17.6	0.28	6.93	46	1	14	0.02	0.48																								
SW10-US	Upstream and downstream sites connected. No visible flow, low water level. Overcast.	8/11/2018	7.12	22.2	0.36	2.59	12	1	6	0.02	0.70	0.015	0.025	0.025	0.025	13	50	50	0.310	0.001	0.001	27.0	0.002	0.002	1.430	0.005	8.9	0.140	0.0001	0.003	0.001	0.001	0.001	0.009	

Monitoring Location	Field Notes	Date	pH (field)	Temperature (field)	Electrical Conductivity (field)	Dissolved Oxygen (field)	Turbidity (field)	Oil & Grease	Suspended Solids	Total Phosphorus	Total Nitrogen	Phosphate	Ammonia	Nitrate	Nitrite	TRH > C16-C16 Fraction	TRH > C16-C34 Fraction	TRH > C34-C40 Fraction	Aluminium	Arsenic	Cadmium	Calcium	Chromium	Copper	Iron	Lead	Magnesium	Manganese	Mercury	Nickel	Selenium	Silver	Zinc	
			pH unit	°C	mS/cm	mg/L	NTU	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	µg/L	µg/L	µg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
Glenugie Ck D/S	All results compliant	1/11/2016	7.33	23.7	0.32	3.00	4		3	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	Standing water no flow	9/11/2016	7.36	24.2	0.20	3.30	4		2	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	EC marginally above P80 (0.071) all other results compliant	3/12/2016	7.27	23.2	0.31	3.50	5		5	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	All results compliant	3/01/2017	7.44	23.9	0.21	2.80	10		5	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	pH marginally (0.19) above P80 SD but similar to U/S reading. All other results compliant	6/01/2017	7.59	22.9	0.13	3.40	34		27	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	All results compliant	9/02/17	7.41	24.6	0.17	3.10	4		5	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	All results compliant	15/02/2017	7.41	23.5	0.27	3.50	4		4	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	All results compliant	1/03/2017	7.17	24.6	0.09	3.20	41		18	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	pH (0.25) and EC (0.022) below P80. All other results compliant	13/03/2017	6.75	23.4	0.26	4.40	42		15	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	EC (0.143) above background. All other results compliant.	27/04/2017	6.87	21.1	0.38	3.80	25		8	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	EC (0.163) and DO (0.9) marginally above P80. All other results compliant	14/05/2017	6.97	14.4	0.40	4.20	14		5	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	All results compliant	19/05/2017	6.95	20.1	0.10	5.40	76		20	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	pH (0.5) below P80 SD. All other results compliant	12/06/2017	6.10	20.5	0.06	4.50	129		84	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	NTU (541.6) above P80 SD but less than upstream result. All results compliant. High TSS and turbidity results not associated with HC2G construction activities. Only area of construction within Glenugie Creek catchment is small area north of Franklins Road, which has completed concrete pavement and topsoiling/revegetation of batters. Result associated with State Forest area outside construction footprint. EPA Forestry section is investigating further following discussion at June 2017 ERG meeting.	17/06/2017	6.69	21.4	0.15	4.40	685		396	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	EC D/S > U/S, all other results compliant	12/10/2017	7.16	23.7	0.24	3.70	27		10	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	All results compliant	24/10/2017	7.14	23.7	0.21	3.60	79		12	N/A	N/A	N/A	N/A	N/A	N/A																			
Glenugie Ck D/S	pH 0.5 above P80, all other results compliant	7/11/2017	7.45	17.2	0.18	3.90	101		34	N/A	N/A	N/A	N/A	N/A	N/A																			
SW11-DS	Upstream and downstream sites connected. High flow, high water level. Overcast. Turbidity exceeded maximum range of probe.	2/01/2018	6.16	25.6	0.09	6.24	800	1	360	0.06	1.95																							
SW11 (Glenugie Creek)	Upstream and downstream sites connected. No visible flow, low water level. Drizzle.	3/02/2018	6.74	20.8	0.32	0.73	178	1	184	0.04	1.80	0.015	0.050	0.025	0.025				3.600	0.009	0.001	19.0	0.007	0.002	7.930	0.005	16.0	0.760	0.0001	0.005	0.001	0.001	0.062	
SW11 (Glenugie Creek)	Upstream and downstream sites connected. Very low flow, low water level. Rain.	6/03/2018	6.99	22.6	0.18	3.33	4	4	17	0.09	2.06																							
SW11 (Glenugie Creek)	Upstream and downstream sites connected. Low flow, low water level. Rain.	24/04/2018	7.42	18.5	0.21	5.10	55	1	29	0.04	0.83	0.015	0.025	0.025	0.025	13	50	50	7.000	0.001	0.001	14.0	0.005	0.002	3.980	0.005	9.1	0.140	0.0001	0.003	0.001	0.001	0.120	
SW11 (Glenugie Creek)	Upstream and downstream sites connected. Very low flow, low water level. Overcast.	7/06/2018	7.48	14.9	0.16	7.47	238	1	90	0.04	0.96	0.015	0.025	0.100	0.025	13	50	50	9.300	0.001	0.001	5.6	0.005	0.005	5.540	0.005	4.4	0.044	0.0001	0.003	0.001	0.001	0.068	
SW11 (Glenugie Creek)	Upstream and downstream sites not connected. No visible flow, very low water level. Overcast. Algal bloom in water column.	25/08/2018	7.44	13.3	0.17	5.74	57	1	31	0.04	1.04	0.015	0.110	0.180	0.025	13	50	50	0.310	0.001	0.001	7.5	0.002	0.002	0.300	0.005	5.3	0.022	0.0001	0.003	0.001	0.001	0.036	
SW11 (Glenugie Creek)	Upstream and downstream sites not connected. No visible flow, very low water level. High algae levels. Overcast.	4/09/2018	7.09	13.3	0.20	4.45	19	1	9	0.06	1.14	0.015	0.100	0.210	0.025	13	50	50	2.300	0.001	0.001	11.0	0.002	0.002	1.350	0.005	8.2	0.068	0.0001	0.003	0.001	0.001	0.038	



Appendix C

Groundwater Quality: Results of Interest

Groundwater Quality Table of Results of Interest

Site	Date	Results of Interest	P20 / P80
GWB31	23/12/2020	TDS = 1760 mg/L Sodium = 492 mg/L Calcium = 46.0 mg/L Magnesium = 13.0 mg/L Chloride = 638 mg/L	1490 418 36.0 11.0 428



Appendix D

Groundwater Quality: Data

(Note: Italicised values in the following tables are below the practical quantification limit and have been halved to enable the calculation of statistics)

			Physical and chemical properties						Hydrocarbons			Nutrients		Major Cations				Major Anions			Heavy Metals (Dissolved)					
Monitoring Location	Field Notes	Date	pH	Temperature	EC	DO	Turbidity	TDS	TRH C10-C16 Fraction	TRH C16-C34 Fraction	TRH C34-C40 Fraction	Total Nitrogen	Total Phosphorus	Sodium	Potassium	Calcium	Magnesium	Chloride	Sulfate	Bicarbonate (Alkalinity)	Aluminium	Cadmium	Copper	Lead	Zinc	
			pH unit	°C	mS/cm	mg/L	NTU	mg/L	µg/L	µg/L	µg/L	mg/L N	mg/L P	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L SO42	mg/L CaCO3 equiv	mg/L	mg/L	mg/L	mg/L	mg/L	
Downgradient Baseline (pre-construction) Monitoring (identifier from pre-construction)																										
GW31		9/04/2014	6.96	21.51	1.48	3.40	131		25	50	50															
Upgradient (construction) Monitoring																										
GWB30		11/09/2015	7.90	19.30	1.89	5.80	240	1070				0.7	0.2	383	2.3	34.8	7.5	319	16	368	0.060	0.0005	0.011	0.001	0.003	
GWB30		16/12/2015	9.10	23.50	1.89	2.88	479	1083				0.6	0.1	418	2.0	34.0	8.0	375	17	380	0.020	0.0005	0.013	0.001	0.005	
GWB30		20/05/2016	7.09	21.76	2.22	9.02	800	1240				1.0	0.3	442	2.0	48.0	9.0	403	16	450	0.011	0.0005	0.010	0.001	0.004	
GWB30		18/08/2016	8.10	21.20	0.39	8.77	193	470				1.0	0.4	83	3.0	15.0	3.0	94	5	85	0.512	0.0005	0.024	0.001	0.020	
GWB30		13/12/2016	7.20	22.80	1.36	8.33	0	1120				0.9	0.6	282	2.0	22.0	4.0	245	9	290	0.087	0.0005	0.004	0.001	0.002	
GWB30		29/03/2017	6.36	23.20	0.28	3.09	353	183	50	50	50	1.3	0.1	46	1.4	5.8	2.0	46	13	42	0.780	0.0010	0.010	0.005	0.011	
GWB30	Turbidity exceeded maximum measuring range of probe.	23/06/2017	7.21	20.24	0.64	0.46	800	401	13	50	50	1.6	0.1	106	1.7	10.3	3.5	103	16	147	0.110	0.0010	0.007	0.005	0.002	
GWB30	Turbidity exceeded maximum measuring range of probe.	12/09/2017	7.70	21.55	0.92	2.04	800	535	13	50	50	1.2	0.0	169	2.6	14.3	4.7	135	19	215	0.028	0.0010	0.036	0.005	0.002	
GWB30	Turbidity exceeded maximum measuring range of probe.	18/12/2017	7.30	23.73	0.98	0.11	800	625	13	50	50	2.0	0.1	200	8.4	25.0	9.1	153	18	224	0.046	0.0010	0.002	0.005	0.002	
GWB30	Turbidity exceeded maximum measuring range of probe.	29/03/2018	7.22	24.71	0.99	0.00	800	655	13	50	50	2.8	0.1	187	1.8	15.0	4.7	142	16	255	0.048	0.0010	0.004	0.005	0.002	
GWB30		21/06/2018	7.92	21.20	1.18	2.05	351	772	13	50	50	1.4	0.1	235	3.2	20.0	6.1	190	17	288	0.013	0.0010	0.031	0.005	0.002	
GWB30		18/09/2018	8.68	22.77	1.21	1.91	205	747	13	50	50	0.7	0.1	233	2.2	17.0	5.2	193	16	313	0.005	0.0010	0.038	0.005	0.002	
GWB30		21/12/2018	8.72	28.17	0.98	1.50	256	702	13	50	50	1.4	0.1	209	3.5	16.0	4.9	168	17	281	0.017	0.0010	0.110	0.005	0.010	
GWB30		28/03/2019	9.21	21.51	1.34	1.97	496	838	13	50	50	2.7	0.1	251	4.9	18.0	6.2	276	18	301	0.005	0.0010	0.027	0.005	0.002	
GWB30		4/09/2019	7.67	24.39	2.07	0.28	349	1320	13	50	50	1.3	0.1	391	18.0	29.0	9.0	428	14	430	0.010	0.0010	0.016	0.005	0.004	
GWB30		7/12/2019	7.52	24.15	2.59	0.00	186	1490	13	50	50	0.9	0.1	460	7.2	36.0	14.0	537	18	431	0.005	0.0010	0.013	0.005	0.024	
GWB30		6/04/2020	7.50	25.11	2.29	1.07	819	1550	13	50	50	2.5	0.2	418	7.3	35.0	11.0	92	49	424	0.005	0.0010	0.002	0.005	0.023	
GWB30		24/06/2020	6.98	19.99	2.39	1.17	393	1540	210	620	50	2.5	0.2	411	10.0	35.0	11.0	502	15	421	0.017	0.0010	0.002	0.005	0.009	
GWB30		23/09/2020	7.31	22.71	2.53	1.25	599	1700	13	50	50	1.3	0.5	457	8.3	42.0	14.0	587	19	444	0.014	0.0010	0.005	0.005	0.017	
GWB30	Turbidity exceeded maximum range of probe.	23/12/2020	8.26	22.45	2.70	17.06	>1000	961	13	50	50	5.0	1.2	185	6.6	80.0	36.0	96	49	680	0.005	0.0010	0.024	0.005	0.061	



Appendix E

Groundwater Levels: Results of Interest

WC2G Groundwater Levels Table of Results of Interest

<i>Bore</i>	<i>P80 Level Difference</i>	<i>Results of Interest</i>
GWB29	3.35 m	18/07/19 - 9/11/20 (approx. 1.3 years) (max. level difference approx. 5.3 m) ¹ 12/12/20 - 2/01/21 (approx. 1 month) (max. level difference approx. 4.4 m)

Notes:

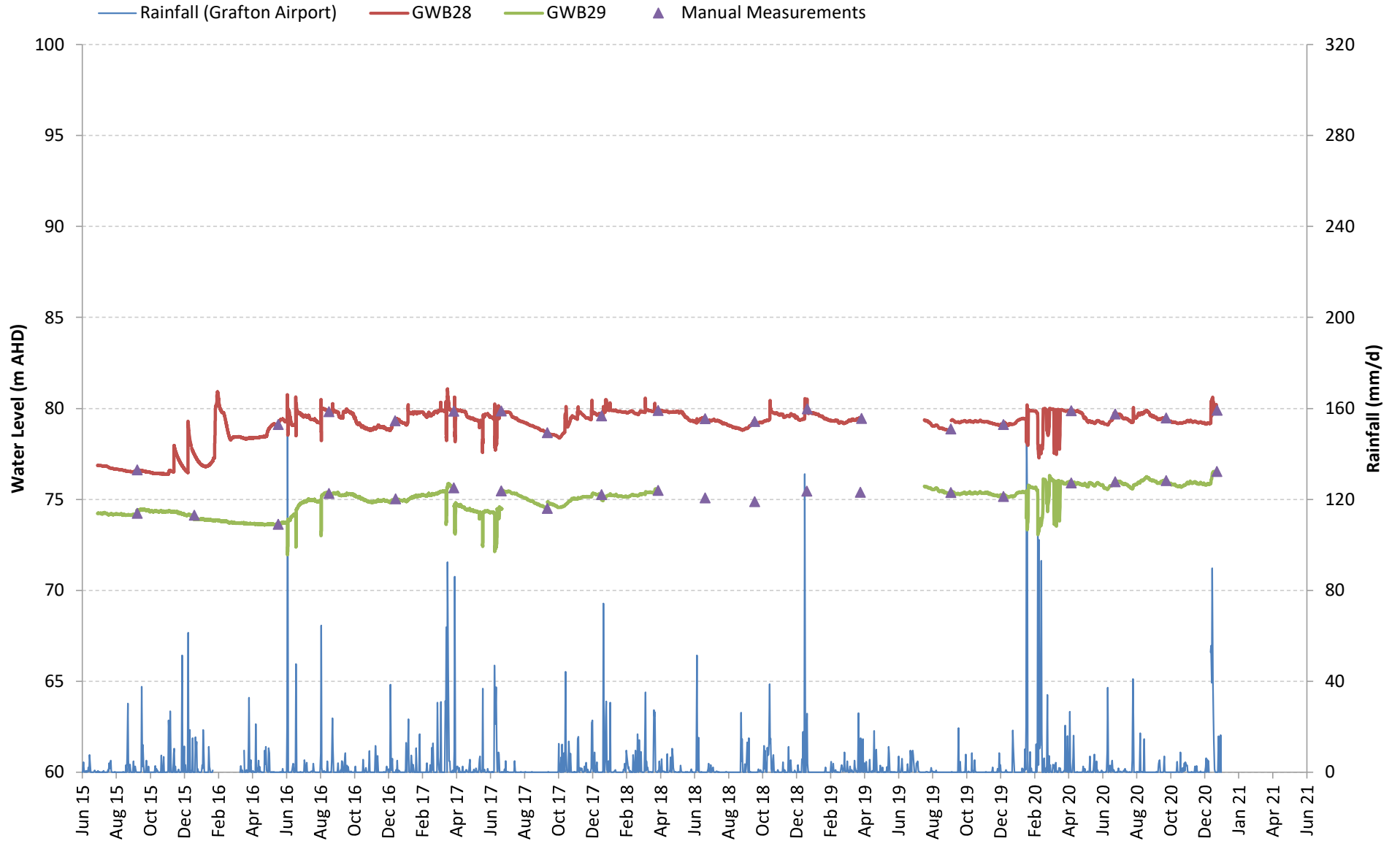
1 - Part of the period of exceedence falls within a previous reporting period and has previously been reported



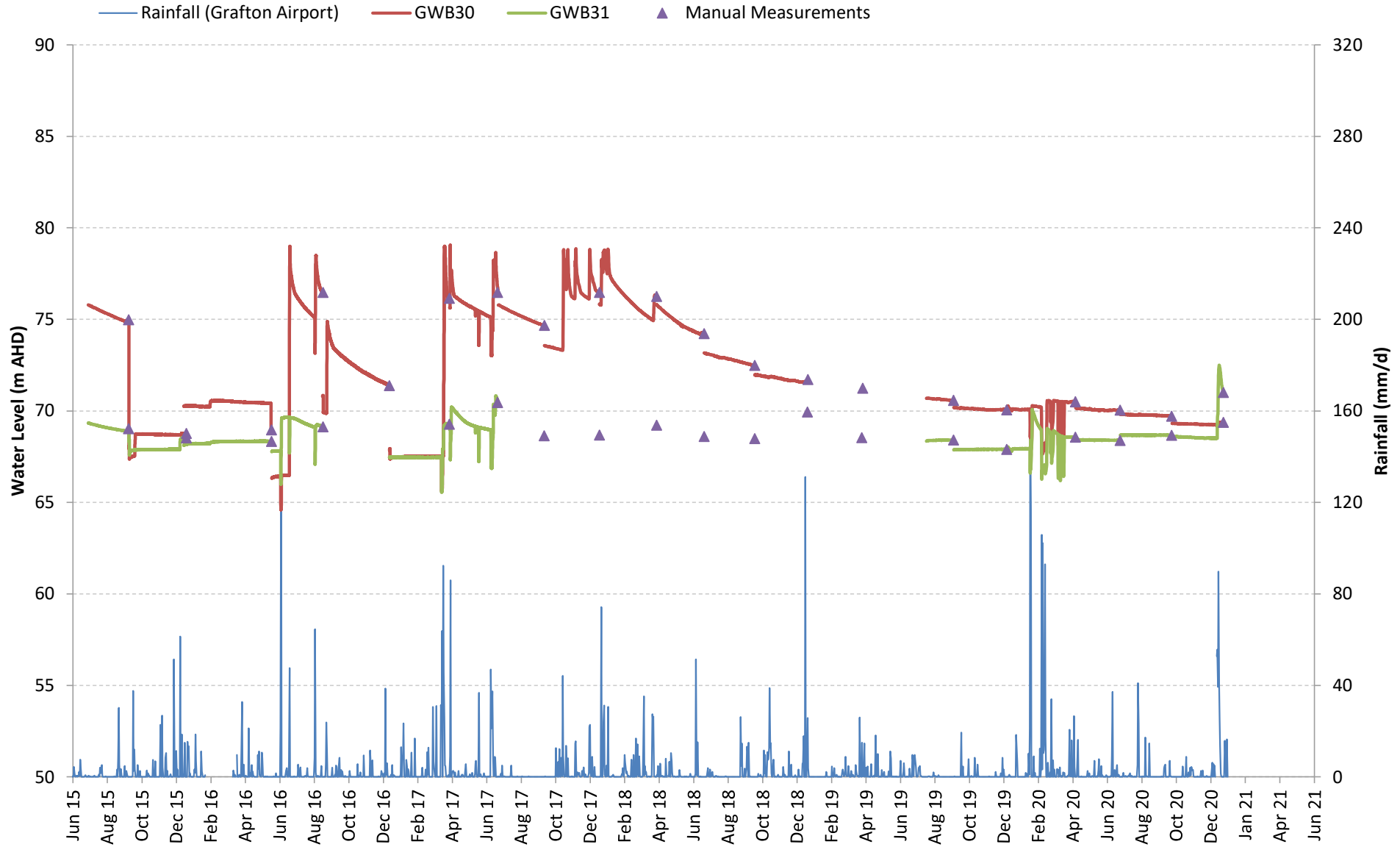
Appendix F

Groundwater Levels: Charts

GWB28 & GWB29 Water Levels



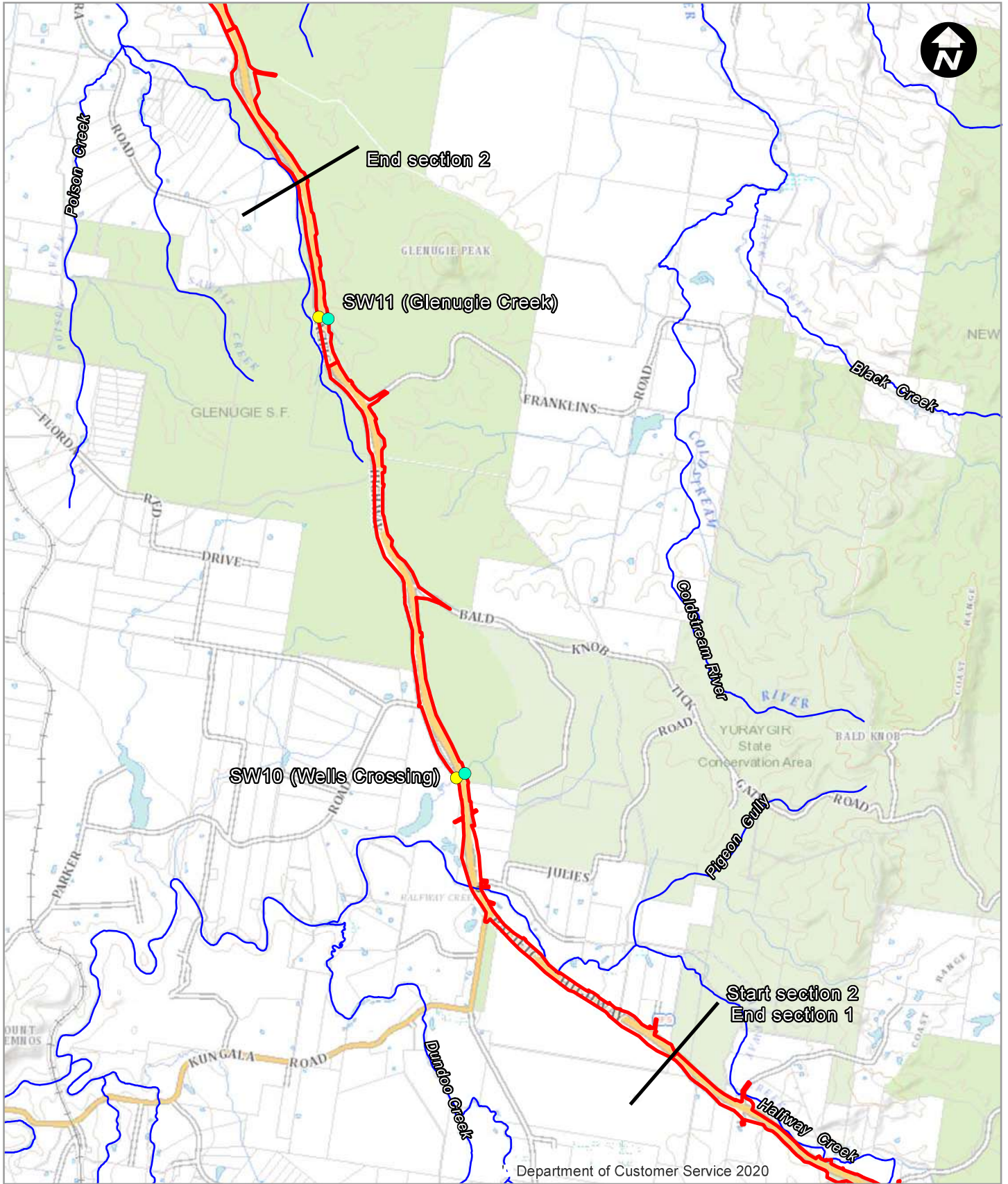
GWB30 & GWB31 Water Levels





Appendix G

Maps of Water Monitoring Sites



Department of Customer Service 2020

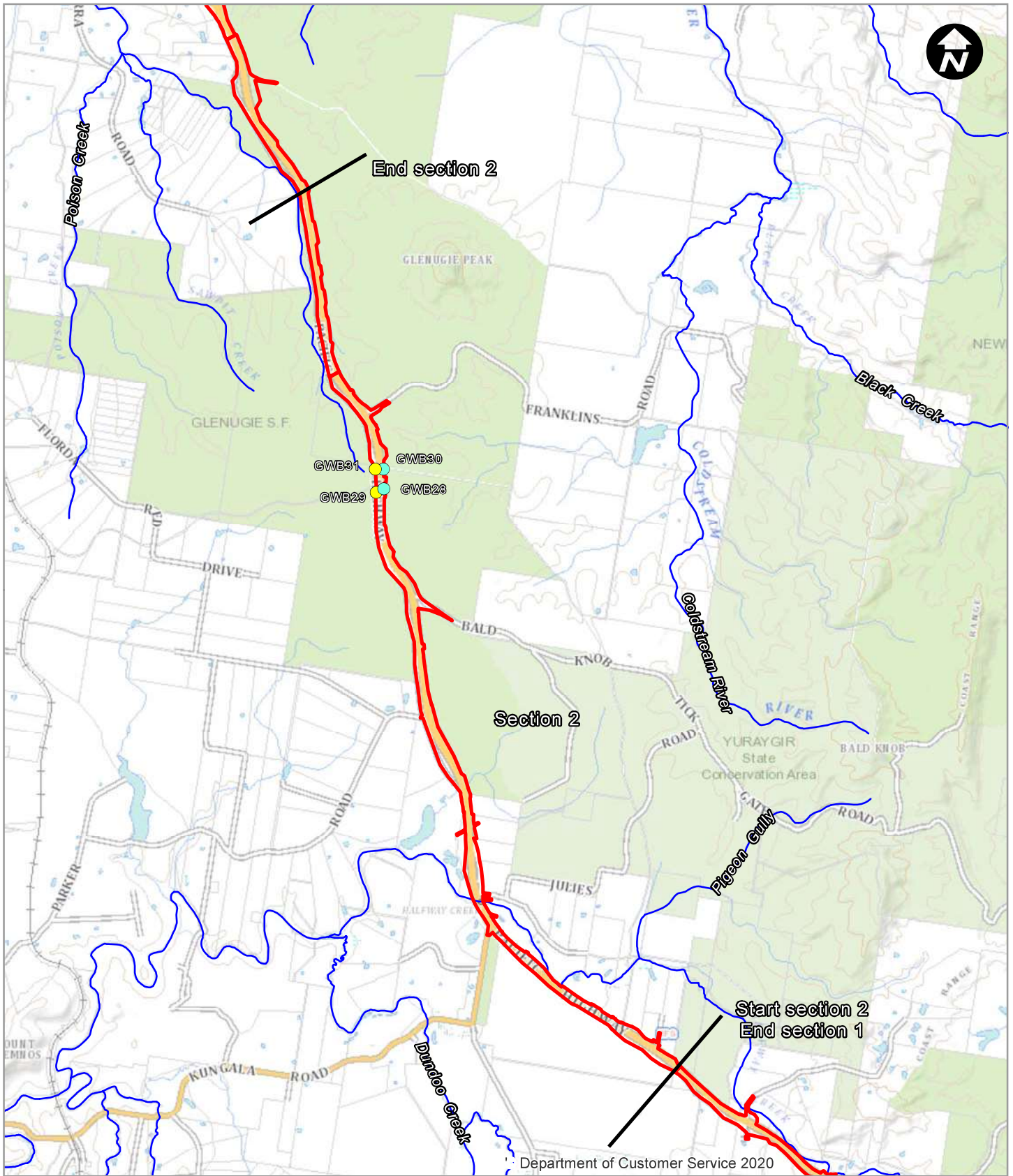
GDA 1994 MGA Zone 56

LEGEND

- Project boundary V12
- Waterway
- Downstream surface water monitoring site
- Upstream surface water monitoring site



Wells Crossing to Glenugie Surface Water Monitoring Sites



Department of Customer Service 2020

GDA 1994 MGA Zone 56

LEGEND

- Project boundary V12
- Waterway
- Groundwater bore - up-gradient
- Groundwater bore - down-gradient



Wells Crossing to Glenugie Groundwater Bore Monitoring Sites