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SYDNEY METRO - WESTERN SYDNEY AIRPORT
STATION BOXES AND TUNNELLING WORKS

Biannual Groundwater Monitoring Report

December 2023 to June 2024

Sydney Metro Western Sydney Airport Station Boxes and Tunnelling Works

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A.01	First draft issue for review by CPBG
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Definitions and Abbreviations

Acronym/ Abbreviation	Definition
ANZG (2018)	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2018)
BTEXN	Benzene, Toluene, Ethylbenzene, Xylene
CoC	Chain of Custody
CPBG	CPB Contractors Gella Joint Venture
DQO	Data Quality Objective
EC	Electrical conductivity
EIS	Sydney Metro Western Sydney Airport – Environmental Impact Statement
EPA	NSW Environment Protection Authority
EPL	Environment Protection Licence
GDEs	Groundwater Dependent Ecosystems
GMP	Groundwater Monitoring Program
GWQ	Groundwater Quality
HHERA	Human Health and Ecological Risk Assessment
LOR	Limit of Reporting
mAHD	Elevation in metres with respect to the Australian Height Datum
mBGL	Metres Below Ground Level
mBTOC	Metres Below Top of Casing
NATA	National Association of Testing Authorities
PAH	Polycyclic Aromatic Hydrocarbons
PCE	Tetrachloroethene
PFAS	Per- and Polyfluoroalkyl Substances
PFOA	Perfluorooctanoic Acid
PFOS	Perfluorooctane-Sulfonic Acid
PLM	ParkLife Metro (SSTOM D&C)
QA	Quality assurance
QC	Quality control
RPD	Relative Percent Difference
SBT Works	Station Box and Tunnelling Works-
SF	Service Facility
SSTOM	Station System Trains Operations and Maintenance
SVOC	Semi-Volatile Organic Compounds

Acronym/ Abbreviation	Definition
TBM	Tunnel boring machine
TCE	Trichloroethene
TDS	Total Dissolved Solids
TfNSW	Transport for NSW
TOC	Total Organic Carbon
TRH	Total Recoverable Hydrocarbons
Tetra Tech	Tetra Tech Major Projects Pty Ltd
µS/cm	Micro-Siemens per centimetre
VOC	Volatile Organic Compounds
VWP	Vibrating Wire Piezometers
WSA	Western Sydney Airport
WSI	Western Sydney International

1 Introduction

Sydney Metro has engaged CPB Ghella Joint Venture (CPBG) for the design and construction of Station Boxes and Tunnelling Works (SBT Works) for the Western Sydney Airport (WSA) project (the Project). The Project forms part of the broader Sydney Metro network and involves the construction and operation of a new 23 km metro rail line from the existing Sydney Trains suburban T1 Western Line (at St Marys) in the north and the Aerotropolis (at Bringelly) in the south. The alignment includes tunnels and civil structures, including a viaduct, bridges, and surface and open-cut troughs between the two tunnel sections (Figure 1-1 below).

This Biannual Groundwater Monitoring Report has been prepared by Tetra Tech Major Projects Pty Ltd (Tetra Tech) on behalf of CPBG to report on the second round of groundwater monitoring and compare it to results from the initial monitoring event undertaken in 2023 (Document Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040410) and to baseline groundwater conditions as well as the adopted performance criteria, as outlined in the Groundwater Monitoring Plan (Document Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT040404, Rev 4).

This report summarises the groundwater level and groundwater quality monitoring undertaken as detailed in the Groundwater Monitoring Plan (GMP) for the second biannual reporting period. The report includes groundwater level and monitoring data collected between 1st December 2023 and 28th June 2024. Groundwater level and quality data is compared to results from the previous (initial) monitoring period and trigger levels as outlined in the GMP.

1.1 Project background and location

The Project is being delivered through several work packages, with SBT works package including the design and construction of:

- Northern Tunnels (between Orchard Hills and St Marys)
- Southern Tunnels (between Western Sydney International (WSI) and the new Aerotropolis station)

As well as excavation works including:

- Four station boxes with temporary ground support at St Mary's, Orchard Hills, Airport Terminal and Aerotropolis
- Two intermediate service facilities, one for each tunnel sections at Claremont and Bringelly
- Turn back excavations and stub tunnels for future extensions to the network

An overview of SBT works, including the tunnels and excavation areas, is shown in Figure 1-1.

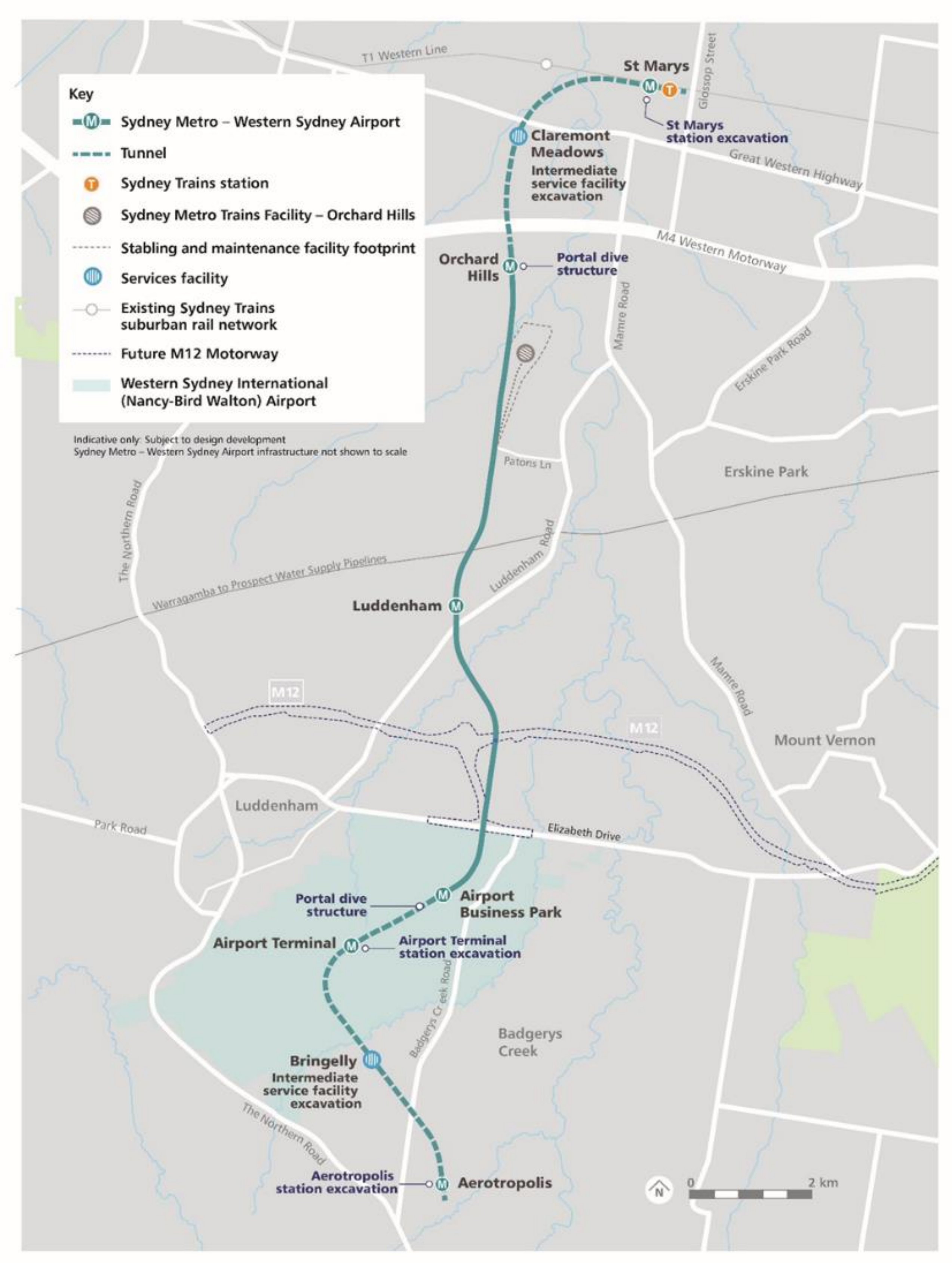

Figure 1-1: Overview of SBT works

1.2 Construction status

A summary of the construction status and works completed, as provided by CPBG, is provided in Table 1-1 for excavations and Table 1-2 for cross passages. Tables also identify areas that have been handed over by CPBG to the SSTOM contractor (PLM) who are now responsible for groundwater management in those areas. Work area Portions discussed in the additional information section of Table 1-1 are shown in Figure 1-2 to Figure 1-7.

TBM progress is shown on Figure 1-8.

Table 1-1: Construction status - Excavations

Excvation	Start	Finish	Additional Information
St Marys Station Box Excavation	13-Jan-23	7-Sep-2023 Station Box handed over to PLM (SSTOM) 15 November 2023	Remaining SBT activities TBM RETRIEVAL -TBM 1 Breakthrough 16 May 2024 -TBM 2 Breakthrough 20 June 2024 Handover of TBM Breakthrough Support Site to PLM -16 August 2024
Claremont Meadows shaft Excavation	16-Dec-22	12-Sep-23	Site handover to PLM (forecast date) - 10 Nov 2024
Orchard Hills Station Box Excavation	13-Jan-23	17-Jul-23	Portion N4 – (forecast date) to be handed over 10 November 2024 Portion N5 – Handed over -10 October 2023 Portion N7 – Handed over -17 July 2023
Airport Business Park Station Box Excavation	13-Sep-22	24-Apr-23	Handed over 4 April 2024
Airport Terminal Station box excavation	13-Feb-23	21-Nov-23	Portion S3 - Handed over 14 Dec 2023 Portion S4 – (forecast date) to be handed over 7 November 2024
Airport Terminal Temporary Shaft Excavation	17-Apr-23	24-Aug-23	Not yet handed over to PLM.
Bringelly Shaft Excavation	22-Dec-22	5-Sep-23	Handover (forecast date): 8 December 2024
Aerotropolis Station Box Excavation	16-Feb-23	22-Sep-23 Station Box Handed over to PLM (SSTOM) 11 October 2023	Remaining SBT activities TBM RETRIEVAL - TBM 3 Breakthrough – 29 May 2024 - TBM 4 Breakthrough – 7June 2024 Handover of TBM Breakthrough Support Site to PLM - 28 August 2024

Table 1-2: Cross Passages (XP)

Cross Passage	Start	Finish	Additional Information
Northern Tunnel			
XP N2	29/05/2024	14/09/2024	
XP N3	11/05/2024	11/09/2024	
XP N4	29/05/2024	2/09/2024	
XP N5	29/05/2024	26/08/2024	
XP N6 (Sump)	11/05/2024	9/08/2024	
XP N7	06/07/2024	18/07/2024	Yet to commence construction
XP N8	22/05/2024	05/07/2024	
XP N9	17/05/2024	28/05/2024	
XP N10	25/04/2024	15/06/2024	
XP N11	03/05/2024	07/06/2024	
XP N12	*Claremont Meadows Service Facility*		
XP N13	08/04/2024	10/06/2024	Excavation start date 08 April 2024. Excavation completed date 10 June 2024. Waterproofing and Invert Reo completed 10 June 2024.
XP N14	24/03/2024	19/06/2024	Excavation start date 24 March 2024. Excavation completed date 05 May 2024. Waterproofing, Invert Reo, Arch Reo completed 6 June 2024. Framework Set Up forecast completed date 19 June 2024.
XP N15	18/03/2024	04/06/2024	Excavation start date 18 March 2024. Excavation completed date 02 May 2024. Waterproofing, Invert Reo, Arch Reo and Framework Set Up completed 04 June 2024.
XP N16	21/12/2023	07/06/2024	Excavation start date 21 December 2023. Excavation completed date 18 May 2024. Waterproofing, Invert Reo, Arch Reo and Framework Set Up completed 07 May 2024.
XP N17	04/03/2024	25/05/2024	Excavation start date 04 March 2024. Excavation completed date 17 April 2024. Waterproofing, Invert Reo, Arch Reo and Framework Set Up completed 25 May 2024
XP N18	01/02/2024	13/05/2024	Excavation start date 01 February 2024. Excavation completed date 21 March 2024. Waterproofing, Invert Reo, Arch Reo and Framework Set Up completed 13 May 2024
XP N19	19/01/2024	23/04/2024	Excavation start date 19 January 2024. Excavation completed date 21 March 2024. Waterproofing, Invert Reo, Arch Reo and Framework Set Up completed 13 May 2024
XP N20	04/11/2023	05/03/2024	Excavation start date 04 November 2023. Excavation completed date 04 January 2024. Waterproofing, Invert Reo, Arch Reo and Framework Set Up completed 05 March 2024.

Cross Passage	Start	Finish	Additional Information
XP N21	06/12/2023	19/03/2024	Excavation start date 16 December 2023. Excavation completed date 25 January 2024. Waterproofing, Invert Reo, Arch Reo and Framework Set Up completed 19 March 2024.
Southern Tunnel			
XP S2	20/07/2023	03/08/2023	Construction complete
XP S3	25/07/2023	1/12/2023	Construction complete
XP S4	21/08/2023	6/2/2024	
XP S5	22/08/2023	6/02/2024	
XP S6	4/09/2023	21/02/2024	
XP S7	*Airport Terminal Shaft*		
XP S8	29/05/2024	13/06/2024	Program completed 16 June 2024.
XP S9	15/05/2024	21/06/2024	Program completed 21 June 2024.
XP S10	08/05/2024	07/07/2024	
XP S11	06/05/2024	17/07/2024	
XP S12	29/04/2024	25/07/2024	
XP S13	11/05/2024	02/08/2024	
XP S14	18/04/2024	17/08/2024	
XP S15	03/05/2024	10/08/2024	
XP S16	*Bringelly Service Facility*		
XP S17	30/04/2024	12/08/2024	
XP S18	09/05/2024	23/08/2024	
XP S19	16/05/2024	29/08/2024	
XP S20	24/05/2024	30/08/2024	
XP S21	20/06/2024	03/10/2024	
XP S22	11/06/2024	16/09/2024	
XP S23	29/06/2024	07/10/2024	Yet to commence construction

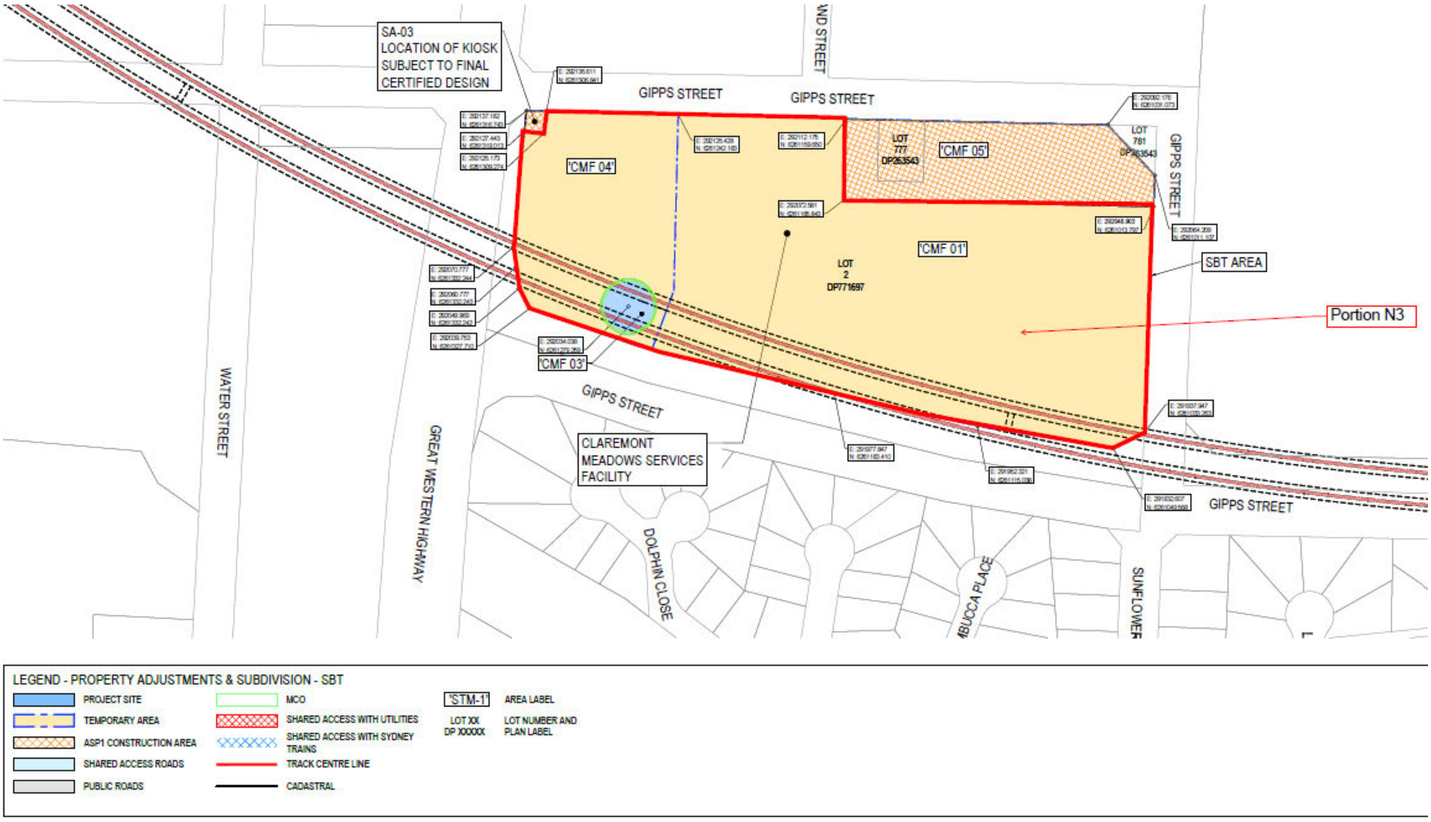

Figure 1-2 Portion N3 Claremont Meadows Facility.

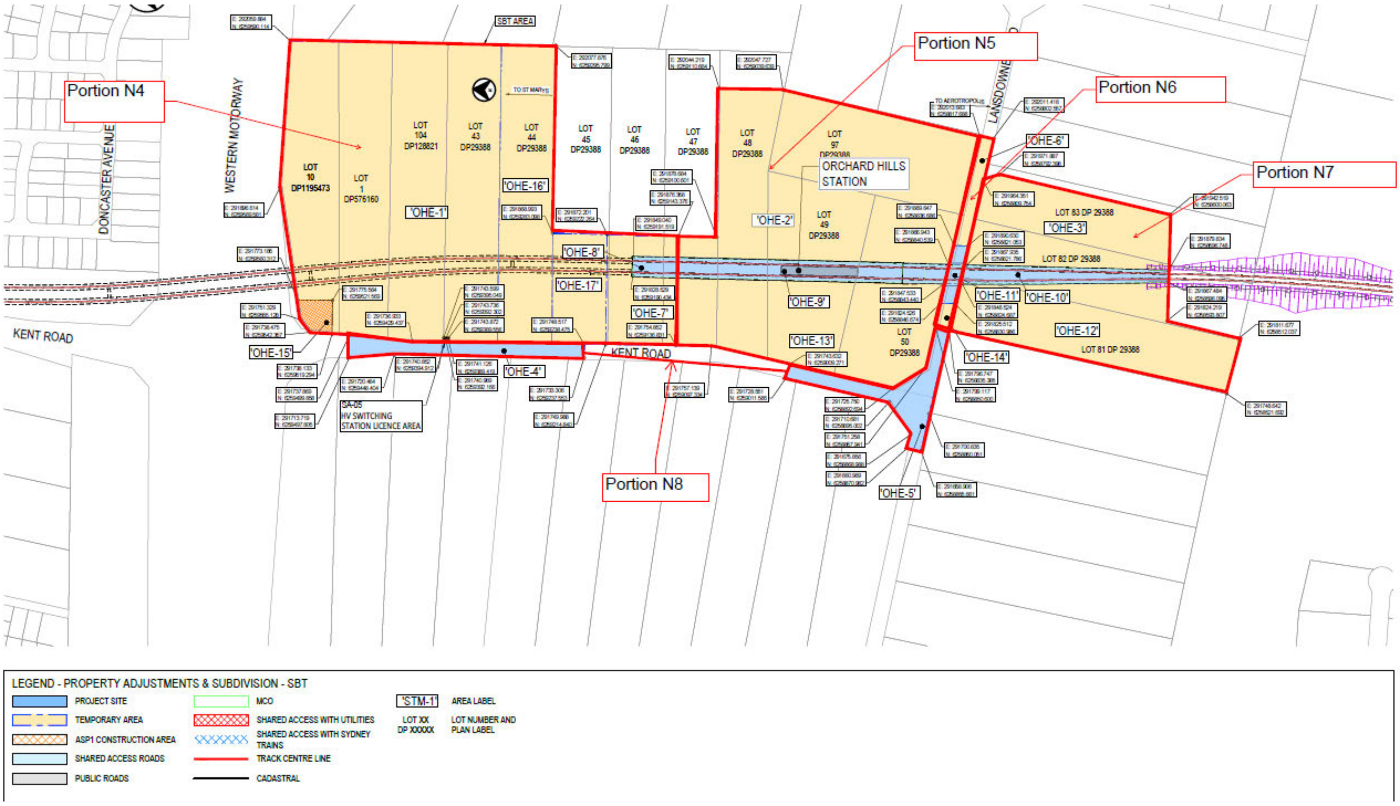

Figure 1-3 Portions N4 to N8, Orchard Hills Area.

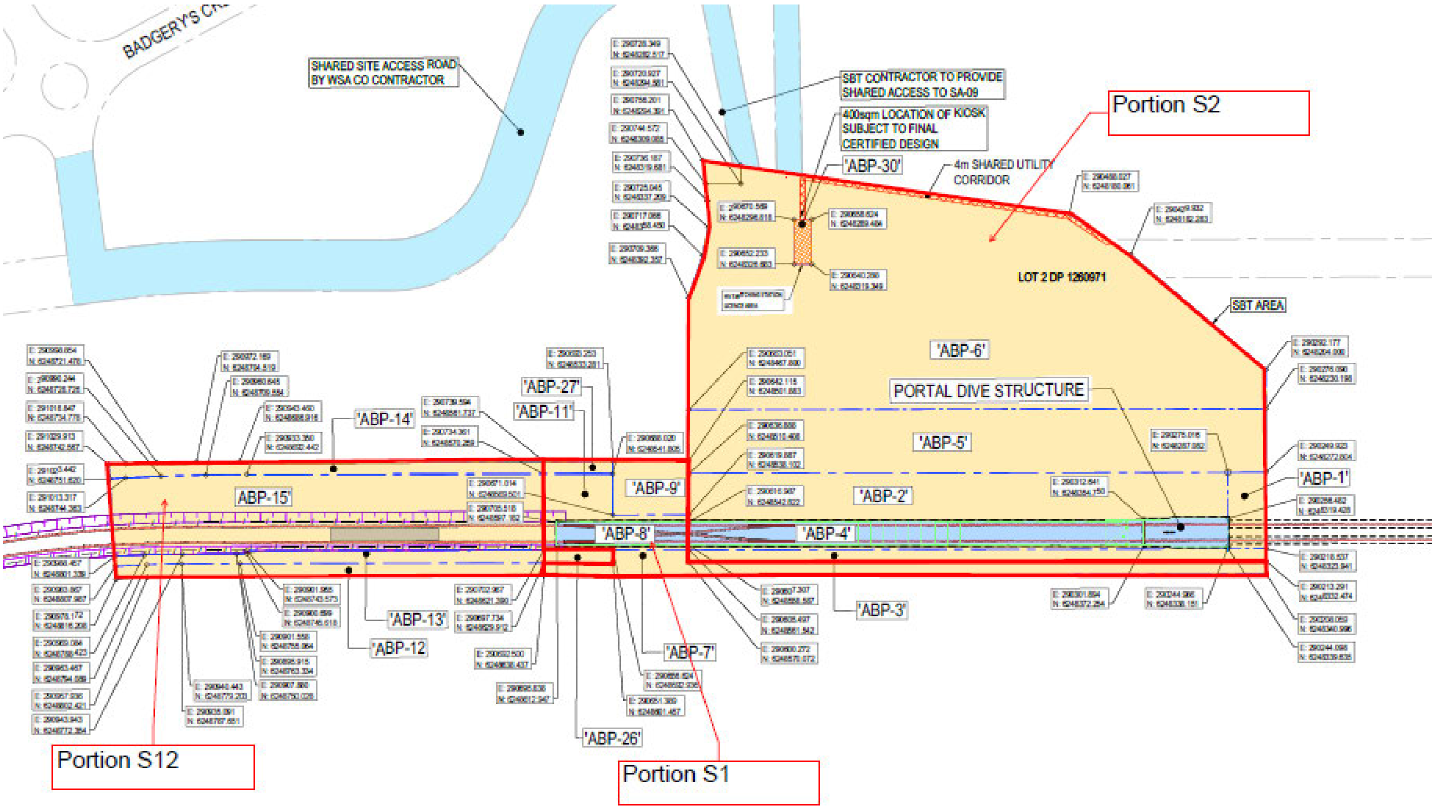

Figure 1-4 Portions S1, S2 and S12, Airport Station.

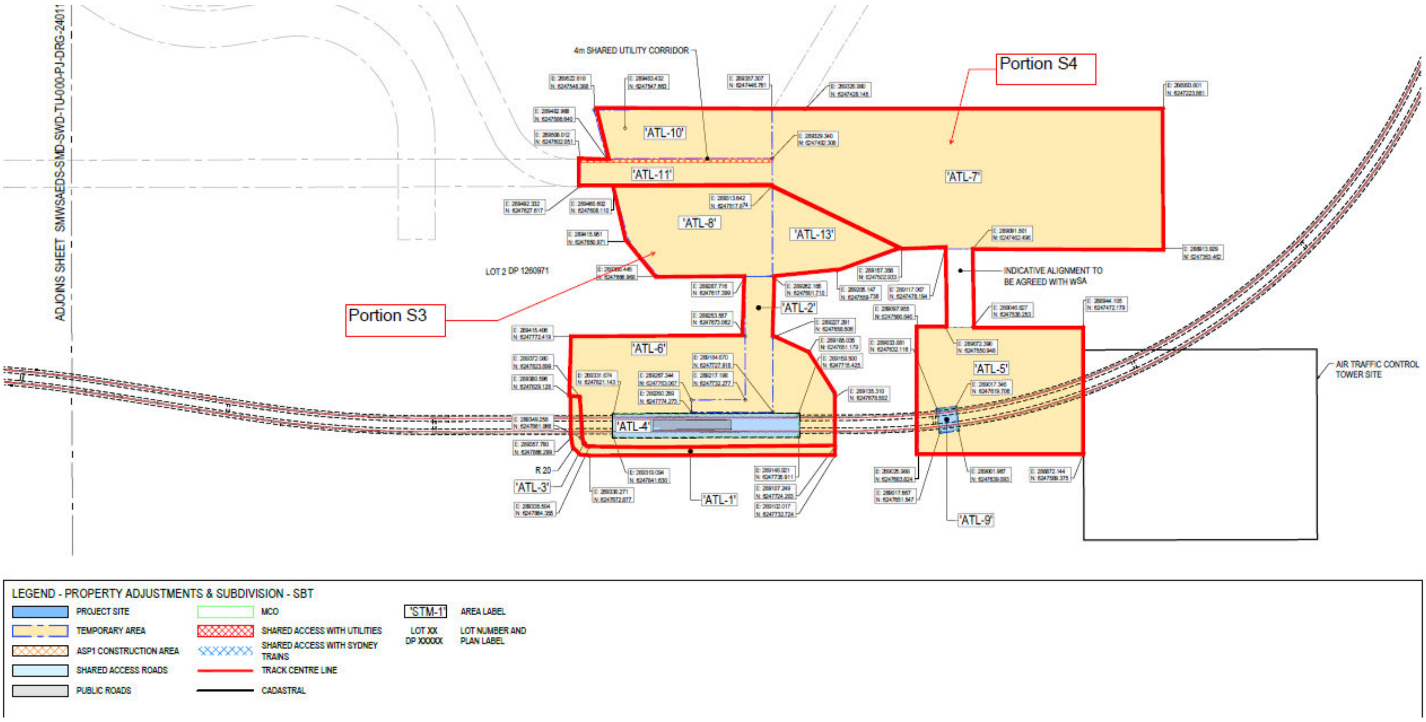

Figure 1-5 Portions S3 and S4, Airport Terminal.

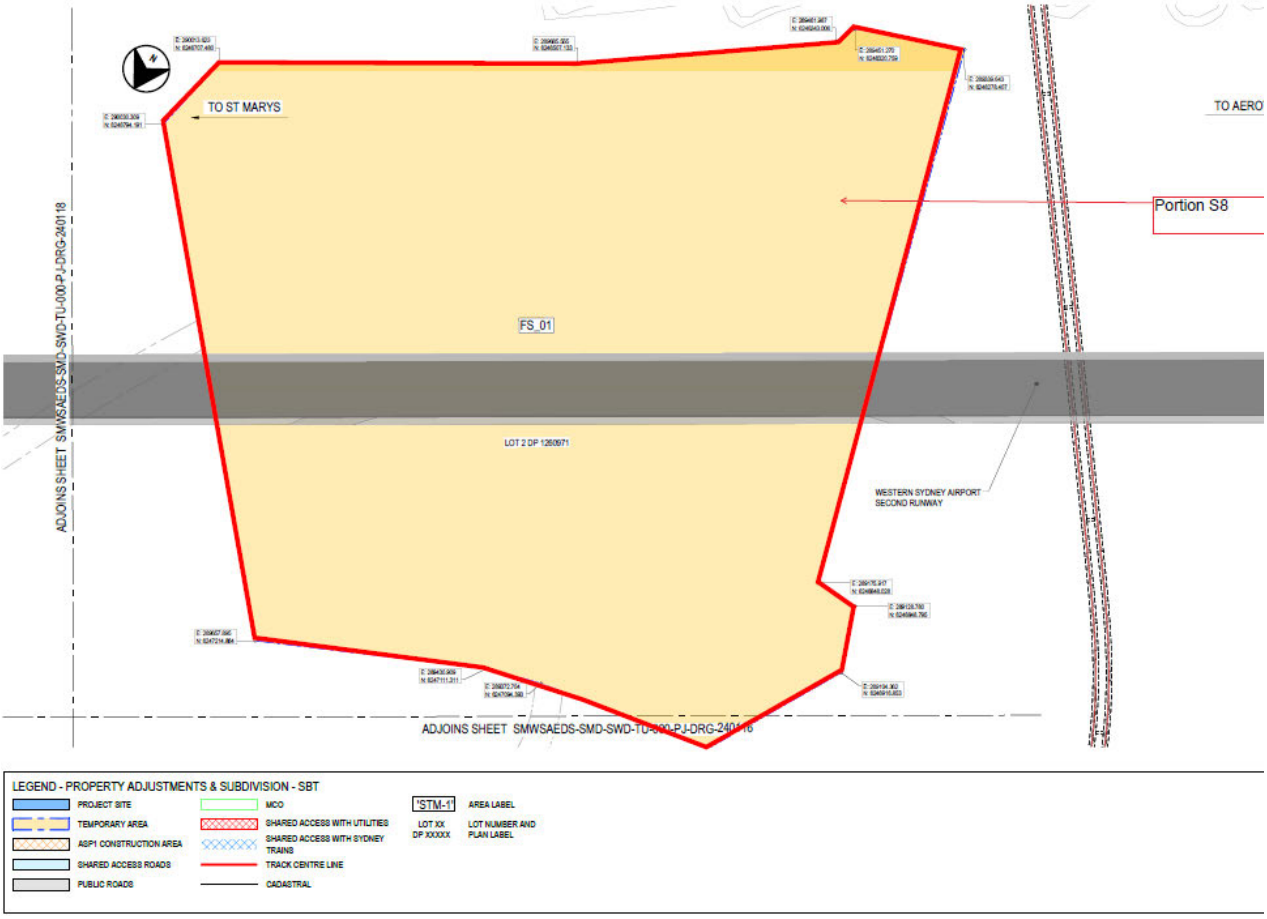

Figure 1-6 Portion S8, SBT Areas Primary Spoil Site

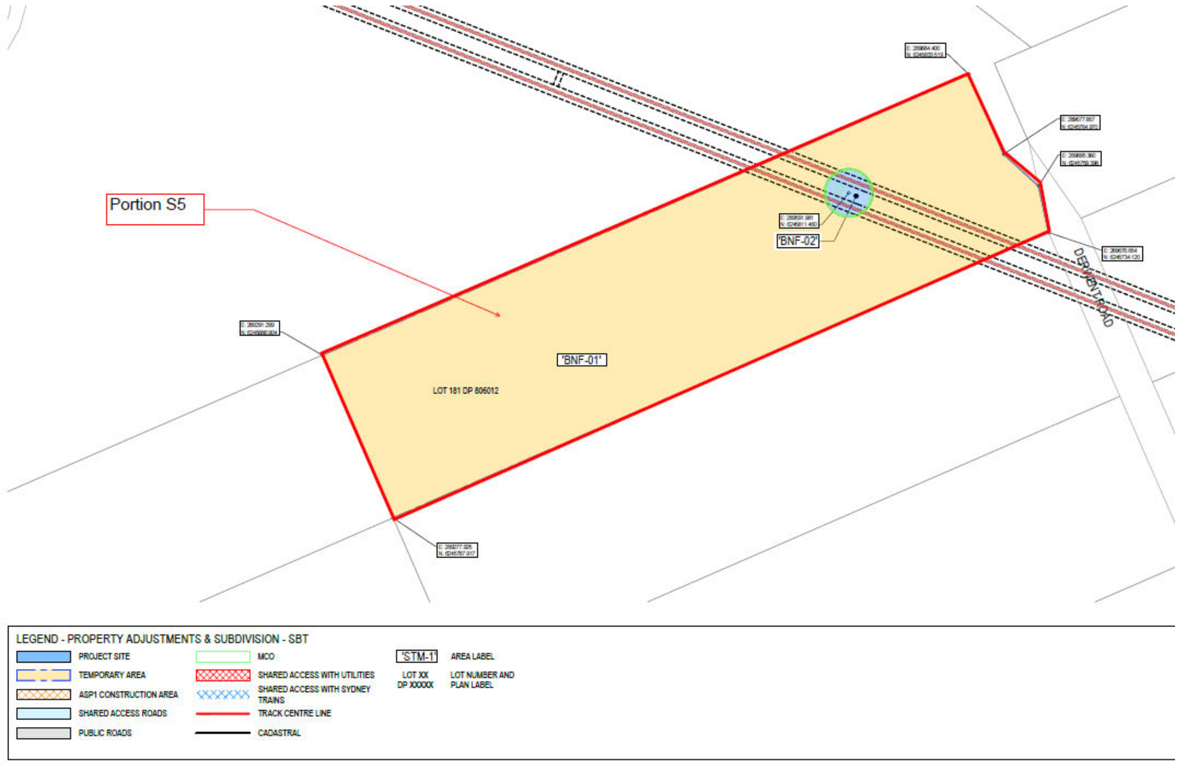

Figure 1-7 Portion S5, Bringelly.

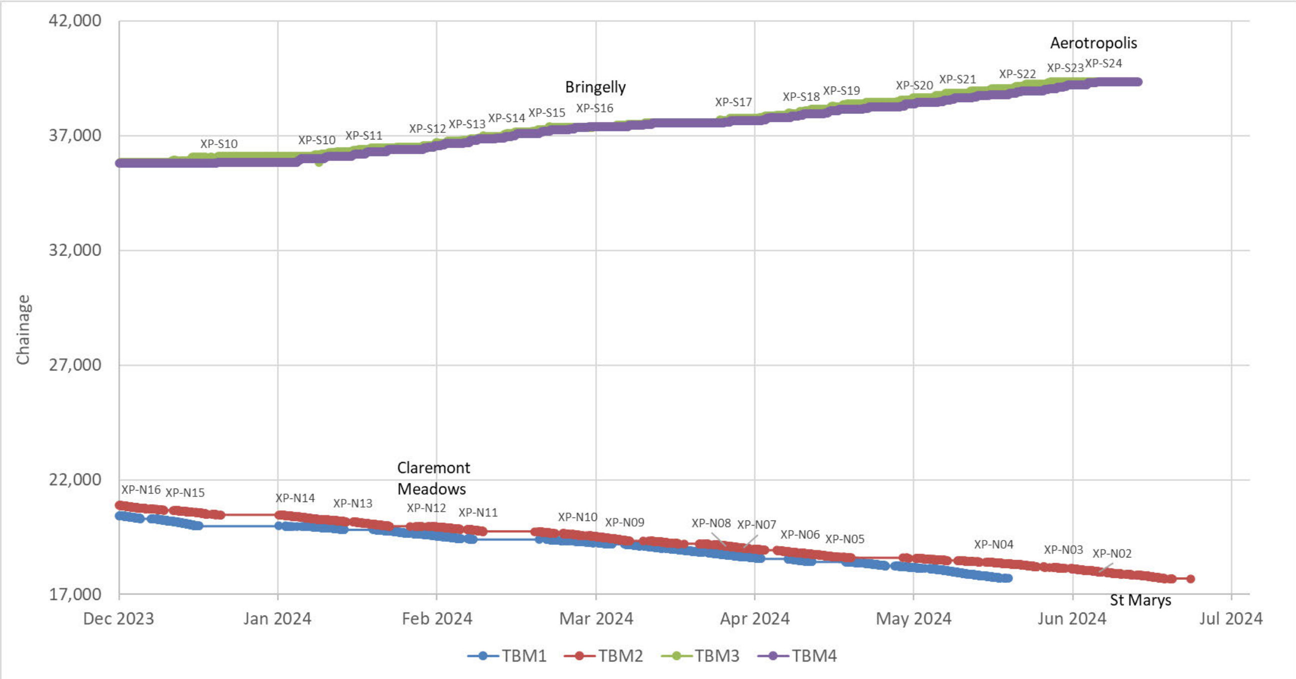

Figure 1-8: TBM progress – December 2023 to June 2024

2 Groundwater Monitoring Program Requirements

2.1 Monitoring Program

A GMP has been developed to meet the requirement for a groundwater construction monitoring program (requirement C13 of the Conditions of Approval for Sydney Metro – Western Sydney Airport (SSI 10051)).

The GMP describes how CPBG will monitor the extent and nature of potential impacts to groundwater levels and quality during the SBT Works, which will allow for implementation of appropriate management measures to address construction impacts. During this reporting period, a number of sites and the associated groundwater monitoring network were handed over to the Stations, Systems, Trains, Operations and Maintenance (SSTOM) Contractor, Parklife Metro (PLM).

The complete monitoring program for SBT works is detailed in the GMP and summarised in the sections below, with all previous and current monitoring locations shown on Figures 2-1 to 2-4. A summary of the groundwater monitoring network associated with the SBT Works for this reporting period is provided in Table 2-1 and Table 2-2. Monitoring locations that are not associated with the SBT Works for this reporting period are not addressed within this report. The requirements of the CPBG GMP are no longer applicable at these locations.

Monitoring is also undertaken as part of the mitigation and management measures associated with groundwater contaminated with chlorinated hydrocarbons from a former dry cleaner located at 1-7 Queen St, St Marys, approximately 200m west of the St Marys Station Box. Mitigation monitoring is discussed in detail in Section 2.5.

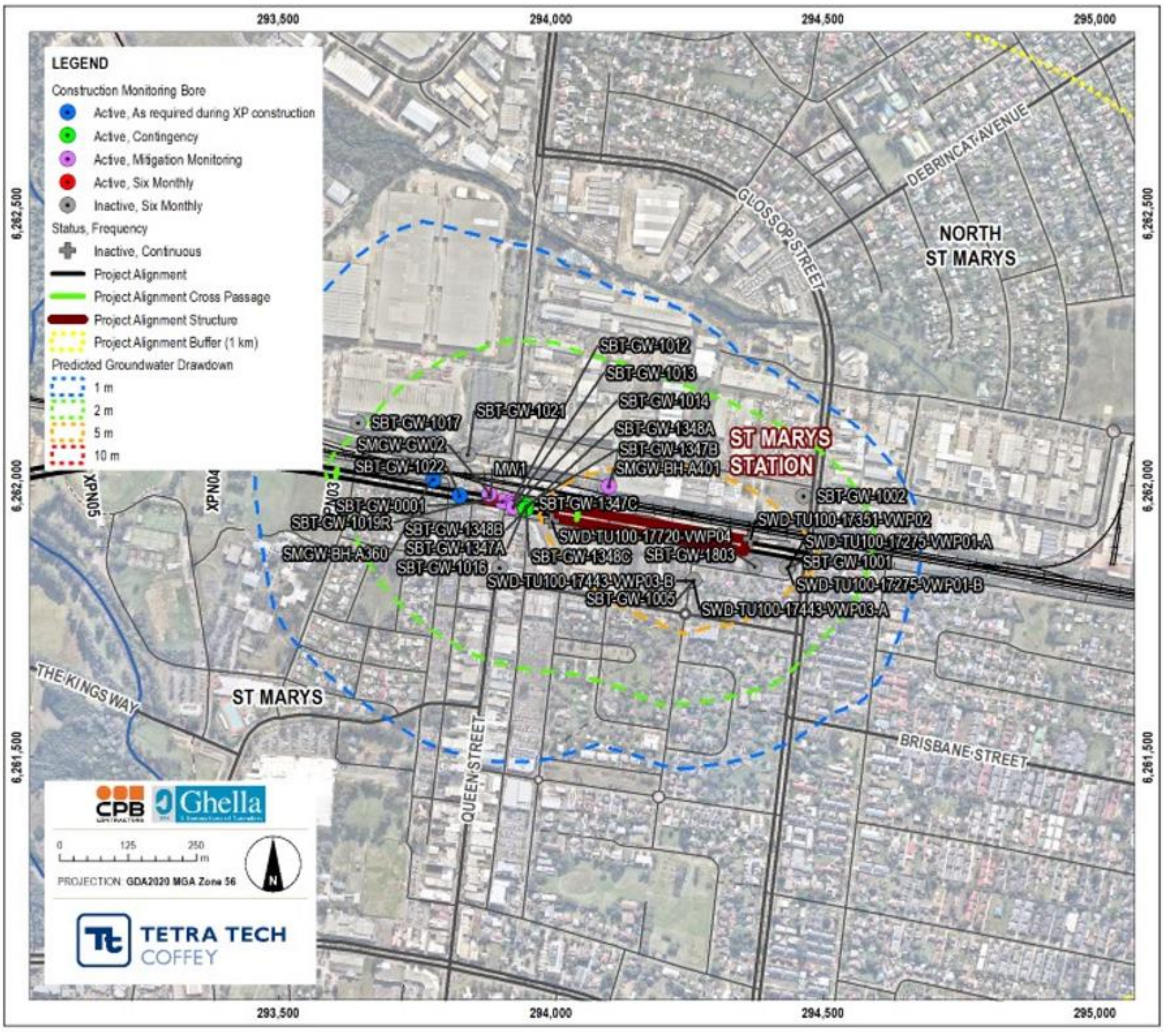

Figure 2-1: Construction groundwater monitoring program – St Marys Station

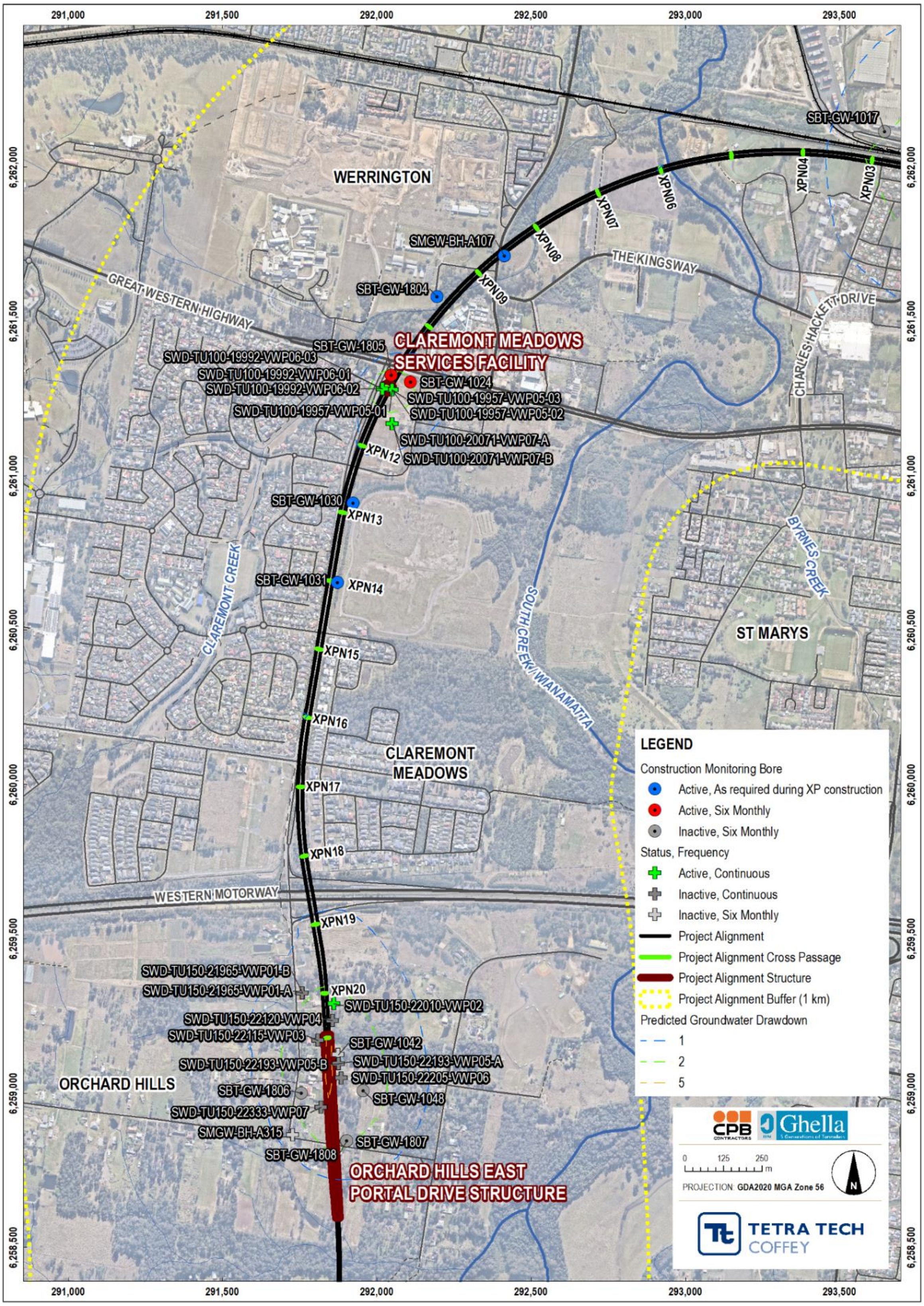

Figure 2-2 Construction groundwater monitoring program – South Creek to Orchard Hills Station

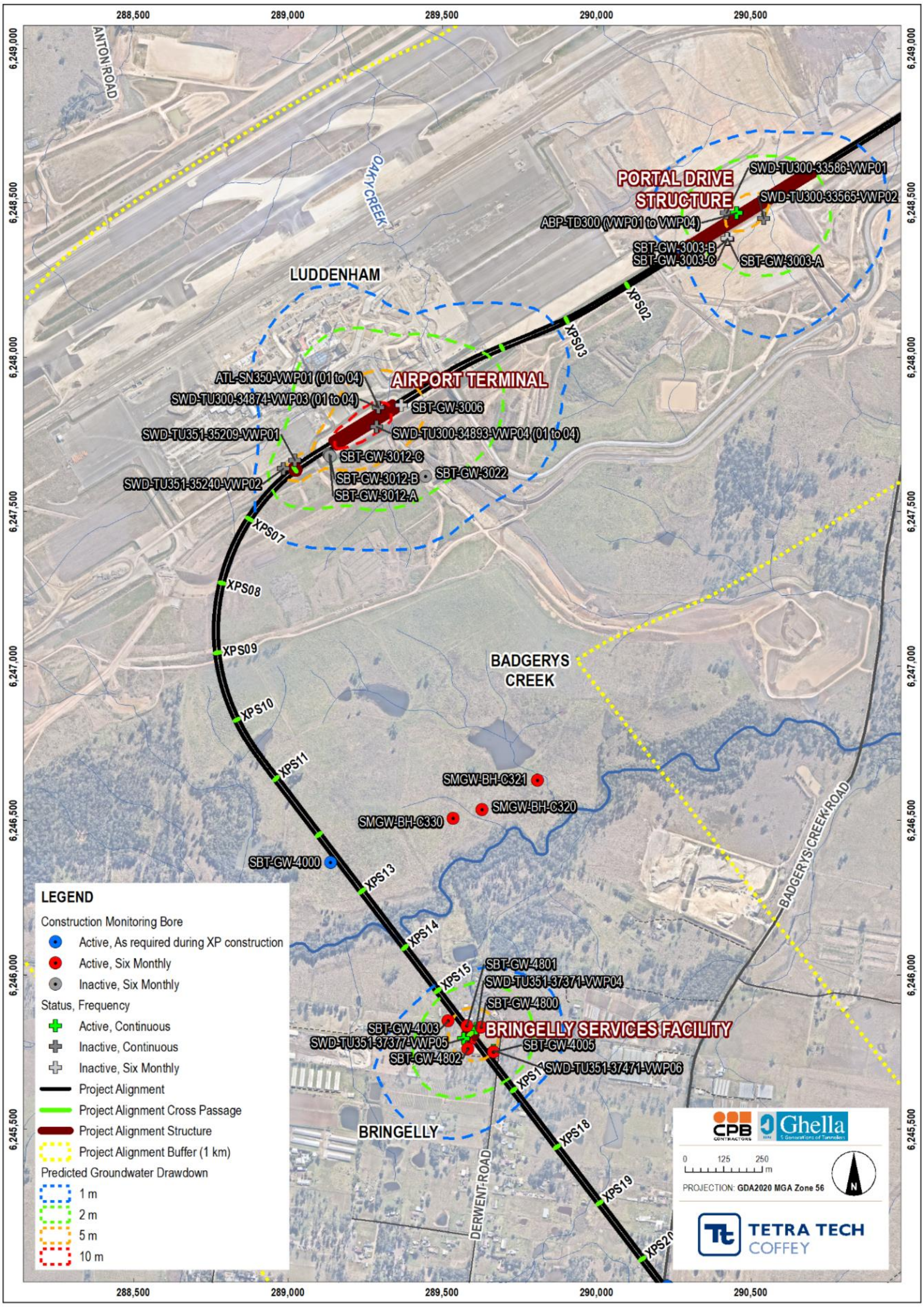

Figure 2-3: Construction groundwater monitoring program – WSI and Bringelly Services Facility

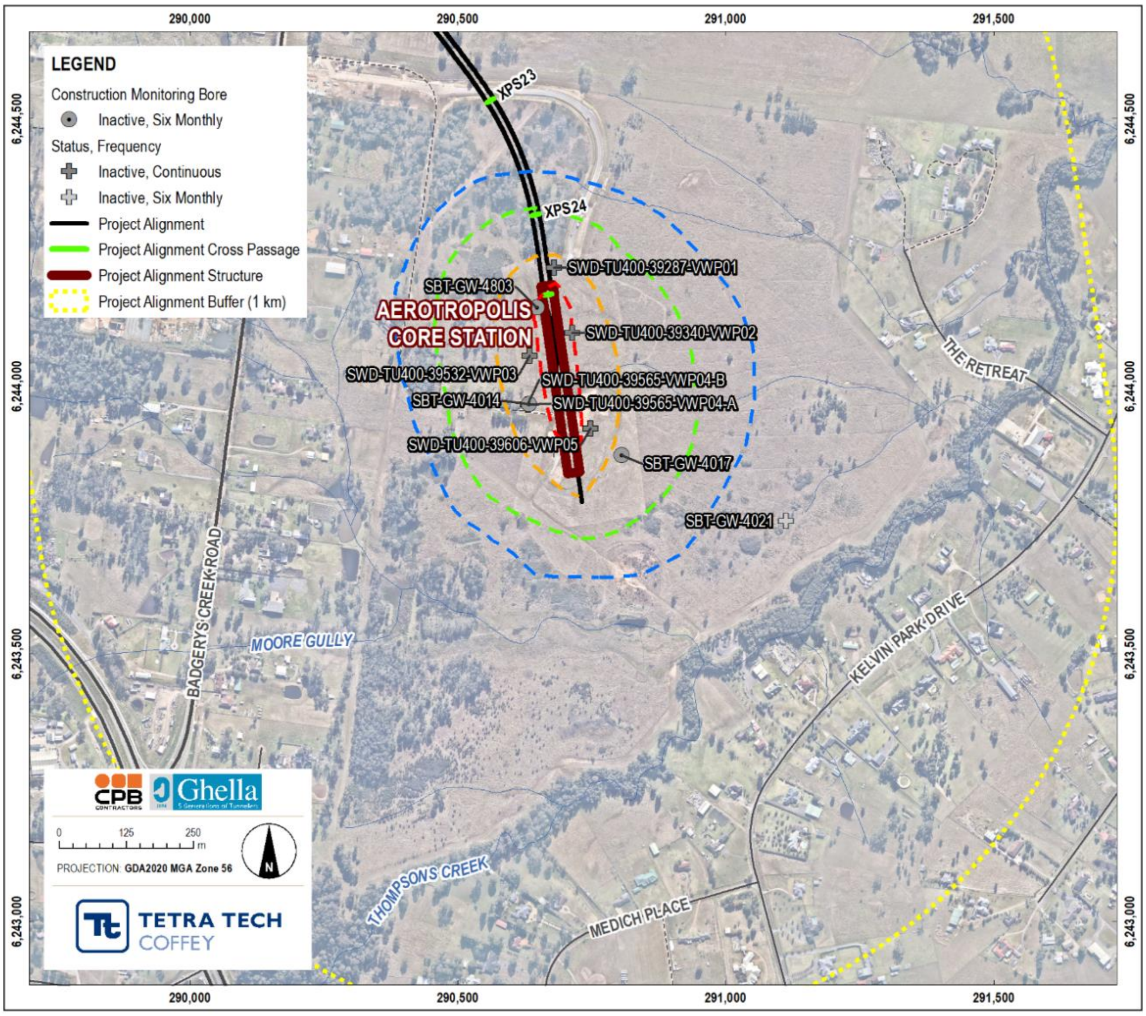

Figure 2-4: Construction groundwater monitoring program – Aerotropolis Core Station

2.2 Methodology

The groundwater monitoring methodology implemented during the SBT Works is detailed in the GMP and summarized below. Specifically, this methodology provides an approach for collection and assessment of:

- Groundwater level as metres below the top of casing (mBTOC) groundwater and Australian Height Datum (mAHD) (as manual measurements and automated datalogger download)
- Groundwater salinity as electrical conductivity (EC) (field measurement and EC datalogger download)
- Groundwater quality at key locations (field measurement and sample collection for laboratory analysis)

The methodology also provides quality assurance/quality control procedures for collecting and managing environmental datasets.

The groundwater sampling methodology has been developed for compliance with the following Australian and International Standards and Guidance:

- AS/NZS 5667.11:1998: Water Quality – Sampling Part 11: Guidance on Sampling of Groundwaters (Reconfirmed 2016)

- AS/NZS 5667.1:1998: Water Quality – Sampling Part 1: Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples (Reconfirmed 2016)
- Sundaram et al (2009) Groundwater Sampling and Analysis – A Field Guide. Geoscience Australia.

With the exception of mitigation monitoring (as outlined in Section 2.6) all groundwater monitoring was undertaken by CPBG personnel. Data portal access, or a summary of field and laboratory data, was provided to Tetra Tech for reporting and comparison with triggers.

2.3 Groundwater Levels

2.3.1 Grouted Vibrating Wire Piezometers (VWPs)

Grouted VWPs have been installed post-award at 45 locations by CPBG, with the locations of the 29 VWP monitored under the GMP shown in Figures 2-1 to 2-4, and summarised in Table 2-3. Key VWPs with level triggers are summarised in Table 4-2, noting that some locations monitored for design purposes do not have triggers.

Telemetered monitoring of groundwater level data for VWPs is hosted on CPBG's SensGrid portal.

Groundwater level results from 1st December 2023 to 28th June 2024 are summarised and compared to triggers in Section 5.1, and graphically shown in Annexure C.

2.3.2 Continuous electrical conductivity/groundwater level monitoring

EC and groundwater level data was initially continuously logged at six locations to monitor conditions during the construction phase to assess potential risks to groundwater dependent ecosystems (GDEs). Two of the six locations remain under CPBG control; SBT-GW-1805 and SBT-GW-1028, with PLM now responsible for monitoring at the other four locations.

GDE monitoring well details and triggers, including their current monitoring status for this reporting period are provided in Section 4.2, with results and comparison to triggers in Section 5.1 and Section 5.2.

Graphs displaying all results and triggers are provided in Annexure D.

2.3.3 Manual Groundwater Levels

Manual gauging to measure groundwater levels was undertaken on groundwater monitoring bores prior to sampling for groundwater quality.

Gauging was conducted using an electronic groundwater level interface meter from a known (surveyed) point at the top of the bore casing. Measurements were recorded to the nearest millimetre (mm) and recorded as mBTOC. Where survey data is available, the groundwater level data has been corrected to mAHD.

A summary of all available manual gauging data to date for the selected monitoring wells can be found with the groundwater quality results in the tables in Annexure A.

Table 2-1: Groundwater Level Monitoring Network

Area	Location ID	Status for Dec 2023 – June 2024 Monitoring Period
St Marys	SWD-TU100-17275-VWP01-A	Handed over to PLM
St Marys	SWD-TU100-17275-VWP01-B	Handed over to PLM
St Marys	SWD-TU100-17443-VWP03-A	Handed over to PLM
St Marys	SWD-TU100-17443-VWP03-B	Handed over to PLM
St Marys	SWD-TU100-17720-VWP04	Handed over to PLM
TBM Tunnel - South Creek	SMGW-BH-A105S	CPBG
TBM Tunnel - South Creek	SMGW-BH-A107	CPBG
TBM Tunnel - South Creek	SBT-GW-1804	CPBG
Claremont Meadows SF	SBT-GW-1805	CPBG
Claremont Meadows	SWD-TU100-19992-VWP06-01	CPBG
Claremont Meadows	SWD-TU100-19992-VWP06-02	CPBG
Claremont Meadows	SWD-TU100-19992-VWP06-03	CPBG
Claremont Meadows	SWD-TU100-20071-VWP07-A	CPBG
Claremont Meadows	SWD-TU100-20071-VWP07-B	CPBG
Claremont Meadows	SBT-GW-1028	CPBG
Orchard Hills	SWD-TU150-21965-VWP01-A	CPBG
Orchard Hills	SWD-TU150-21965-VWP01-B	CPBG
Orchard Hills	SWD-TU150-22010-VWP02	CPBG
Orchard Hills	SWD-TU150-22115-VWP03	CPBG
Orchard Hills	SBT-GW-1042	Handed over to PLM
Orchard Hills	SWD-TU150-22193-VWP05-A	Handed over to PLM
Orchard Hills	SWD-TU150-22193-VWP05-B	Handed over to PLM
Orchard Hills	SWD-TU150-22205-VWP06	Handed over to PLM
Orchard Hills	SWD-TU150-22333-VWP07	Handed over to PLM
Orchard Hills	SMGW-BH-A315	Handed over to PLM
Orchard Hills	SBT-GW-1063	Handed over to PLM
Airport Portal	SWD-TU300-33565-VWP02	CPBG
Airport Terminal	ABP-TD300-VWP03	CPBG
Airport Terminal	ABP-TD300-VWP02	CPBG
Airport Terminal	ABP-TD300-VWP01	CPBG
Airport Terminal	ABP-TD300-VWP04	CPBG
Portal / Cross passage XPS01	SBT-GW-3003-A	Handed over to PLM
Portal / Cross passage XPS01	SBT-GW-3003-B	Handed over to PLM
Portal / Cross passage XPS01	SBT-GW-3003-C	Handed over to PLM
Airport Terminal	SBT-GW-3006	Handed over to PLM
Airport Terminal	ATL-SN350-VWP01-01	Handed over to PLM
Airport Terminal	ATL-SN350-VWP01-02	Handed over to PLM
Airport Terminal	ATL-SN350-VWP01-03	Handed over to PLM
Airport Terminal	ATL-SN350-VWP01-04	Handed over to PLM

Area	Location ID	Status for Dec 2023 – June 2024 Monitoring Period
Airport Terminal	SWD-TU300-34874-VWP03-01	Handed over to PLM
Airport Terminal	SWD-TU300-34874-VWP03-02	Handed over to PLM
Airport Terminal	SWD-TU300-34874-VWP03-03	Handed over to PLM
Airport Terminal	SWD-TU300-34874-VWP03-04	Handed over to PLM
Airport Terminal	SWD-TU300-34893-VWP04-04	Handed over to PLM
Airport Terminal	SWD-TU300-34893-VWP04-01	Handed over to PLM
Airport Terminal	SWD-TU300-34893-VWP04-02	Handed over to PLM
Airport Terminal	SWD-TU300-34893-VWP04-03	Handed over to PLM
Airport Terminal Temp Shaft	SWD-TU351-35209-VWP01	CPBG
Airport Terminal Temp Shaft	SWD-TU351-35240-VWP02	CPBG
Western Sydney Airport	SBT-GW-4000	CPBG
Bringelly SF	SWD-TU351-37371-VWP04	CPBG
Bringelly SF	SWD-TU351-37377-VWP05	CPBG
Bringelly SF	SWD-TU351-37471-VWP06	CPBG
Aerotropolis	SBT-GW-4008	CPBG
Aerotropolis	SBT-GW-4010	CPBG
Aerotropolis	SWD-TU400-39287-VWP01	Handed over to PLM
Aerotropolis	SWD-TU400-39340-VWP02	Handed over to PLM
Aerotropolis	AEC-SN450-EW-VWP07	Handed over to PLM
Aerotropolis	SBT-GW-4021	Handed over to PLM

2.4 Groundwater Quality

A summary of the groundwater monitoring well network is provided in Table 2-1, detailing the location, required monitoring frequency and laboratory analytical suite. Generally, the frequency of water quality monitoring along the alignment is six monthly. The frequency changes to monthly at some locations prior to, during and after cross passage construction.

A summary of the well status for this current monitoring period is included in the table below, including wells that are no longer controlled by CPBG as responsibility for the areas have been handed over to the SSTOM contractor (PLM) as outlined Section 1.2 and the Construction Summary (Table 1-1). The status also includes if wells still within CPBGs control were damaged, destroyed or inaccessible.

The detailed analytical suites for construction monitoring for groundwater quality are provided in Table 2-2.

Table 2-2: Construction water quality monitoring Wells – frequency, water quality analysis and level/EC monitoring

Location ID	Monitoring Zone	Status for Dec 2023 – June 2024 Monitoring Period	Aquifer	TOC mAHD	Water quality sampling frequency	Base analytical Suite	Additional analytes
MW1	St Marys	CPBG	Residual	NK	Six Monthly	✓	VOCs, PFAS
SBT-GW-1001	St Marys	Handed to PLM	Residual/ Bedrock	48.8	Six Monthly	✓	
SBT-GW-1002	St Marys	Handed to PLM	Residual/ Bedrock	42.6	Six Monthly	✓	
SBT-GW-1005	St Marys	Handed to PLM	Residual/ Bedrock	44.2	Six Monthly	✓	
SBT-GW-1016	St Marys	Handed to PLM	Residual/ Bedrock	36.1	Six Monthly	✓	TPH/BTEXN, PFAS
SBT-GW-1017	St Marys	Handed to PLM	Residual/ Bedrock	32.5	Six Monthly	✓	TPH/BTEXN, PFAS
SBT-GW-1019R	St Marys	CPBG	Bedrock	35.2	Six Monthly[2]	✓	VOCs, PFAS
SBT-GW-1021	St Marys	Handed to PLM	Residual/ Bedrock	33.9	Six Monthly	✓	Phenols
SBT-GW-1022	St Marys	CPBG	Bedrock	34.3	As required [1,2,3]	✓	VOCs, PFAS
SBT-GW-1803	St Marys	Handed to PLM	Bedrock	47.6	Six Monthly	✓	
SMGW-BH-A401	St Marys	Handed to PLM	Residual/Bedrock	36.5	Six Monthly	✓	TPH/BTEXN, PFAS
SMGW-GW02	St Marys	Handed to PLM	Residual	35.4	Six monthly	-	VOC, PFAS
SBT-GW-1804	TBM Tunnel - South Creek	CPBG	Residual	21	As required [1]	✓	
SMGW-BH-A107	TBM Tunnel - South Creek	CPBG	Bedrock	22.5	As required [1]	✓	
SBT-GW-1030	Cross passage / Tunnel (XPN13)	CPBG	Residual/Bedrock	36.8	As required [1]	✓	PFAS
SBT-GW-1031	Cross passage / Tunnel (XPN14)	CPBG	Bedrock	40.8	As required [1]	✓	
SBT-GW-1024	Claremont Meadows SF	CPBG	Alluvium/Bedrock	28.5	Six Monthly	✓	TPH/BTEXN, PFAS
SBT-GW-1805	Claremont Meadows SF	CPBG	Residual	27.3	Six Monthly	✓	
SBT-GW-1806	Orchard Hills	Handed to PLM	Bedrock	43	Six Monthly	✓	TPH/BTEXN
SBT-GW-1807	Orchard Hills	Handed to PLM	Bedrock	37.5	Six Monthly	✓	
SBT-GW-1808	Orchard Hills	Handed to PLM	Residual	37.5	Six Monthly	✓	

Location ID	Monitoring Zone	Status for Dec 2023 – June 2024 Monitoring Period	Aquifer	TOC mAHD	Water quality sampling frequency	Base analytical Suite	Additional analytes
SMGW-BH-A315	Orchard Hills	Handed to PLM	Residual/Bedrock	42.3	Six Monthly	✓	TPH/BTEXN, PFAS
SBT-GW-1042	Orchard Hills	Handed to PLM	Alluvium	40.1	Six Monthly	✓	
SBT-GW-1048	Orchard Hills	Handed to PLM	Alluvium/Bedrock	39.6	Six Monthly	✓	
SBT-GW-3003-A	Portal / Cross passage XPS01	Handed to PLM	Bedrock	67.7	Six Monthly	✓	
SBT-GW-3003-B	Portal / Cross passage XPS01	Handed to PLM	Bedrock	67.4	Six Monthly	✓	
SBT-GW-3003-C[3]	Portal / Cross passage XPS01	Handed to PLM	Bedrock	67.3	Six Monthly	✓	
SBT-GW-3006	Airport Terminal	Handed to PLM	Bedrock	84.3	Six monthly	✓	
SBT-GW-3012-A	Airport Terminal	Handed to PLM	Bedrock	84	Six Monthly	✓	
SBT-GW-3012-B	Airport Terminal	Handed to PLM	Bedrock	83.9	Six Monthly	✓	TPH
SBT-GW-3012-C	Airport Terminal	Handed to PLM	Bedrock	83.8	Six Monthly	✓	
SBT-GW-3022	Airport Terminal	Handed to PLM	Bedrock	77.8	Six Monthly	✓	TPH
SBT-GW-4000	Western Sydney Airport	CPBG	Bedrock	72.2	As required [1]	✓	TPH/BTEXN
SMGW-BH-C320	Western Sydney Airport	CPBG	Residual/Bedrock	66.5	Six Monthly	✓	TPH/BTEXN, PFAS
SMGW-BH-C321	Western Sydney Airport	CPBG	Residual/Bedrock	63.5	Six Monthly	✓	
SMGW-BH-C330	Western Sydney Airport	CPBG	Bedrock	69.4	Six Monthly	✓	
SBT-GW-4003	Bringelly SF	CPBG	Residual/Bedrock	71.9	Six Monthly	✓	TPH/BTEXN, PFAS
SBT-GW-4005	Bringelly SF	CPBG. Dry well, no sample able to be collected.	Bedrock	73.6	Six Monthly	✓	
SBT-GW-4800	Bringelly SF	CPBG	Residual/ Bedrock	71.432	Six Monthly	✓	
SBT-GW-4801	Bringelly SF	CPBG	Residual/ Bedrock	71.372	Six Monthly	✓	
SBT-GW-4802	Bringelly SF	CPBG	Bedrock	74.348	Six Monthly	✓	
SBT-GW-4008	Aerotropolis	CPBG. Well damaged.	Bedrock	78.3	As required [1]	✓	

Location ID	Monitoring Zone	Status for Dec 2023 – June 2024 Monitoring Period	Aquifer	TOC mAHD	Water quality sampling frequency	Base analytical Suite	Additional analytes
SBT-GW-4010	Aerotropolis	CPBG	Bedrock	78.8	As required [1]	✓	
SBT-GW-4014	Aerotropolis	Handed to PLM	Residual/Bedrock	73.9	Six Monthly	✓	PFAS
SBT-GW-4017	Aerotropolis	Handed to PLM	Residual	71.3	Six Monthly	✓	TPH/BTEXN, PFAS
SBT-GW-4021	Aerotropolis	Handed to PLM	Alluvium/Bedrock	62.8	Six Monthly	✓	
SBT-GW-4803	Aerotropolis	Handed to PLM	Bedrock	72.7	Six Monthly	✓	

Note: *Italic* denotes bore detail unknown as not installed by CPBG
Grey denotes monitoring locations handed over to PLM

1. Monthly sampling during cross passage construction
2. Well decommissioned April 2024 due to being located within 3m of the northern tunnel alignment.
3. Existing well SMGW-BH-A360 to replace SBT-GW-1022 for monitoring during cross-passage construction. As there is no baseline water quality data, first sample undertaken will be analysed for full analytical suite. Analytical suite for subsequent monitoring will be determined by a suitably qualified person based on previous sampling results.

2.4.1 Sampling procedure

All groundwater quality monitoring was undertaken by CPBG trained personnel, and is understood to have been completed in accordance with the methodology detailed in Section 7.4 of the GMP.

Prior to collecting groundwater samples for water quality analysis, groundwater levels were manually gauged.

Groundwater samples were collected using the Hydrasleeve™ method. A Hydrasleeve captures a core of water, typically 1 litre, from the screened interval of the well. The Hydrasleeve™ is deployed to a target depth based on screened interval and the rationale for sampling, and is left until conditions within the well are considered likely to have stabilised. The time to stabilisation depends on the transmissivity of the aquifer, with more transmissive aquifer stabilising more rapidly. It is understood that the methodology provided in the GMP was followed by CPBG, with the hydrasleeves allowed a minimum of five days to stabilise given most of the wells are screened within the bedrock aquifer that would have a relatively low transmissivity.

The Hydrasleeve™ remains empty in the well until the time of sample collection when it is pulled up through the sampling interval, opening the sleeve to collect the column of water, and seals once full. Therefore, only groundwater from the target depth interval is sampled.

Groundwater field testing, sampling and analysis was carried out at monitoring wells as specified in Appendix A of the GMP and Table 2-1 of this report, where sampling locations were accessible.

Groundwater samples were collected from the Hydrasleeve™ in appropriate laboratory-supplied bottles and sent to a National Association of Testing Authorities (NATA) accredited laboratory for analysis under Chain of Custody (COC) procedures. The laboratory analytical suites are outlined in Table 2-2 below.

Table 2-3: Analytical schedule for monitoring bores

Program	Analysis suites
Construction Monitoring - Base Analytical Suite	General indicators (pH, EC, TDS)
	TOC
	Major cations (calcium, magnesium, sodium, potassium)
	Major anions (chloride, sulphate) and speciated alkalinity (bicarbonate, carbonate, hydroxide)
	Dissolved metals (aluminium, arsenic, cadmium, chromium, copper, iron, lead, manganese, mercury, nickel, zinc) and Total metals (aluminium, cobalt, iron, manganese)
	Nutrients (ammonia, nitrate, nitrite, total kjeldahl nitrogen, total nitrogen, total phosphorous, reactive phosphorous)
Additional analytes – included for select wells where compounds were detected and/or exceeded adopted criteria in the Baseline Assessment (refer Table 2-1 for relevant wells)	Total Recoverable Hydrocarbons (TRH)
	Benzene, Toluene, Ethylbenzene, Xylene, Naphthalene (BTEXN)
	Volatile Organic Compounds (VOCs)
	Phenols
	Per- and Polyfluoroalkyl Substances (PFAS) (short suite)

2.4.2 Decontamination

Decontamination of re-useable sampling equipment was conducted between each sampling location. Equipment was rinsed with tap water, cleaned with Liquinox (or equivalent), further rinsed with tap water and then deionised water. Equipment was then allowed to dry before being used.

2.4.3 Quality assurance and quality control

Quality assurance (QA) and quality control (QC) measures implemented during sampling and field data collection to ensure data integrity are detailed in Section 7 of the GMP. The measures outlined in the GMP included:

- Using NATA accredited laboratories for sample analysis;
- Using Chain of Custody (CoC) procedures between sample collection in the field and subsequent reception of the sample by the laboratory. CoC documentation included the sample type and code, analysis required, collection data, sampler and sample receiver(s);
- Implementing appropriate sample handling and storage protocols, including using laboratory supplied containers, keeping samples chilled during storage and transport, and ensuring samples are received in good condition within specified holding times by the laboratory;
- Adopting a consistent program of quality control sampling for fieldwork, including:
    - Collection of duplicate and triplicate samples at an average frequency of one sample per twenty primary samples (an overall ratio of 1:10 where PFAS sampled in accordance with NEMP 2.0);
    - Collection of rinsate blanks to measure the effectiveness of decontamination procedures; and
    - Collection of trip blanks to assess the adequacy of sample storage and transport procedures in preventing cross contamination.

As detailed in Section 7.10 of the GMP, a data validation assessment was completed for samples collected during groundwater monitoring up to 28th June 2024, and is provided in Annexure F.

2.4.4 Documentation of field results

CPBG protocols were applied during field works. Field forms are reported by CPBG to have included the following detail:

- Bore location and condition;
- Summary of climatic setting including weather;
- Type of equipment used and equipment serial numbers/calibration certificates;
- Method of sampling (Hydrasleeve deployment and retrieval dates);
- Details of the sampler;
- Field parameters, groundwater level, odour, colour and any other observations made during sampling; and
- Date and time of sampling.

A summary of field monitoring and sampling results provided by CPBG is included as Annexure A.

2.5 Mitigation monitoring – St Marys

Groundwater contaminated with chlorinated hydrocarbons from a former dry cleaner located at 1-7 Queen St, St Marys has been identified approximately 200m west of the St Marys Station Box. Construction related dewatering during station box construction was predicted to draw down groundwater in the vicinity, reversing the existing westerly groundwater flow direction, potentially drawing the contamination toward the excavation (Tetra Tech 2023b).

A permeable reactive barrier (PRB) was installed in May 2023 to intercept potential migration of chlorinated hydrocarbons in groundwater due to construction associated drawdown. Given the potential for unacceptable vapour inhalation or direct contact risk, mitigation monitoring has been implemented to assess conditions, and identify if contingency mitigations need to be implemented before an unacceptable risk occurs.

In addition to monitoring for potential contaminant mobilisation due to station construction, a weekly monitoring program was implemented on behalf of Sydney Metro to assess conditions in the vicinity of the source area when the TBMs pass through the area.

The TBM monitoring included weekly sampling of groundwater in the vicinity of the former dry cleaner at 1-7 Queen Street. The monitoring started in mid-March, four weeks before TBM-1 passed through the suspected source area (12 April 2024), and will continue until four weeks after TBM-2 passes through in mid to late June 2024. The program nominally consists of 16 weekly monitoring events.

The TBMs are pressurised, therefore PRB mitigation monitoring wells within 3m of the tunnels required decommissioning prior to the TBMs passing through the area, as the wells potentially provided a pathway to the surface which would result in depressurisation. The mitigation monitoring program was revised as many monitoring wells were decommissioned (Tetra Tech 2024).

The purpose of the mitigation monitoring is to:

- Monitor the effectiveness of the PRB;
- Identify if an adverse change in risk profile is likely which requires contingency mitigation measures to be implemented as outlined in the Remediation Action Plan (RAP, Tetra Tech 2023c). This will be assessed if detectable concentrations of chlorinated ethenes are reported between the station and the PRB, and concentrations exceeding the trigger values are predicted to reach the excavation before sealing occurs; and
- Assess potential impacts of tunnelling beneath the suspected source area on chlorinated hydrocarbon concentrations and trends in groundwater due to at the rear of the former dry cleaner.

Details of the mitigation monitoring program are provided in Section 6.3.1 of the GMP, with amendments made to the program between December 2023 and June 2024 included in the Monthly Mitigation Monitoring Report for June 2024 (provided as Annexure G).

The TBMs broke through at St Marys Station Box in May (TBM-1) and 20 June 2024 (TBM-2).

Monitoring wells included in the mitigation monitoring network both before and after well decommissioning in April 2024 are shown on Figure 2-5, with details in Table 2-4 and Table 2-5. Sampling was undertaken by Tetra Tech as detailed in Annexure G.

Table 2-4: PRB mitigation monitoring – December 2023 to June 2024

Monitoring Well	Monitoring frequency	Analytes	Trigger Value and Contingency Plan
SBT-GW-0001 **SBT-GW-0001b**	Fortnightly	Volatile chlorinated hydro-carbons	**Trigger Values:** PCE 0.3mg/L TCE 0.055mg/L cis 1,2 DCE 0.25mg/L VC 0.2mg/L
SBT-GW-1012 [1] SBT-GW-1013 [1] SBT-GW-1014 [1]	Fortnightly		
SBT-GW-1347a [2] SBT-GW-1347b [2] **SBT-GW-1347c [2]** SBT-GW-1348a [2] SBT-GW-1348b [2] SBT-GW-1348c [2]	Fortnightly for 'c' interval wells (at ~18mAHD) *If contingency mitigation implemented, then all multi-level wells monitored weekly*		Refer HHRA (Tetra Tech 2023b) for determination of trigger values **Contingency Plan**: Refer to Section 11.6 of the RAP (Tetra Tech 2023c)

1. SBT-GW-1012, SBT-GW-1013 and SBT-GW-1014 are screened from the pre-construction water table to 20mAHD with a saturated interval of 12m. Three hydrasleeves placed in each well at 30mAHD, 27mAHD and 24mAHD.

2. SBT-GW-1347a, SBT-GW-1347b, SBT-GW-1347c, SBT-GW-1348a, SBT-GW-1348b, SBT-GW-1348c are multi-level groundwater wells, with details provided in Table A1 of Annexure G.

Bold indicates well sampled from April 2024 onward. All other monitoring wells decommissioned prior to TBM passing through area.

Table 2-5: Source Area/TBM monitoring – March 2024 to June 2024

Monitoring Well	Monitoring frequency	Analytes	Assessment
MW1 **MW2** SBT-GW-1019_R SBT-GW-1020 **SMGW-GW02**	Weekly from mid-March to four weeks after TBM-2 reaches St Marys Station	Volatile chlorinated hydro-carbons	Comparison to previous concentration ranges for PCE, TCE, cis 1,2 DCE and vinyl chloride, and trends over TBM monitoring period

Bold indicates wells to be sampled from April 2024 onward. Other monitoring wells decommissioned prior to TBM passing through area.

CPB CONTRACTORS

Ghella 1894 5 Generations of Tunnelers

LEGEND

- Ongoing mitigation monitoring
- PRB monitoring well - To be decommissioned
- TBM monitoring well - To be decommissioned
- PRB injection well - To be decomissioned
- Tunnel Alignment
- Tunnel Alignment - Chainage
- Railway
- Minor Road
- Path
- STM Site Boundary
- Cadastral Boundary

NOTE
SBT-GW-1347b has been decommissioned.
SOURCE
Mitigation Monitoring Wells, PRB Wells and boundary from Tetra Tech Coffey.
Existing investigations, site layout, station box and alignment supplied by CPBG.
Cadastre from DFSI.
Aerial imagery from Nearmap (capture date 30-03-2023).

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CPB - GHELLA

WESTERN SYDNEY AIRPORT
STATION BOXES AND TUNNELLING WORKS

FIGURE 2

Ongoing Mitigation Monitoring Wells – St Marys

TETRA TECH COFFEY

DATE: 01.07.24 PROJECT: 754-SYDGE292575 FILE: 292575_RAP_F002_GIS

SAVED BY: MATTHEW GOLJANIN 01.07.24 10:44 AM

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3 Compliance review

A review of groundwater monitoring activities completed between 1st December 2023 and 28th June 2024 indicated that it was generally in line with the requirements of construction monitoring as outlined in the GMP. During the current reporting period, a number of SBT work areas were handed over to the SSTOM contractor. Monitoring locations sampled by CPBG to monitor the extent and nature of potential impacts to groundwater during the SBT works are detailed in Section **Error! Reference source not found.** above.. Deviations from the GMP are summarised in Tables 3-1 and 3-2.

3.1 Groundwater levels and GDE

Table 3-1: Variation from Water Quality Sampling Plan and Groundwater Level and EC monitoring plan in GMP

Location ID [1]	Monitoring Zone	Reason for being not monitored	Action to be taken
Groundwater Quality Monitoring Well			
SBT-GW-4005	Bringelly SF	Dry well at time of sampling, no sample able to be collected.	Data from VWP SWD-TU351-37471-VWP06 nearby instead used to assess water levels.
SBT-GW-4008	Aerotropolis	Dry or damaged well at time of sampling. No logger data available.	Required to be monitored during Cross passage construction. Cross-passage construction now complete. No action required, refer to discussion in Section 5.1.4.
GDE Monitoring Well – EC and GW Levels			
SBT-GW-1028	Claremont Meadows	Continuous data not able to be collected as logger was damaged.	Manually gauged water levels and field readings of EC were collected in April, May and June 2024. Data from nearby VWP SWD-TU100-20071-VWP07-A was also used to assess groundwater levels.
Vibrating Wire Piezometers (VWPs)			
SWD-TU351-35209-VWP01	Airport Terminal	Destroyed	Required for monitoring during temporary shaft excavation. Data available until December 2023. Shaft excavation completed in August 2023. Purpose of monitoring asset was wall design as drawdown was not the critical design case. No action required.
SWD-TU351-35240-VWP02	Airport Terminal	Destroyed	
SWD-TU150-21965-VWP01-A	Orchard Hills	Destroyed	Required for monitoring during station box excavation. Station box excavation (including waterproofing) completed in July 2023. Data until November 2023 indicates no groundwater level exceedances. No action required.
SWD-TU150-21965-VWP01-B	Orchard Hills	Destroyed	
SWD-TU150-22115-VWP03	Orchard Hills	Destroyed	

During the reporting period the logger in SBT-GW-1028, which automatically monitors groundwater level and EC, has been damaged. The data was instead collected by manual measurement for this monitoring period. Level data obtained from nearby VWP SWD-TU100-20071-VWP07-A has also been used to assess groundwater levels in the area (refer to Annexure C).

As noted in Section 6.4.1 of the GMP, preliminary SSTVs were developed following completion of baseline groundwater level and quality monitoring. No baseline EC or preliminary EC SSTV was able to be established at SBT-GW-1028 as the well was unable to be located during baseline monitoring. The well has subsequently been located and field readings of EC collected. The EC SSTV was established based on a rolling mean following the collection of three samples. In analysing the data, the SSTV responses would be initiated as per the instructions in Section 4.2. Further discussion provided in Section 5.2.

SBT-GW-4005 was dry and unable to be sampled. Groundwater level data obtained from nearby SWD-TU351-37471-VWP06 have been used to assess groundwater levels in the area (refer to Annexure C).

3.2 Groundwater quality

The groundwater sampling compliance and quality control assessment is presented in the Quality Assurance Report in Annexure F. Recommendations from the assessment are included in Section 7.2.

Overall, the percentage of issues identified in the quality assessment (1.5%) indicates that the dataset is acceptable, and of appropriate quality for use.

4 Performance Criteria

4.1 Groundwater Level Triggers

Groundwater trigger levels were developed to manage potential impacts associated with drawdown propagation during construction, Table 4-2.

1. Trigger levels were set based on risk assessment for GDEs and adopt a traffic light system.
2. Level monitoring data has been compared to triggers
3. Triggers may be revised as the hydrogeological understanding is developed during construction.

The trigger levels were based on the modelled response to (Project-wide groundwater modelling report, Tetra Tech (2023a) Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040402) identify where exceedances of the predicted drawdown.

Groundwater level during construction were compared to trigger values, and assessed and revised as the groundwater response to excavation and construction activities is better understood.

Groundwater level monitoring locations handed over to PLM before the current monitoring period commenced are shown in grey in Table 2-1 and are not included in this report as they are now the responsibility of PLM.

A traffic light system has been adopted based on baseline groundwater conditions and anticipated groundwater level drawdown from the works, with Table 4-1 summarising proposed actions when the specific trigger level is activated for wells remaining under SBT's control.

Table 4-1: Traffic light trigger level system

Trigger level	Action
Green	Groundwater levels observed are within the target / green trigger level range and require no additional action.
Amber	• Investigation to the possible reason for the drawdown or drawdown trend. • Possible increase in monitoring frequency to confirm trend. • Checks on instrumentation / monitoring equipment. • Consideration for need of application of mitigation (i.e. targeted recharge) where drawdown is not found to be a seasonal variation, and is identified to be due to Project activities.
Red	• Investigation to the possible reason for the drawdown or drawdown trend. • Increase in monitoring frequency to confirm trend. • Changes to groundwater level management where trend is deemed to be a function of the Project activities. May include implementation of localised recharge or other hydraulic control.

Table 4-2: Groundwater trigger levels

Area	Location ID	Monitoring bore screen / VWP sensor elevation (m AHD)	Pre-development groundwater level range (mAHD)	Trigger levels based on anticipated groundwater level at completion of excavation and tunnelling		
				Green Trigger (m AHD)	Amber Trigger (m AHD)	Red Trigger (m AHD)
TBM Tunnel - South Creek	SMGW-BH-A105S	14.6 to 20.6	19 to 19.8	18.9	18.4	17.9
TBM Tunnel - South Creek	SMGW-BH-A107	-4.44 to 3.46	20.9 to 21.6	20.8	20.3	19.8
TBM Tunnel - South Creek	SBT-GW-1804	16.0 to 19.0	18.7 to 19	18.5	18.0	17.5
Claremont Meadows	SBT-GW-1805	18.3 to 24.3	24.7 to 25.6	21.5	21.0	20.5
Claremont Meadows	SWD-TU100-19992-VWP06-01	5.998	20.2 to 25	Note 1		
Claremont Meadows	SWD-TU100-19992-VWP06-02	11	20.2 to 25	Note 1		
Claremont Meadows	SWD-TU100-19992-VWP06-03	17.5	20.6 to 25	Note 1		
Claremont Meadows	SWD-TU100-20071-VWP07-A	2.813	26.9 to 27	25.4	24.9	24.4
Claremont Meadows	SWD-TU100-20071-VWP07-B	7.813	27.1 to 27.3	25.6	25.1	24.6
Claremont Meadows	SBT-GW-1028	22.5 to 27.5	26.7 to 26.5	25.2	24.7	24.2
Orchard Hills	SWD-TU150-21965-VWP01-A	16.6	37.8 to 38.5	36.0	35.5	35.0
Orchard Hills	SWD-TU150-21965-VWP01-B	21.6	36.8 to 37.5	35.0	34.5	34.0
Orchard Hills	SWD-TU150-22010-VWP02	22.81	33.8 to 35.3	31.5	31.0	30.5
Orchard Hills	SWD-TU150-22115-VWP03	23.58	35.2 to 37.6	Note 1		
Airport Terminal	ABP-TD300-VWP03	56.296	60 to 62.2	Note 1		
Airport Terminal	ABP-TD300-VWP02	56.277	59.8 to 61.7	Note 1		
Airport Terminal	ABP-TD300-VWP01	55.1	59.3 to 62.9	Note 1		
Airport Terminal	ABP-TD300-VWP04	55.123	60.5 to 62.7	Note 1		
Western Sydney Airport	SBT-GW-4000	59.2 to 69.7	70.5 to 70.9	70.5	70.0	69.5
Bringelly SF	SWD-TU351-37371-VWP04	50.313	62.5 to 67.1	50.6	50.1	49.6
Bringelly SF	SWD-TU351-37377-VWP05	52.53	64.5 to 67.2	56.0	55.5	55.0
Bringelly SF	SWD-TU351-37471-VWP06	52.516	67.6 to 68	62.5	62.0	61.5
Aerotropolis	SBT-GW-4008	50.3 to 56.3	72 to 72.2	71.8	71.3	70.8

Area	Location ID	Monitoring bore screen / VWP sensor elevation (m AHD)	Pre-development groundwater level range (mAHD)	Trigger levels based on anticipated groundwater level at completion of excavation and tunnelling		
				Green Trigger (m AHD)	Amber Trigger (m AHD)	Red Trigger (m AHD)
Aerotropolis	SBT-GW-4010	62 to 68	73.3 to 73.8	73.0	72.5	72.0

Notes: (1) Purpose of monitoring asset is wall design where drawdown is not the critical design case.

4.2 GDE Trigger Values

Site specific trigger values (SSTVs) were established to minimise potential risks to GDE health by altered groundwater quality and levels using baseline data in key wells in the vicinity of GDEs.

SSTVs for EC and groundwater level, as detailed in the GMP, are listed in Table 4-3 and 4-4 below. Groundwater level related SSTVs are equivalent to the amber trigger level values (refer Table 4-2).

Four other GDE monitoring wells, as listed in Table 6-10 of the GMP, were handed over to PLM during this monitoring period.

Table 4-3: SSTVs for continuous EC monitoring of GDEs

Area	Bore ID	Screened unit	Screen depth (mbgl)	Baseline EC range (µS/cm)	Preliminary EC SSTV (µS/cm)
Claremont Meadows	SBT-GW-1805	Residual	3-9	2,480 – 3,100	3,650
Claremont Meadows	SBT-GW-1028	Residual	3-6	No baseline assessment.	25,350

Table 4-4: Level SSTVs for continuous level monitoring of GDEs

Area	Bore ID	Screened unit	Screen/sensor depth (mbgl)	Baseline level range (mAHD)	Preliminary Level SSTV (mAHD) *
Claremont Meadows	SBT-GW-1805	Residual	3 - 9	24.7 - 25.6	21.5
Claremont Meadows	SBT-GW-1028	Residual	3 - 6	26.5 – 26.7	24.7
Orchard Hills	SWD-TU150-22010-VWP02	Bedrock	16 (VWP)	33.8 – 35.3	31.0

* Based on Amber Trigger Level as presented in Table 4-2

The GMP requires that EC and groundwater level data be downloaded monthly and assessed against the SSTVs to identify where conditions are not as expected and where they may pose a risk to GDEs.

The SSTVs will provide an identifiable indication of a potential change in salinity, with a management response to be initiated if any of the following occurs:

- EC data continuously exceeds the SSTV over a period of three months and displays a rising trend; or
- EC data exceeds the SSTV at any time by more than 150%.

If one or both of the above EC triggers are observed, a review will be initiated to determine the significance of the exceedance(s) and possible causes, including a review to assess the historical and surrounding monitoring bore data, and modelling predictions (refer to Section 7.2 of the SWMP). Where high saline areas are identified, measures such as planting, regenerating and maintaining native vegetation and good ground cover in recharge, transmission and discharge zones would be implemented where possible.

As noted in Section 6.4.1 of the GMP, a review of the monitoring program has been completed (refer Section 5.2.1) to determine the efficiency of the monitoring program for GDEs and whether any require changes.

The EC SSTVs will continue to be refined over time as additional data is available, and existing variability including seasonal trends and vertical stratification can further assessed.

Where groundwater levels fall below the SSTVs listed in Table 4-4 as a result of the SBT Works, the GDE mitigation measures detailed in Table 4-1will be implemented.

Data from the monthly downloads will continue to be assessed against the SSTVs to identify where conditions are not as expected or predicted (discussed further below).

4.3 Groundwater Quality Triggers

Site-specific groundwater quality action triggers have been developed for locations where the baseline assessment identified that groundwater contamination may be within the area predicted to be influenced by construction related drawdown. Triggers were based on where concentrations were:

- Above detect for TPH or PFAS, or
- 10 x the Environment Protection Licence (EPL) criteria for compounds of potential concern (COPCs) which typically exceed the EPL along the alignment (i.e aluminium, cadmium, copper, zinc, total nitrogen and total phosphorus)

Site specific triggers are outlined in the GMP and summarised below in Table 4-5. Triggers are based on detection of a COPC at a concentration above the baseline maximum, with action triggers set for filtered metal concentrations.

This approach acknowledges that existing groundwater conditions exceed EPL limits for a number of parameters in groundwater along the alignment. An adverse change in risk is likely to be at locations where high concentrations already exist (as reported in the baseline assessment), with the intent of the triggers to identify where conditions have significantly changed.

At select sentinel wells, and for analytes where baseline concentrations are less than 10 x the EPL but exceed the initial screening criteria (based on ANZG 2018, 95% species protection), a potential adverse change in conditions is identified by statistical trend assessment (Mann Kendall Statistic), rather than via specific action triggers. As trend analysis requires a minimum of four values, and many construction sampling locations have three or less baseline values, the analysis has been undertaken using the two most recent baseline values combined with the construction monitoring phase data.

Where a statistically increasing trend is reported, the baseline data range will be reviewed, and a trigger exceedance reported if the construction monitoring concentration is greater than 250% of the maximum historical concentration.

Where a trigger is exceeded, or a statistically increasing trend is identified for select analytes (see Table 4-5) and concentrations exceed the initial screening criteria, then an investigation will be carried out which may include:

- Further monitoring to confirm groundwater conditions (increased frequency).
- Assessment to identify if the exceedance represents an adverse change in risk profile and a remedial response is required (refer to Section 7.9.1 of the SWMP), or if the action trigger should be revised or implemented in a sentinel well or for the COPC triggered.

Where trigger exceedances are identified, and concentrations are outside the background range for groundwater along the alignment, the monitoring program will also be reviewed and updated as required.

Table 4-5: Groundwater Quality Triggers relevant to current monitoring period

Location ID [1]	Monitoring Zone	Aluminium	Copper	Zinc	pH	Total N	Total P	Total PFAS	TRH/BTEXN	Other	COPC Trends
MW1 [1]	St Marys							PFOS >1.07ug/L		cis 1,2 DCE >4.7mg/L PCE >0.98mg/L VC > 0.32mg/L	✓
SBT-GW-0001 *	St Marys										✓
SBT-GW-0001B *	St Marys										✓
SBT-GW-1012*	St Marys										✓
SBT-GW-1013*	St Marys										✓
SBT-GW-1014*	St Marys										✓
SBT-GW-1019R [1]	St Marys					>13mg/L	>5.6mg/L	>0.0066ug/L		PCE >203ug/L	✓
SBT-GW-1022	St Marys										✓
SBT-GW-1347A to C*	St Marys										✓
SBT-GW-1348A to C*	St Marys										✓
SMGW-GW02 [1]	St Marys							>0.2ug/L		PCE >1,900ug/L cis1,2 DCE>17ug/L	✓
SBT-GW-1804	TBM Tunnel - South Creek										✓
SMGW-BH-A107	TBM Tunnel - South Creek										✓
SBT-GW-1030	Cross passage / Tunnel (XPN13)	>7.5mg/L	>26ug/L	>542ug/L	pH <4.4			>0.13ug/L			
SBT-GW-1031	Cross passage / Tunnel (XPN14)										✓
SBT-GW-1024	Claremont Meadows SF							>0.09ug/L	TPH C6-C9 > 2,100ug/L		
SBT-GW-1805	Claremont Meadows SF					>19.9mg/L	>6.6mg/L				
SBT-GW-4000	Western Sydney Airport						>5.4mg/L		TPH >C10 >1,620ug/L Toluene > 46ug/L		
SMGW-BH-C320	Western Sydney Airport							> 0.5ug/L	Toluene > 34ug/L		
SMGW-BH-C321	Western Sydney Airport							> 0.046ug/L			
SMGW-BH-C330	Western Sydney Airport	>5,310ug/L		>1,090ug/L	pH <4.9						

Location ID [1]	Monitoring Zone	Aluminium	Copper	Zinc	pH	Total N	Total P	Total PFAS	TRH/BTEXN	Other	COPC Trends
SBT-GW-4003	Bringelly SF								TPH C6-C9 > 20ug/L		
SBT-GW-4005	Bringelly SF							>0.01ug/L			
SBT-GW-4800	Bringelly SF						2.2mg/L				
SBT-GW-4801	Bringelly SF										✓
SBT-GW-4802	Bringelly SF										✓
SBT-GW-4008	Aerotropolis										✓
SBT-GW-4010	Aerotropolis										✓

* Monitored under the St Marys RAP, and reported separately in Monthly mitigation reports. The Monthly Mitigation Report for June 2024 is provided in Annexure G.

1.Included in both Construction Monitoring Program (assessed by Triggers) and St Marys Mitigation Monitoring Program (assessed by trends)

5 Groundwater Monitoring Results

The sampling and monitoring results from the six months of construction monitoring to the 28th June 2024 are included in the following Annexures:

- Annexure A – Summary of Groundwater quality results, with full laboratory reports as provided by CPBG in Annexure B
- Annexure C – VWP hydrographs showing groundwater levels and triggers for each location
- Annexure D – Groundwater level and EC for continuous monitoring wells, with SSTVs shown for GDE monitoring locations
- Annexure E – Statistical analysis of groundwater COPC concentrations for wells with triggers based on trend analysis

All trigger exceedances identified are discussed in the following sections.

5.1 Groundwater Levels

Groundwater levels were monitored by continual telemetry at a total of 22 VWP locations during this monitoring period, with 12 of these locations having established groundwater trigger levels and six of these locations also monitoring EC concentrations. Hydrographs of groundwater level are provided in in Annexure C and Annexure D.

Groundwater level triggers were exceeded during the monitoring period at eight locations which are summarised in in Table 5-1, and graphs of levels provided in Annexure C.

Groundwater levels also show some decrease at most other VWP locations which do not have trigger levels (graphs also provided in Annexure C). Most locations generally showing some stabilisation of levels over time.

Table 5-1: GW Level Trigger Exceedances – Summary and Recommendations

Area	Location ID	Green Trigger Level (m AHD)	Amber Trigger Level (m AHD)	Red Trigger Level (m AHD)	Latest Reading Date	Latest Reading (m AHD)	Comments/Recommendation
Groundwater Wells monitored for EC and level during construction							
TBM Tunnel - South Creek	SMGW-BH-A105S	18.9 Minimum of 18.5	18.4	17.9	12-6-24	**19.22**	Exceedance of green trigger level with decreasing trend from July 2023 to mid-December 2023 and then stabilisation of levels with some fluctuation until early April 2024. Levels then increased in April 2024 above green trigger and continue to fluctuate and possibly increased to end of current monitoring period. Both TBMs advanced through the area in around mid to late April 2024 with construction of XP-N05 commencing on 29 May 2024. As such, the exceedance of the green trigger cannot be attributed to construction activities, as it occurred prior to tunnelling activities commencing near this location. Groundwater levels demonstrate no clear response to the construction of XPN-05 and remain above the trigger values to the end of the reporting period. No action required, continue to monitor.
TBM Tunnel - South Creek	SMGW-BH-A107	20.8	20.3	19.8	27-06-24	11.59	Groundwater levels show gradual decline from August 2023 to 31 January 2024, over which time they decreased to exceed the green and then amber trigger levels. On approximately 31st January 2024, groundwater levels sharply declined by around 8 meters and exceeded the red trigger level. This corresponds a period when the TBMs that were advancing through the area and were stationary and may have allowed groundwater to drain to the tunnel. Groundwater levels continued to fluctuate and showed some recovery between February 2024 to April 2024 as the TBMs progressed and the tunnel was sealed but remained below and exceeding the red trigger level. Groundwater levels since April 2024 have decreased again in response to local cross passage construction and are most recently measuring approximately 8.2 meters below the red trigger level. Discussed further in Section 5.1.1 below.
Western Sydney Airport	SBT-GW-4000	70.5	70	69.5 Minimum of 69	18-6-24	68.99	Green trigger level had been exceeded at this location since monitoring started in June 2023 and levels show a fluctuating slow decline from June 2023 to February 2024, decreasing and exceeding the amber trigger in August 2023. In February 2024, levels abruptly decreased by approximately 0.5 meters and exceeded the red trigger, Levels then generally stabilised at ~69 m AHD for the rest of the monitoring period recorded up to June 2024, excluding 3 abrupt recharge and drawdown events and one abrupt drawn down (to 66.94 mAHD) and recovery to ~69 mAHD over the remaining time period. Further discussion and recommendation provided in Section 5.1.3 below.
Aerotropolis	SBT-GW-4008	71.8	71.3	70.8	7-6-2024	<56	Well has been reported to be dry since 8 May 2024. No level or EC data is available in this monitoring period as the logging equipment has been stuck in well or damaged. Refer to Section 5.1.4 for further discussion and recommendations.
Aerotropolis	SBT-GW-4010	73	72.5	72	24-6-24	65.93	Groundwater levels show a very gradual decrease over time from the start of monitoring in May 2023 until October 2023 where an abrupt decrease of 16.8 meters in groundwater levels was recorded and all trigger levels were exceeded. Water level data quality is then questionable from mid-October 2023 until early June 2024 as the telemetered levels do not align with the available manually gauged water levels (see graph in Annexure D). Water levels recorded from 7 June 2024 onward seem more reliable and show stabilization of water level at around 66 mAHD which remains exceeding the red trigger level by approximately 6.2 meters. Refer to Section 5.1.4 for further discussion.
Exceedances in VWPs							

Area	Location ID	Green Trigger Level (m AHD)	Amber Trigger Level (m AHD)	Red Trigger Level (m AHD)	Latest Reading Date	Latest Reading (m AHD)	Comments/Recommendation
Claremont Meadows	SWD-TU100-20071-VWP07-A	25.4	24.9	24.4	1-7-24	25.03	Groundwater levels fluctuated up and down by approximately 1 meter from the start of monitoring in June 2023 to December 2023 after which they abruptly decreased by approximately 2 meters, exceeded the green trigger value and stabilized until the latest reading date. No action required, continue to monitor.
Orchard Hills	SWD-TU150-22010-VWP02	30.5	30.0	29.5	5-6-24	29.4	Red trigger level first exceeded in early April 2024 following on from an earlier rapid decrease in levels from ~35mAHD to 30 mAHD in August 2023 which exceeded the green and amber trigger levels in October and November 2023 respectively. The initial decrease in August 2023 appears to coincide with when TBM2 was advancing in the area. Construction of the nearest cross-passage (XP-N21) commenced in December 2023 and was completed in March 2024. Levels have fluctuated but show a continual gradual decrease, continuing to exceed the amber trigger until the red trigger was consistently exceeded from late May 2024. Discussed further in Section 5.1.2 below.
Bringelly SF	SWD-TU351-37371-VWP04	50.6	50.1	49.6	28-5-24	50.23	Exceedance of green trigger level after a decrease of ~17m from January 2023 to June 2023, with groundwater levels showing a gradual continual decrease over time. This is likely associated with shaft excavation which commenced in December 2022 and was completed in September 2023. Groundwater levels appear to have stabilised since June 2023 and remain above the amber trigger value. No action required, continue to monitor.

5.1.1 SMGW-BH-A107

In response to the trigger exceedance at SMGW-BH-A107, CPBG initiated a combined hydrogeological and ecological assessment of Claremont Creek and the surrounding area to assess whether impacts to aquatic and terrestrial GDEs may occur, and to implement a mitigation response as may be required. Claremont Creek is a tributary of South Creek and is located around 50m from SMGW-BH-A107.

Site inspections and ecological surveys concluded that previously isolated pools within Claremont Creek in the areas predicted to be experiencing groundwater drawdown were full and flow observed along the creek channel. If groundwater drawdown had altered the baseflow contribution to Claremont Creek, recent heavy rainfall within the catchment appears to have mitigated any changes to water levels and the availability of aquatic habitat within the creek. The ecological survey concluded that ecosystem conditions were similar to previous surveys completed prior to drawdown occurring and no impact has been observed (see Appendix I).

Inspection of stream flow and water level is being conducted periodically (monthly) by CPBG until one month post cross-passage waterproofing completion. The inspections are to identify change in water levels against that recorded in the AMBS report. If groundwater recovery has not occurred and a reduction in creek water levels is observed, ecological surveys will be repeated.

5.1.2 SWD-TU150-22010-VWP02

SWD-TU150-22010-VWP02 is located in the SBT Orchard Hills site, with both groundwater level triggers (Table 6-4 of the GMP) and GDE level triggers (Table 6-11 of the GMP). Along with SBT-GW-1042, the VWP monitors the impact of construction on nearby terrestrial GDEs, with drawdown at both locations predicted to be greater than 2m (Figure 5-1).

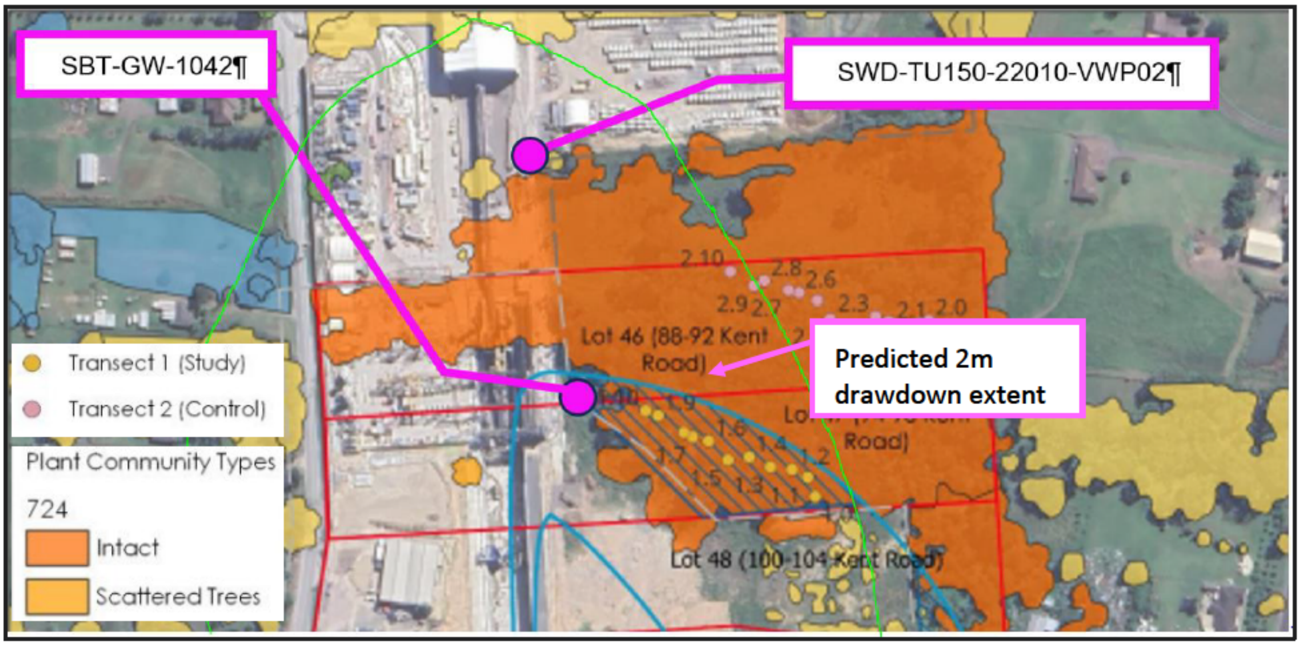

Figure 5-1:Predicted extent of greater than 2m drawdown (green line) and vegetation monitoring locations

(Adapted from AMBS (2024). Orchard Hills Metro Station Vegetation Monitoring, Year 2: 3rd Survey)

SBT-GW-1042 has been handed over to PLM, however when last recorded in late January 2024 levels were at 36.5 mAHD, approximately 3.5m below top of casing. Levels were 1.2m lower than adopted baseline levels, but 3m above the green trigger level of 33.5mAHD, with no significant decrease as was observed in SWD-TU150-22010-VWP02 in August 2023.

This indicates that drawdown was less than predicted in the southern section of the GDE area where vegetation is monitored by Transect 1, which was adopted to assess project impacts (Figure 5-1). Conversely, the western edge of Transect 2, which was adopted as a control, is likely to better represent impacts to the northern portion of the GDE area where levels in SWD-TU150-22010-VWP02 indicate drawdown has been greater.

Three vegetation surveys of these transects have been undertaken; May/June 2023 (before groundwater levels decreased), October 2023 after levels in SWD-TU150-22010-VWP02 decreased, and in June 2024, with results summarised in Table 5-4.

Table 5-2: Mean percent canopy cover (AMBS, 2024)

Survey Transect	Canopy Cover (%)		
	Survey 1 31 May 2023 & 21 June 2023	Survey 2 17 & 18 October 2023	Survey 3 5 June 2024
Transect 1	77	62	75
Transect 2	70	63	74

A decrease in canopy cover was reported in Survey 2 at both transects, with the canopy recovered by Survey 3. The report, which is included in full as Annexure H, concluded that the changes were likely to be within natural variation expected due to the time of year the surveys were completed, and was unlikely to be due to groundwater drawdown. This conclusion is consistent with the lack of impact reported in Transect 2 in June when sustained groundwater drawdown had been reported nearby in SWD-TU150-22010-VWP02 for nine months (August 2023 to June 2024).

Groundwater levels in SBT-GW-1042 at the end of January 2024, and vegetation monitoring in June 2024 indicate that the main woodlands area to the east of the Orchard Hills site has not been impacted by construction related drawdown. The current vegetation monitoring does not include survey sites within the isolated trees closer to SWD-TU150-22010-VWP02, where the red trigger exceedance has been reported and levels continue to decrease. Nonetheless, the use of the monitoring data to support the conclusion is valid in this situation. This is because there is no significant deviation between the data in the two transects and the metrics used to assess impacts of groundwater drawdown to vegetation health improved between survey 2 and 3.

CPBG will continue implementing the current GDE vegetation monitoring at Orchard Hills. Should outcomes of this monitoring indicate potential impacts to vegetation as a result of the decrease in water levels at SWD-TU150-22010-VWP02, the existing GDE vegetation monitoring methodology would be expanded to include additional survey sites in order to determine the potential extent of the impact.

5.1.3 SBT-GW-4000

The previous Biannual Groundwater Monitoring Report (SMWSASBT-CPG-SWD-SW000-GE-RPT-040410) noted groundwater levels steadily decreasing by ~0.1m per month, with exceedance of amber trigger in August 2023, prior to construction commencing in the area. It was concluded that the steady decrease in combination with no construction yet in this area, suggested that the decreasing levels may be associated with equipment drift. It was recommended that a comparison with manual groundwater levels is undertaken to determine if this data logger required maintenance. It was also noted that limited groundwater level data was available to set triggers.

A comparison of the data logger level readings against manually gauged data indicated that there was no equipment drift, and that the level data provided by the data logger was representative of actual groundwater levels. As such, it appears that groundwater levels had exceeded the amber trigger values prior to works commencing in the area. It is recommended to reduce trigger levels by 0.5m based on the availability of more data to assess natural variability. Logger data indicates that groundwater levels for the most recent reading on 18 June 2024 are slightly below the red trigger (68.99mAHD), manually gauged level readings from 18 June 2024 indicate that groundwater levels remain above the revised red trigger at 69.135mAHD.

The groundwater level decrease in February 2024, which coincided with the TBMs reaching XPS13, would exceed the revised amber, but not the revised red trigger.

As the closest GDE is 230m away, and drawdown beside the XPS13 is less than 2m, if levels remain above the red trigger, then active management measures are not considered to be required.

5.1.4 SBT-GW-4008 and SBT-GW-4010

No level data is available for SBT-GW-4008 in this monitoring period as loggers are unable to be downloaded as connections are damaged.

The well has been dry since first manually gauged on 8 May 2024, after the TBMs had passed through the area, indicating that groundwater has drawdown at least 16m. Manual gauging has confirmed drawdown, with the well dry when gauged on 27 May 2024 and 7 June 2024 after cross passage (XPS 20) construction commenced on 24 May 2024.

Groundwater levels at SBT-GW-4010 show a very gradual decrease over time from the start of monitoring in May 2023 until October 2023. Water level data logger failed mid-October 2023 until early June 2024. Water level data logger recordings from 7 June 2024 onward show stabilization of water level at around 66 mAHD which remains exceeding the red trigger level by approximately 6.2 meters.

As the lateral extent and duration of drawdown is unknown, impacts on groundwater receptors are unclear. As such further, investigation was undertaken to determine the potential impacts of the decrease in water levels.

Based on the pre-construction depth to groundwater measured at SBT-GW-4008 and SBT-GW-4010 and the geological log for this borehole, the watertable was positioned approximately 6 and 5 m bgl respectively, placing it 3 m and 1.5m below the top of the weathered siltstone rock. While the root depths of individual tree species can vary significantly, the average maximum root depth of mature trees is around 5 m, with the vast majority of the root mass occurring within the first 0.5 m of the soil profile (Canadell et al., 1996). The likelihood that deep roots would penetrate several metres into siltstone rock to access the watertable is relatively low outside of arid climate settings, as shallow sources of rainfall recharge would be more readily available. The available data, whilst limited, suggests that it is unlikely that local vegetation would access and rely on groundwater.

Furthermore, it was noted that SBT-GW-4008 and SBT-GW-4010 are in an area subject to precinct planning requirements of the Order to confer biodiversity certification on the *State Environmental Planning Policy (Sydney Region Growth Centres) 2006*. This SEPP has been superseded by the *State Environmental Planning Policy (Precincts—Western Parkland City) 2021*.

Section 3.28 of the Precincts – Western Parkland City SEPP stipulates when approval to clear native vegetation is required. This includes land zoned for Environmental and Recreation, land identified as a High Biodiversity Value Area, Flood Prone and Major Creeks land and Transitional Land. This well is not located in or near any of these areas.

Given that there is limited evidence to indicate that the vegetation in this area is groundwater dependent, as well as the fact that these wells are located within a biodiversity certified area, no further action is recommended.

5.2 EC Results

Groundwater ECs recorded in GDE trigger wells to approximately 28th June 2024 are shown with pre-construction data in charts in Annexure D, with results summarised in Table 5-3.

Field readings during water quality sampling were reviewed for SBT-GW-1805 as the EC logger data continues to show erroneous readings constant at around 23,124 µS/cm. Field readings confirmed that the EC SSTV trigger had not been exceeded during the monitoring period. Logger maintenance or replacement is required.

Table 5-3 : EC results in GDE trigger wells

Area	Bore ID	Preliminary EC SSTV (µS/cm)	Latest EC	Comments
Claremont Meadows	SBT-GW-1805	3,650	Logger reading consistently: ~23,124 µS/cm Field EC of 2,070 µS/cm when sampled in October 2023 Field EC of 558 µS/cm when sampled in April 2024	Error with EC logger. Instrument was reset in 2023. Field readings in 2023 and 2024 confirmed no breach of EC trigger. Instrument being replaced in September.
Claremont Meadows	SBT-GW-1028	Inaccessible.	Field measured EC ranged between 21,400 to 27,600 uS/cm during this monitoring period.	Manually gauged data collected, and will be on-going. Refer to Section 3.1 and Table 5-4 below

Table 5-4: EC SBT-GW-1028

Sample date	EC (µS/cm)	SSTV	Discussion
23-Jun-23	26100	-	While the field EC readings exceeded the mean SSTV in both May and June 2024, the exceedance was not more than 150% greater than the SSTV on either occasion and does not indicate a rising trend. No action required. Continue to monitor EC via field readings.
24-Apr-24	21400	-	
2-May-24	27600	25033	
27-Jun-24	26300	25350	

5.3 Groundwater Quality Results

5.3.1 Cross Passage Construction

Seven locations were monitored to assess the impact of cross passage construction on groundwater quality, with sampling dates and changes in groundwater chemistry summarised in Table 5-5.

Where four or more sample results are available groundwater quality trends have been statistically assessed (summary provided in Annexure E). Where three or less data points are available, the results have been reviewed qualitatively for significant changes in response to construction.

Where changes in groundwater quality during construction were identified, the range of concentrations reported during the baseline assessment (Tetra Tech 2023d) have been reviewed to assess whether quality results reported during construction were outside of the baseline range.

Recommendations are provided where additional sampling is required to confirm post construction conditions or, where monitoring is ongoing, to assess additional analytes.

Table 5-5: Groundwater quality monitoring for cross passage construction

Location	Cross Passage	Construction Period	Groundwater sampling	Changes in groundwater quality during construction	Recommendation
SMGW-BH-A360	XP-N2	29 May to 14 September 2024	1 May, 12 June, 28 June (ongoing)	Decrease in filtered metals (aluminium, manganese). Increase in TOC (from 4mg/L to 33mg/L). TDS and major cations and anions no trend.	Due to increase in TOC include TPH in final rounds of XP monitoring
SMGW-BH-A107	XP-N09	17 May to 28 May 2024	1 May, 15 May, 4 June, 28 June	Increase in pH (field) from 7.04 to 9.28. (Baseline range 7.3 to 8.1) Increase in total nitrogen from 2.4mg/L to 7.9mg/L (mostly organic N). Baseline range 2mg/L to 6.6mg/L	Sample for base suite to confirm return to pre-construction conditions.
SBT-GW-1804	XP-N10	25 April to 15 May 2024	15 May, 4 June, 28 June	Increase in TDS from 516mg/L to 2,990mg/L. Baseline TDS of 18,100mg/L. No change in conditions based on trends including baseline event	None
SBT-GW-1030	XP-N13	8 April to 10 June 2024	3 March, 24 April, 15 May, 3 June, 28 June	Increase in pH and decrease in TDS during construction, but return post construction. Increase in TOC from 2mg/L to 21mg/L, and similar to baseline range 11 to 15mg/L.	None
SBT-GW-1031	XP-N14	24 March to 19 June 2024	6 March, 24 April, 15 May (ongoing)	Increase in filtered metals (aluminium, zinc, nickel) Decrease in total nitrogen 78.7mg/L to 1.4mg/L (mostly organic N), total phosphorus 16.4mg/L to 0.1mg/L and TOC 59mg/L to 10mg/L	Sample for base suite to confirm return to pre-construction conditions if metals remain elevated.
SBT-GW-4000	XP-S13	11 May to 2 August 2024 (forecast)	9 February, 14 April, 10 May, 18 June (ongoing)	Decrease in TDS from 11,500mg/L to 1,000mg/L (baseline range 11,500 to 10,700mg/L) Decrease in filtered metals (iron, manganese), total nitrogen and phosphorus Increase in TOC from 4mg/L to 21mg/L, baseline 2mg/L Detectable TPH C10 – C36 (250ug/L to 600ug/L), within historical range	Continue to sample for base suite and TPH
SBT-GW-4008	XP-S20	24 May to 30 August 2024 (forecast)	Not sampled as well dry due to drawdown	Not assessed	See Section 5.1.4
SBT-GW-4010	XP-S21 and XP-S22	11 June to 3 October 2024 (forecast)	4 May, 27 May, 19 June 2024 (ongoing)	Insufficient construction data points to assess impact (only one)	Continue with monthly sampling during XP construction

5.3.2 Trigger exceedances and increasing trends

Groundwater quality data collected during the monitoring period from GMP wells was compared to the groundwater quality triggers detailed in Table 4-5.

The only trigger exceedance reported was for PFAS in SBT-W-1019_R where the total PFAS concentration of 0.11 µg/L exceeded the GMP trigger of 0.066 µg/L, which was based on the concentration previously reported at this location. Multi-level sampling was undertaken at SBT-GW-1019_R in March 2024 before the well was decommissioned prior to the TBMs passing through the area. Only the shallow sample exceeding the trigger, with both deeper samples below the level of reporting (LOR) of 0.01 µg/L, indicating the vertical extent of impact was limited. This minor trigger exceedance is therefore not considered to indicate a change in conditions, or risk profile.

Mann-Kendall statistical analysis was used to assess trends for selected COPC as detailed in Table 4-5. COPCs with increasing, probably increasing, or decreasing trends are summarised in Table 5-6, and presented alongside the previous highest concentration.

Trends for all COPCs for all wells are summarised in Annexure E.

Table 5-6: Triggers based on increasing COPC trends

Location Code	Monitoring Zone	COPC	Latest Concentration	Previous Highest result	Trend
SMGW-BH-A107	Northern Tunnels	pH	9.0	7.8 December 2022	Increasing
MW1 [1]	St Marys	Total nitrogen	8.6 mg/L	31 mg/L October 2023	Increasing
MW1 [1]	St Marys	Zinc	65 ug/L	21 ug/L December 2022	Increasing
SBT-GW-1019_R	St Marys	pH	7.7	8.0 December 2023	Increasing
SBT-GW-1024	Claremont Meadows	Zinc	104 ug/L	1,090 December 2022	Probably increasing
SMGW-BH-C330	WSI	pH	7.3	6.7 September 2023	Probably decreasing

1. Mitigation monitoring well. Refer to Section 5.4 and Annexure G for chlorinated hydrocarbon trends

The pH was observed to be statistically increasing at three locations, however at two of the locations the latest pH was less than the previous maximum reported (SBT-GW-1019_R) or the increase bought the pH into the neutral range (SMGW-BH-C330). The pH changes in these wells are therefore within the expected or desired range and are not discussed further.

Similarly, changes in concentrations of total nitrogen in MW1 and zinc in SBT-GW-1024 were either within the previous range or indicated an improvement in groundwater quality.

The increase in laboratory-measured pH above the previous range in SMGW-BH-A107 in June 2024 (Figure 5-2) corresponds to construction of XP-N09, and significant drawdown of groundwater levels in the area as discussed in Sections 5.1. As construction of XP-N09 is now complete, based on the schedule provided, a review of levels and water quality post construction is required to assess whether the water quality has returned to pre-construction conditions.

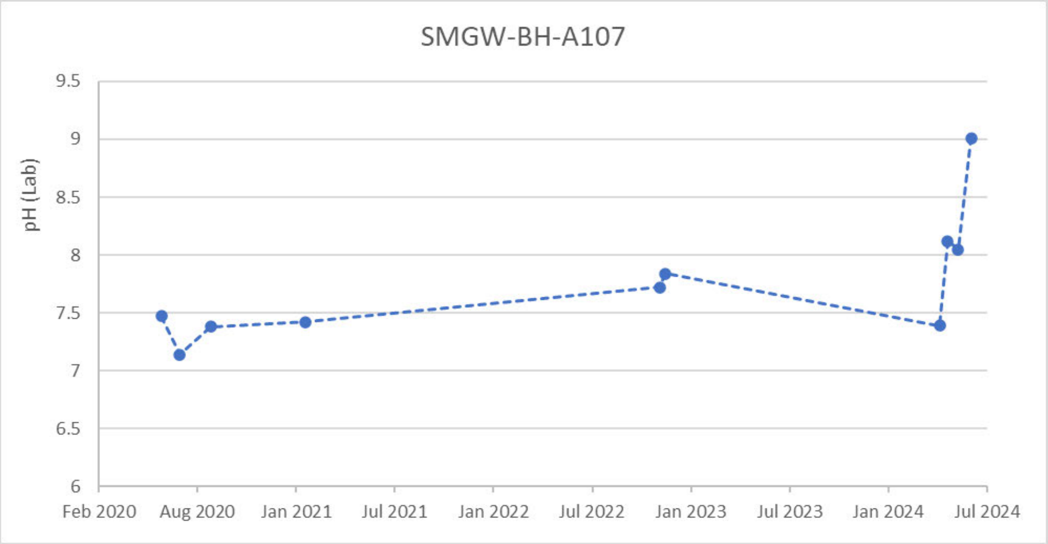

Figure 5-2: Groundwater pH over time in SMGW-BH-A107

The concentration of zinc (filtered) in MW1 in March 2024 represented a threefold increase over the previous reported maximum (Figure 5-3), with concentrations historically ranging from <5 µg/L to 21 µg/L. Groundwater levels in MW1 have not been affected by construction activities, and the TBMs did not pass beneath MW1 until April/May 2024, therefore the change in zinc concentrations is not attributed to project activities. Additional monitoring will assess whether the concentration of 65 µg/L in March 2024 represents an increase over the longer term.

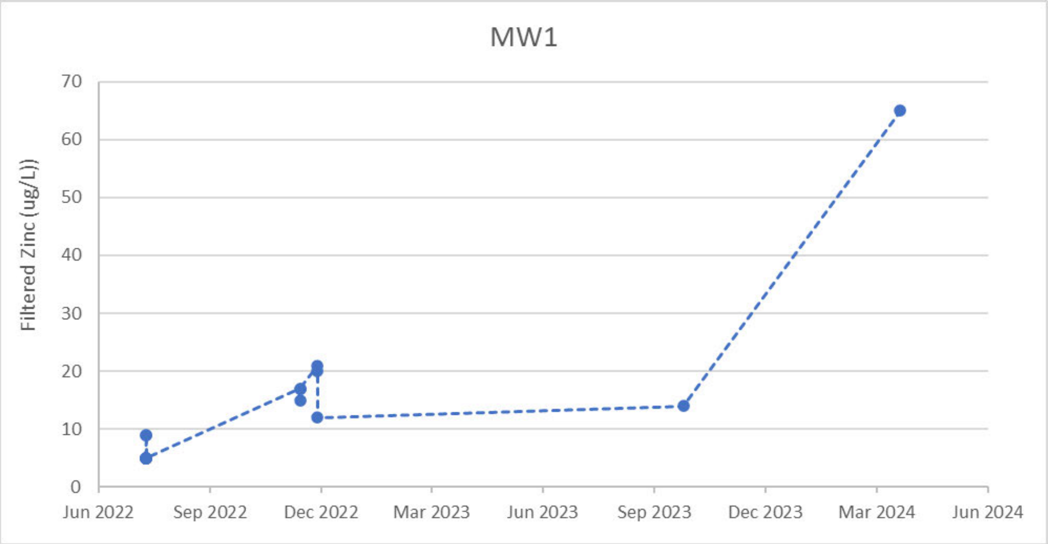

Figure 5-3: Filtered zinc concentrations over time in MW1, St Marys

Note that the responsibility for construction monitoring has now been passed to PLM for the following locations where trigger exceedances were identified in the previous Biannual report: SBT-GW-1002 (for aluminium)

- SMGW-BH-A401 (for total phosphorus)
- SBT-GW-1042 (for pH)
- SBT-GW-1017 (for zinc)
- SBT-GW-1001 (for cadmium).

5.4 Mitigation Monitoring – St Marys

Groundwater mitigation monitoring has been conducted at St Marys in accordance with the mitigation monitoring program as detailed in Section 2.5. The full report for June 2024 is provided in Annexure F. In summary, the results to the end of June 2024 indicate:

- Groundwater levels close to the Station excavation have been drawn down by excavation related dewatering, however Station construction activities do not appear to have changed the groundwater flow regime and gradient in the vicinity of the chlorinated hydrocarbon source area and PRB;
- Concentrations of chlorinated hydrocarbons in groundwater samples collected from between the PRB and the station box were below the LOR and the trigger values;
- Concentrations of Trichloroethene (TCE) and cis 1,2 dichloroethene (DCE) are statistically increasing in one monitoring well (MW2) in the vicinity of the contaminant source, with all other key chlorinated hydrocarbons in source area wells decreasing, stable, or showing no trend, and are broadly consistent with previously reported concentrations;
- The maximum concentrations in MW2, where TCE and cis 1,2 DCE were statistically increasing, were reported in early May and corresponded with TBM-1 passing beneath the source area. Lower concentrations within the historical range were reported in all following monitoring events in May and June 2024, indicating that the increase was transient. The short-term increase is not considered to indicate a major change in conditions, or an adverse change in the risk profile;
- No additional assessment or contingency measures are currently required.

The second TBM (TBM-2) broke through at St Marys on 20 June 2024, therefore weekly sampling in the source area will continue at least until 12 July, which will provide four rounds of post-TBM data.

PRB mitigation monitoring will continue to assess groundwater levels and gradients, and contaminant concentrations between the Station box excavation and the PRB.

6 Construction Groundwater Inflow and EC monitoring

A summary of inferred groundwater inflows and wastewater treatment plant (WTP) discharges is provided below, consistent with the reporting schedule as outlined in Table 8-1 of the GMP.

The WTPs at Aerotropolis and St Marys were handed over to PLM in October and November 2023 respectively, and therefore are not discussed in this report.

The WTP effluent, reuse and disposal associated with the project is summarised in Table 6-1 along with reporting completed.

Table 6-1: Summary of waste water treatment, reuse and disposal, and reporting

Water Treatment Plant	WTP Effluent Reuse / Disposal during Reporting Period	Reporting
Claremont Meadows	Discharge to Sydney Water asset under Trade Waste Agreement 52828. Flows at Claremont Meadow are measured at two locations; the offsite tanks which collect water from the site (see Figure 6-1), and the tradewaste flow, which includes water from the site and also water transferred from other sites (see Figure 6-3).	Samples at Trade Waste discharge point have been collected every 8 days since 3 June 2023 Results provided directly to Sydney Water within 21 days of sampling event.
Orchard Hills	Transported to Claremont Meadows for Discharge to Sydney Water asset under Trade Waste Agreement 52828. Reuse as dust suppression on spoil conveyor.	Samples at Trade Waste discharge point have been collected every 8 days since 3 June 2023 Results provided directly to Sydney Water within 21 days of sampling event.
Airport Business Park	Disposal at licensed waste facility. Note: Airport Business Park site handed over to SSTOM Contractor on 4 June 2024. All discharges thereafter are managed by the SSTOM Contractor.	N/A
Airport Terminal	Disposal at licensed waste facility.	N/A
Bringelly	Transport to Claremont Meadows for Discharge to Sydney Water asset under Trade Waste Agreement 52828. Disposal at licensed waste facility. Note: Bringelly WTP decommissioned in March 2024 after TBM breakthrough and water sent to Airport Terminal WTP.	Samples at Trade Waste discharge point have been collected every 8 days since 3 June 2023 Results provided directly to Sydney Water within 21 days of sampling event.

WTP daily and cumulative volumes have been used as a surrogate measure of groundwater inflows, noting that the volumes may also capture additional inflows from rainfall over the excavation footprints, and any water generated by construction and washdown activities.

In general, the timing of inflows matches well to when excavations began extending below the water table, consistent with groundwater contributing the majority of the total volume. The EC of inflow has also been assessed and compared to groundwater EC ranges reported for each area during the Baseline Groundwater Assessment (Tetra Tech, 2023d).

6.1 Claremont Meadows

Claremont Meadows (CLM), shaft excavation started 16th December 2022 and finished 12th September 2023.

Flow into the excavation at CLM were negligible until April 2023. The average daily inflow has been ~ 32 kL/day up to a maximum of 533 kL/day. Electrical conductivity data indicates that excavation inflows were initially fresh (<1 mS/cm), increased over time to >20 mS/cm (assumed to be the maximum range for the sensor based on flatline), and then decreased to between 5 to 10 mS/cm in the current reporting period. The EC trends are consistent with fresher water from the alluvium flowing in while the excavation was shallow, with increasing contribution from groundwater in the residual and bedrock aquifer as the excavation deepened (Table 6-2).

Table 6-2: Claremont Meadows groundwater EC baseline groundwater values

CLM Alluvium EC (mS/cm)			CLM Residual EC (mS/cm)			CLM Bedrock EC (mS/cm)		
Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean
5.9	8.8	7.7	0.9	34.1	12.1	1.8	26.1	16.4

(from Baseline Groundwater Assessment, Tetra Tech 2023d)

The flows provided below are understood to be from the site, noting that trade waste discharge from Claremont Meadows also includes water from Orchard Hills and Bringelly as this is transported in trucks to the Claremont Treatment Plant (refer Table 6-1). Trade waste flows are shown on Figure 6-3.

In total there has been approximately 22 ML of inflow to the Claremont Meadow shaft.

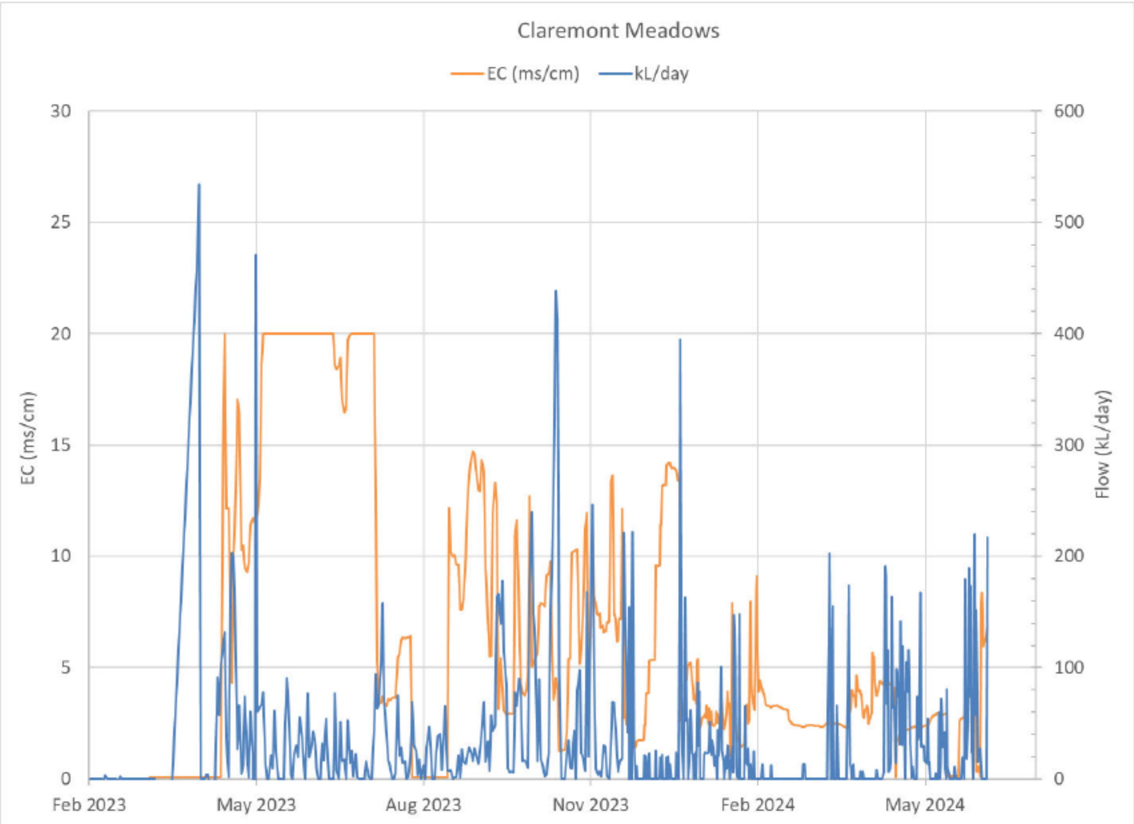

Figure 6-1: Daily inflows and EC at Claremont Meadows Offsite Tanks

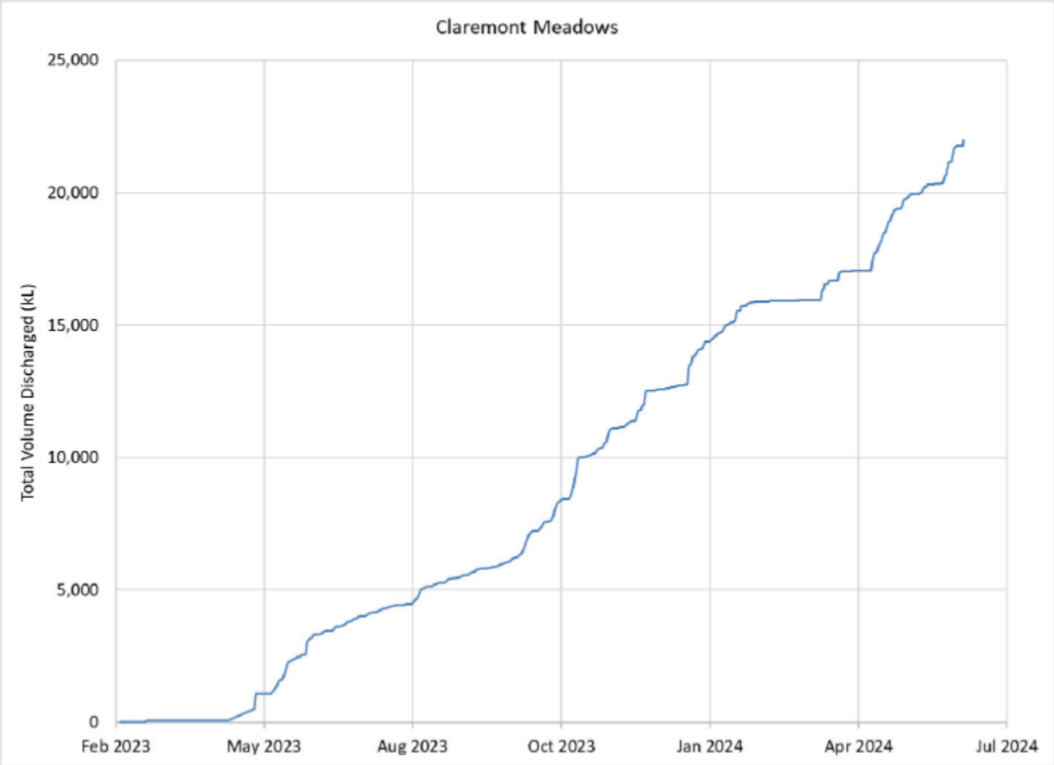

Figure 6-2: Cumulative volumes to Offsite Tanks at Claremont Meadows

Daily trade waste discharge from Claremont since the beginning of December 2023 has ranged up to 680 KL on 28th February 2024, with no effective discharge since 10 May 2024 (Figure 6-3, note flows shown as KL/12hr period).

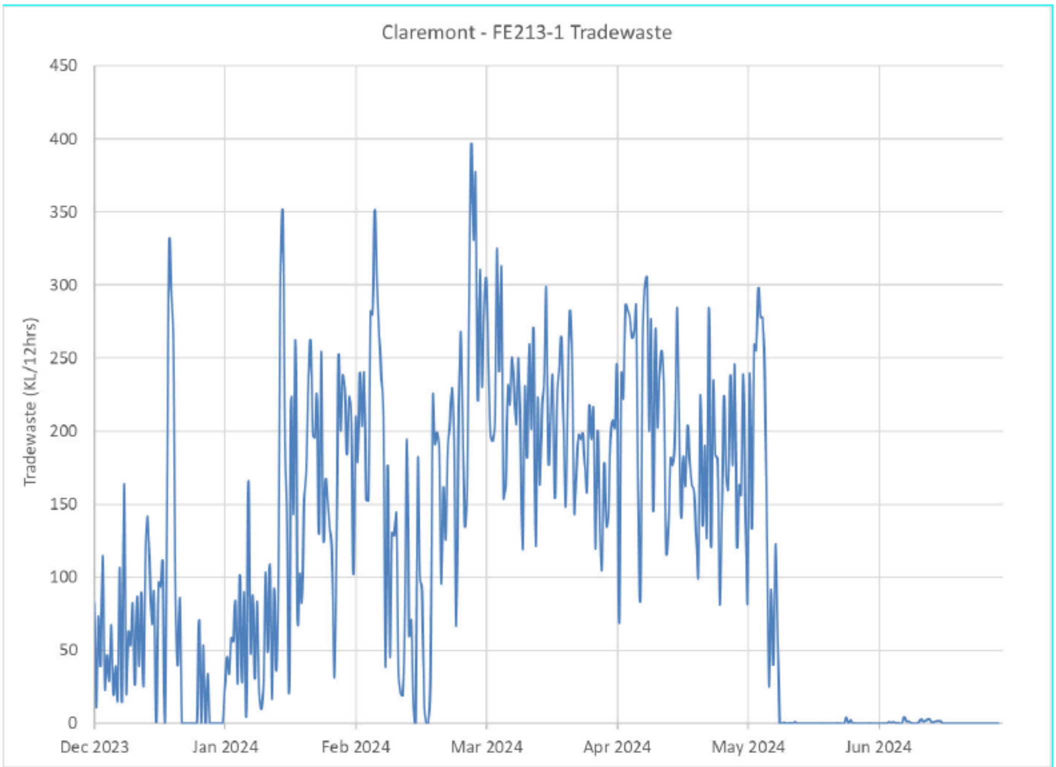

Figure 6-3: Tradewaste from Claremont Meadows - 3 December 2023 to 30 June 2024

6.2 Orchard Hills 1

Flow into the excavation at Orchard Hills commenced early April 2023, although volumes were minor until mid-June 2023.

There are two WTP at Orchard Hills; Orchard Hills 1 and Orchard Hills 2.

Water from Orchard Hills 1 is either transported to Claremont Meadows or the recycle tank which is used for dust suppression. The average measured daily flow at Orchard Hills 1 was 92 kL/day at the measurement point, with sporadic maximums of around 600 kL/day reported in June 2023, December 2023 and May 2024 (Figure 6-4).

Water from Orchard Hills 2 is fed into the plant (included in OH1) of offsite tanks at Airport Dive to be used for dust suppression (Figure 6-5). The highest flows were reported in September and October 2023 of over 2,400 KL/day. In the past eight months daily flows have significantly reduced, and have averaged around 90 KL/day since December 2023, similar to OH1.

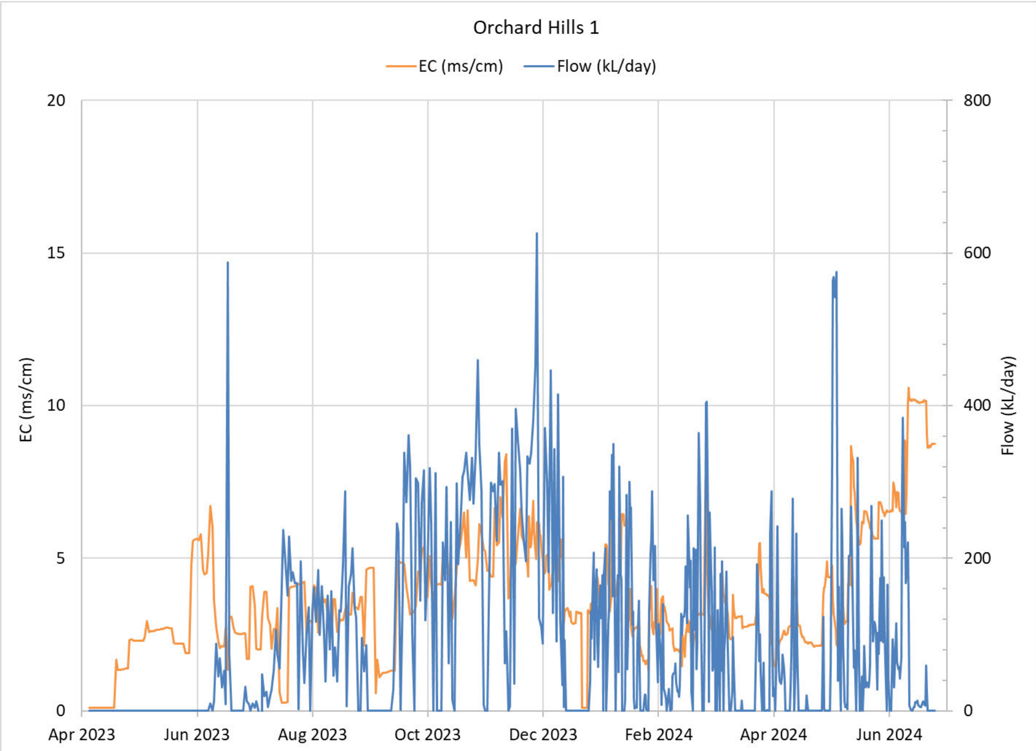

Figure 6-4: Daily plant feed flows and EC at Orchard Hills 1

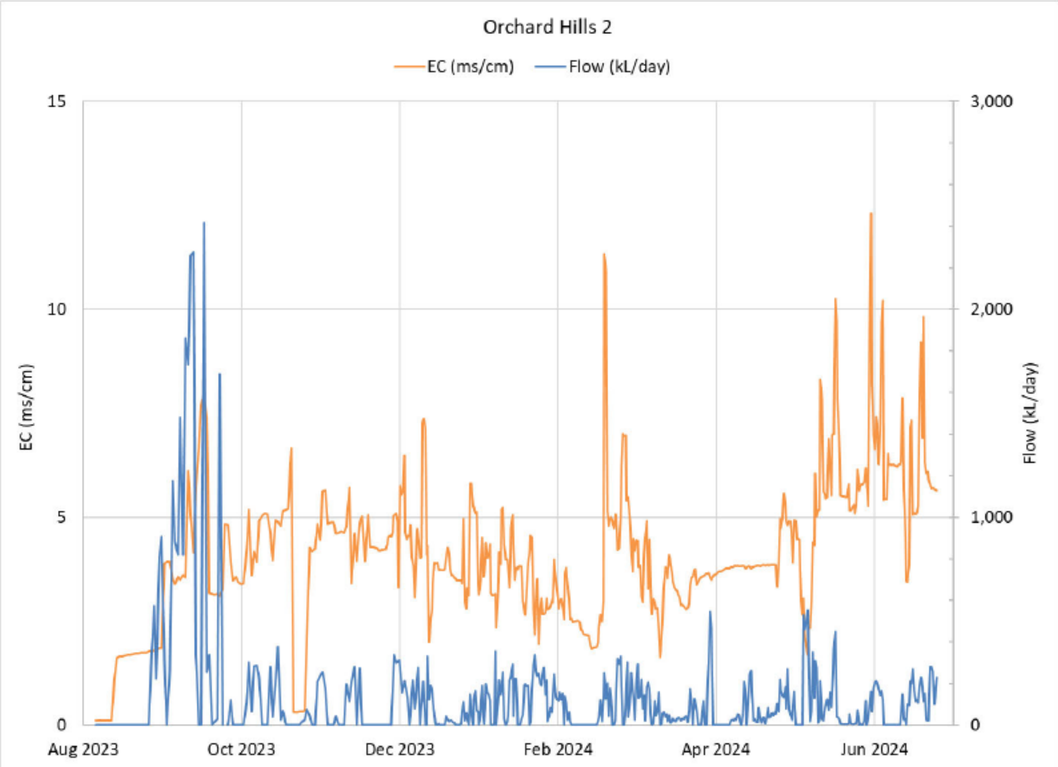

Figure 6-5: Daily inflows and EC at WTP feed for Orchard Hills 2

Electrical conductivity data indicates that excavation inflows were relatively fresh (~2 mS/cm) and increased slightly over time to around 5 mS/cm, which is lower than expected based on average groundwater EC in all aquifers (Table 6-3). EC has been variable in 2024, with relatively fresh (~3 mS/cm) inflows reported at both OH1 and OH2 until May 2024. The EC at both OH1 and OH2 in June 2024 has been the highest reported, indicating increasingly saline water is being drawn into the excavation.

Table 6-3: Orchard Hills groundwater EC baseline values

OHE Alluvium EC (mS/cm)			OHE Residual EC (mS/cm)			OHE Bedrock EC (mS/cm)		
Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean
8.3	37.0	18.0	11.5	31.9	23.5	1.8	32.7	24.3

(from Baseline Groundwater Assessment, Tetra Tech 2023d)

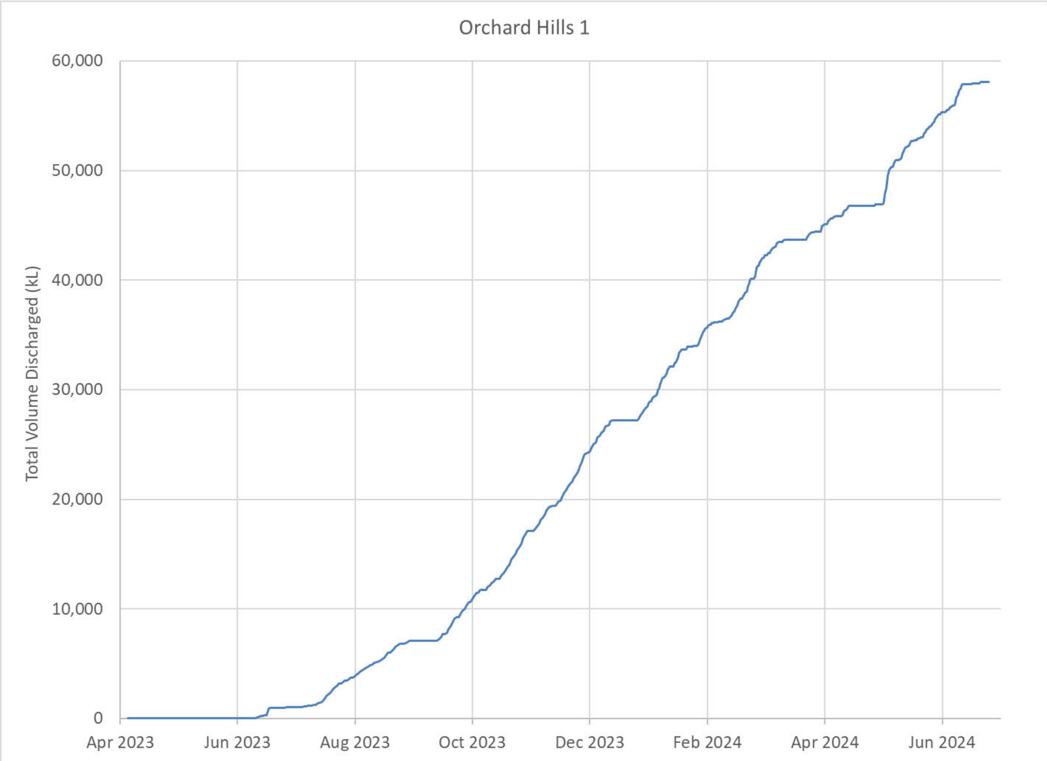

Figure 6-6: Cumulative inflows at WTP feed at Orchard Hills 1

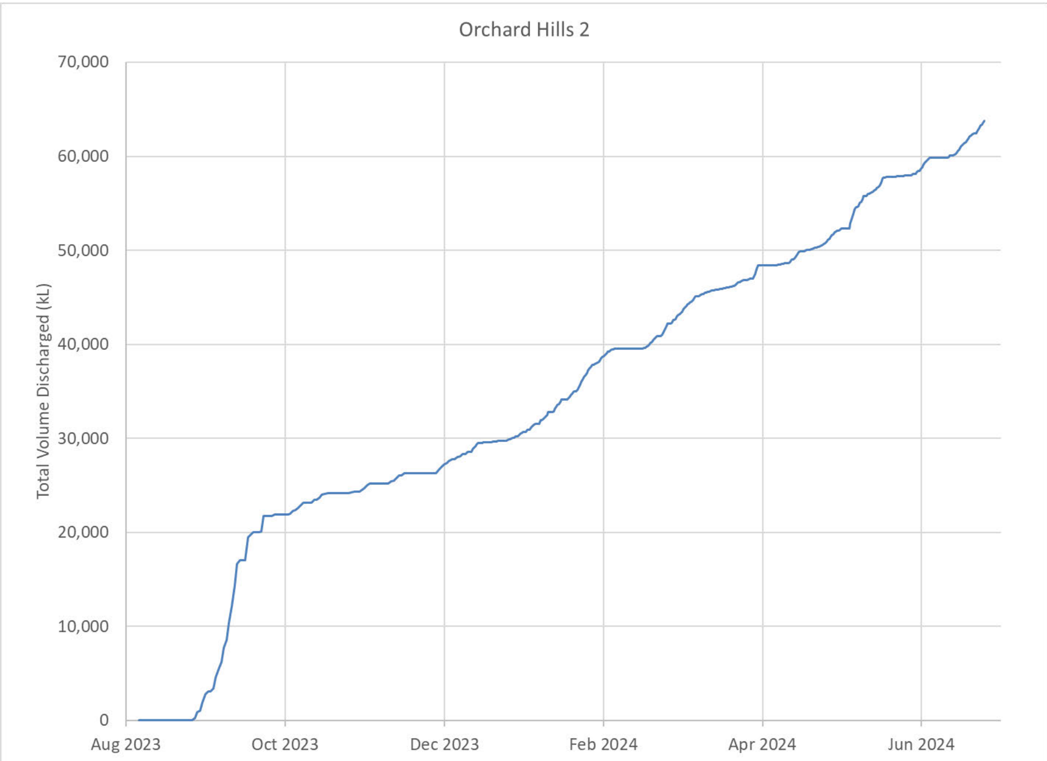

Figure 6-7: Cumulative plant feed volumes to Orchard Hills 2

A total of nearly 58 ML has been recorded at Orchard Hills 1, with flow relatively constant since mid-June 2023 (Figure 6-7). Total volumes at Orchard Hills 2 have been slightly higher (~64 ML), with the majority of flow occurring since September 2023 (Figure 6-7).

6.3 Airport Business Park

Excavation at the Airport Business Park started 13th September 2022 and finished 24 April 2023. The area was handed over to PLM on 4 April 2024.

Flow into the WTP at Airport Business Park commenced in December 2023. The average measured daily inflow was 80 kL/day, however rates have been variable, ranging from <1 KL/day up to a maximum of 455 kL/day in April 2024 (Figure 6-8).

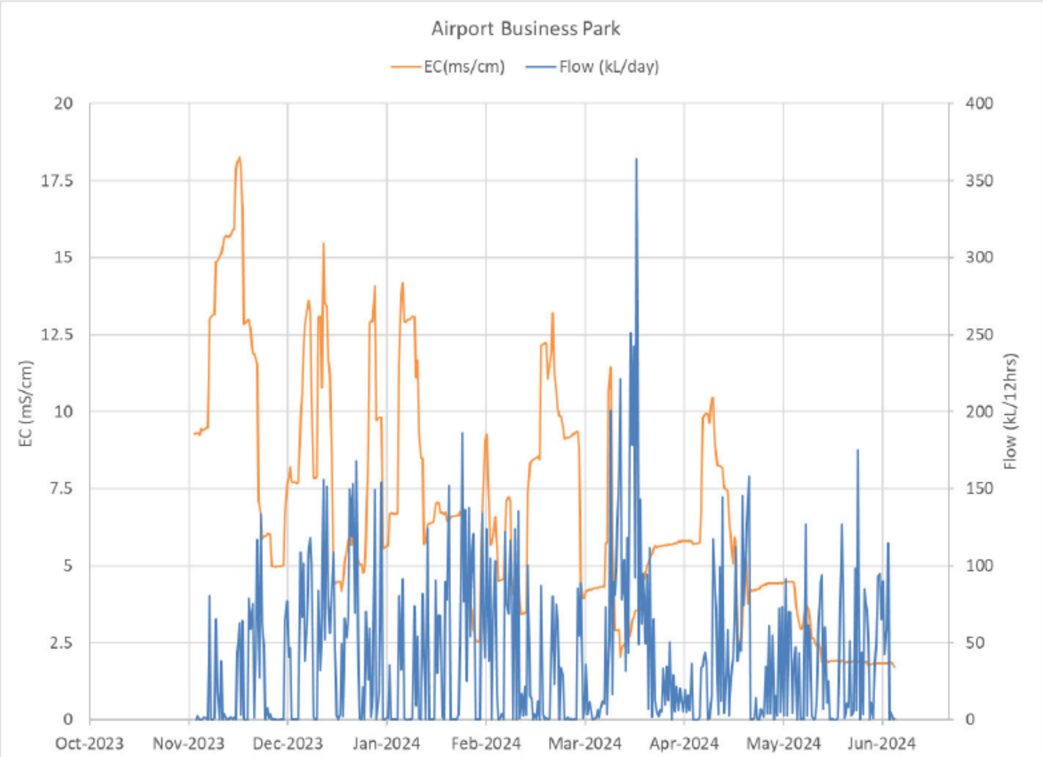

Figure 6-8: Daily inflows and EC at Airport Business Park WTP

Electrical conductivity data indicates that flows to the WTP have been variable but were initially high (>10 mS/cm) and have decreased over time, with the flows in June 2024 much fresher and mostly <2 mS/cm. Both the initial and recent reported EC are fresher than the mean EC reported in all groundwater on Airport Land (Table 6-2).

Table 6-4: Airport Land EC Baseline Values

Airport Alluvium EC (mS/cm)			Airport Residual EC (mS/cm)			Airport Bedrock EC (mS/cm)		
Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean
0.83	26.7	18.2	4.7	32.0	22.1	2.3	37.2	22.5

(from Baseline Groundwater Assessment, Tetra Tech 2023d)

In total, flow at Airport Business Park WTP has been approximately 17ML since December 2023 (Figure 6-9).

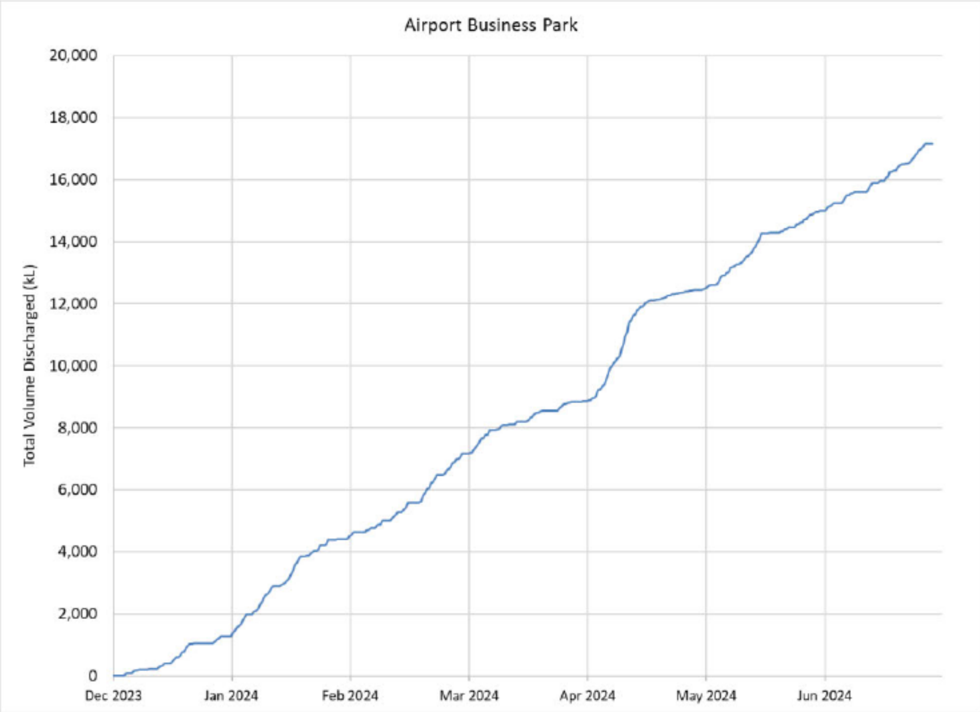

Figure 6-9: Cumulative WTP volumes at Airport Business Park

6.1 Airport Terminal

Airport Terminal Station Excavation started 13th February 2023 and finished 21st November 2023.

Flow into the Airport Terminal Station WTP commenced on 1st December 2023, with an average measured daily inflow of 310 kL/day and a maximum of 990 kL/day recorded 29th May 2024. Inflows volumes have been variable, but generally increased from December to the end of May, with a decrease from mid-June 2024 (Figure 6-10).

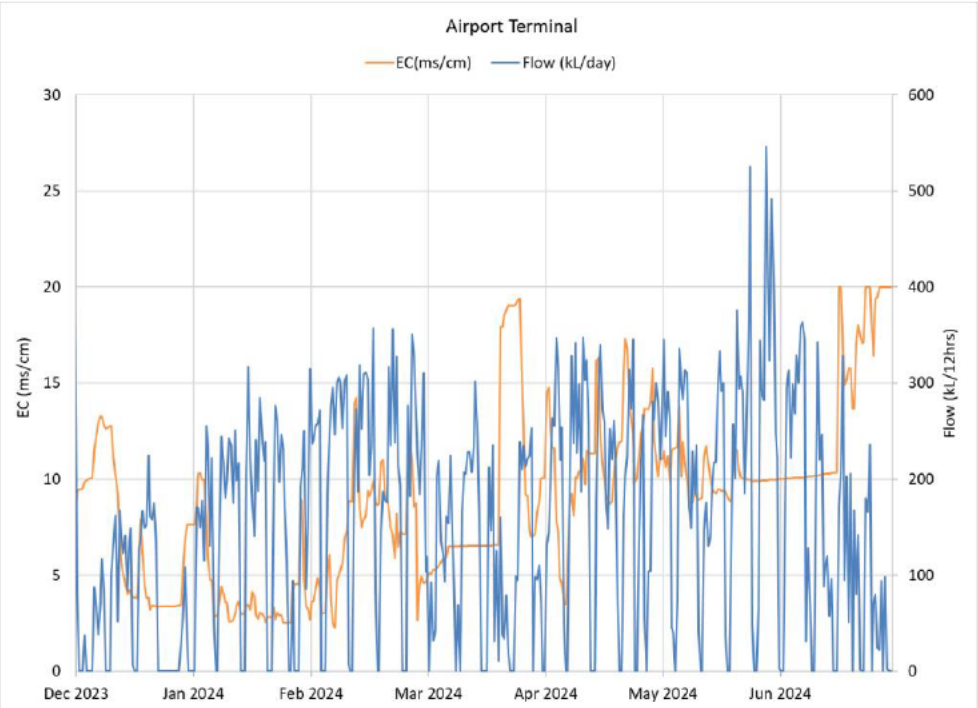

Figure 6-10: Inflows (per 12hrs) and EC at Airport Terminal WTP

Electrical conductivity data indicates that flows to the WTP have increased over time from 5 mS/cm or less from mid December 2023 to early February 2024, up to between 15 to 20 mS/cm in the second half of June 2024.

The ECs of inflow to the WTP were initially much less than the mean EC reported in all aquifers for the baseline groundwater assessment on Airport Land (Table 6-4), but by June 2024 were similar to what is expected from groundwater inflows. Total discharge volumes at Airport Terminal since December 2023 have been approximately 66 ML (Figure 6-11).

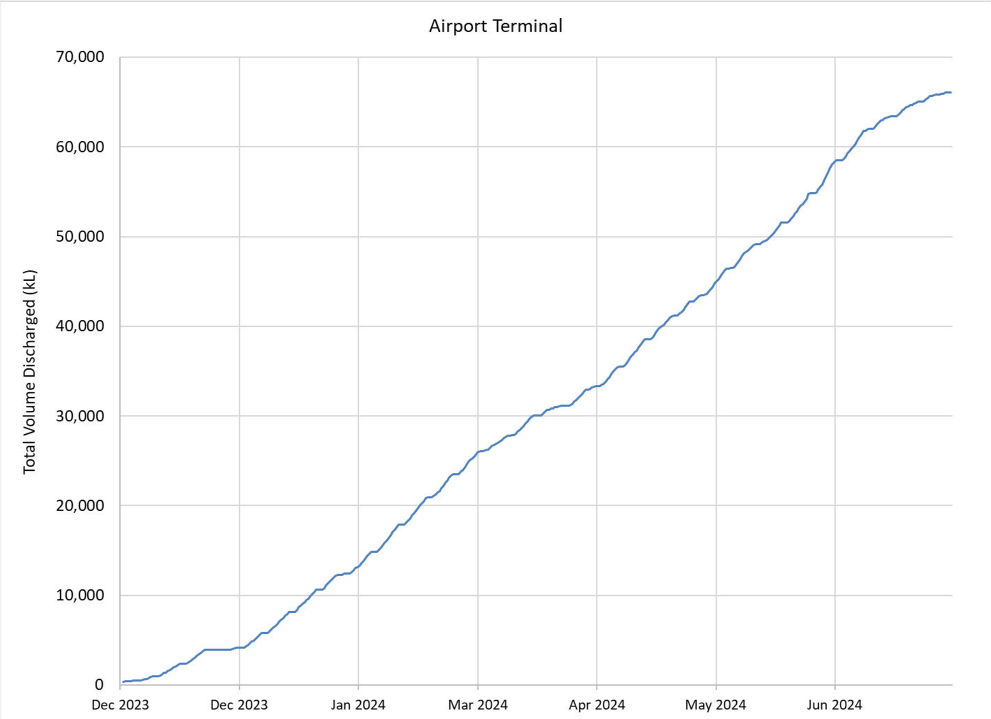

Figure 6-11: Cumulative discharge volume at Airport Terminal

6.2 Bringelly

Bringelly Shaft excavation started 22nd December 2022 and finished 5th September 2023.

Flow into the excavation at Bringelly commenced May 2023, with an average measured daily inflow of 9.5 kL/day and a maximum of 146 kL/day on the 16th April 2024. With the exception of the spike around mid-April 2024, there has been limited flow to the WTP since mid-March 2024.

EC data indicates that excavation inflows rapidly increased to >20 mS/cm (assumed to be the maximum range for the sensor), decreasing slightly after excavation finished in September to around 17 mS/cm, similar to the baseline EC range for the area (Table 6-5). In January and February 2024, the water quality changed significantly from an EC of close to 20 mS/cm at the start of the year, decreasing to ~2.5 mS/cm at the start of March.

As with Orchard Hills, the flow from Bringelly is then transported to CLM. Total volumes discharged from Bringelly to May 2024 were approximately 4.19ML (Figure 6-13).

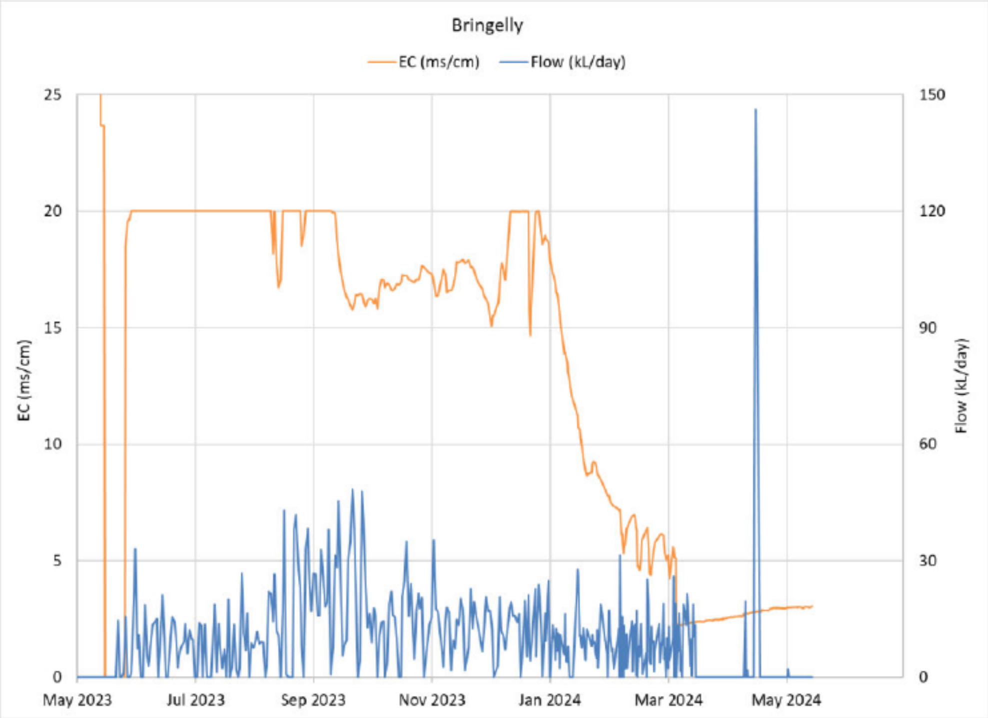

Figure 6-12: Daily inflows and EC at Bringelly WTP feed

Table 6-5: Bringelly groundwater EC baseline values

Bringelly Alluvium EC (mS/cm)			Bringelly Residual EC (mS/cm)			Bringelly Bedrock EC (mS/cm)		
Minimum	Maximum	Mean	Minimum	Maximum	Mean	Minimum	Maximum	Mean
21.0	21.0	21.0	23.4	23.9	23.6	21.0	26.0	22.5

(from Baseline Groundwater Assessment, Tetra Tech 2023d)

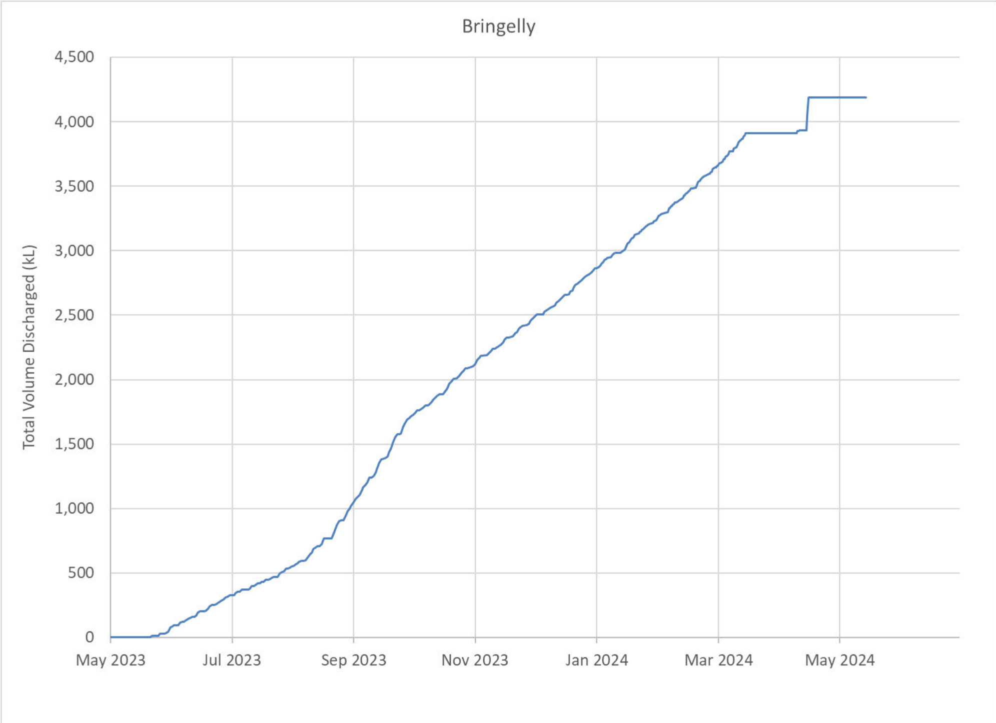

Figure 6-13: Cumulative volume at Bringelly WTP feed

7 Conclusions and recommendations

7.1 Conclusions

Due to the progression of works, 26 wells and 29 VWPs have been handed over to PLM since the beginning of the program as they monitor areas no longer controlled by CPBG.

Of the wells and VWPs remaining within CPBG's control during this monitoring period, an additional 12 monitoring wells and 12 VWPs were either damaged, destroyed or decommissioned prior to TBMs passing through the area. These included:

- Seven mitigation monitoring and/or contingency wells associated with the PRB in St Marys (SBT-GW-1012, SBT-GW-1013, SBT-GW-1014, SBT-GW-1347B, SBT-GW-1348A, SBT-GW-1348B and SBT-GW-1348C) and three GMP wells (SBT-GW-1019_R, SBT-GW-1020 and SBT-GW-1022) were decommissioned by CPBG to prevent depressurisation as the TBMs moved through the area immediately to the west of St Marys Station.
- SBT-GW-4008 was reported as damaged, with attempts made to repair the well so far unsuccessful. Manual gauging indicates groundwater in this area has drawn down by more than 16m. This well was required for monthly monitoring during construction of cross passage XP-S20, with works on XP-S20 recently completed in August 2024.
- The majority of VWPs that were damaged or destroyed were in areas that have been handed over by CPBG due to the progression of work. Damaged or destroyed locations should be assessed by PLM to determine if potential risks to groundwater receptors based on construction activities indicate replacement is warranted.
- The EC logger at GDE monitoring well SBT-GW-1805 is malfunctioning. Based on available lab and field EC data there has not been an exceedance of the EC trigger level. Continue to monitor at this location.

Eight locations had exceedances of groundwater level triggers in the current monitoring period:

- SMGW-BH-A107 which monitored construction of XP-N09 showed drawdown aligning with TBMs passing through the area and construction of the cross passage, with no recovery yet reported. Ecological survey concluded that ecosystem conditions were similar to previous surveys completed prior to drawdown occurring and no impact has been observed.
- SMGW-BH-A105S, which monitors cross passage construction activities at XP-N05, reported a temporary breach of the green trigger which does not align with activity dates.
- SBT-GW-4000 and SBT-GW-4010 monitored during cross passage construction activities at both show drawdown aligned with the start of construction activities in that area and continued drawdown to current reporting date aligning with ongoing construction activities in those areas.
- SBT-GW-4008 was damaged and no level data could be obtained from logger. The well has been dry since first manually gauged on 8 May 2024. Manual gauging has confirmed drawdown, with the well dry when gauged on 27 May 2024 and 7 June 2024 after cross passage (XPS 20) construction commenced on 24 May 2024. SBT-GW-4008 and SBT-GW-4010 are located in a biodiversity certified area and there is limited evidence to indicate that vegetation located near these wells are groundwater dependent.
- SWD-TU100-20071-VWP07-A in Claremont Meadows and SWD-TU351-37371-VWP04 in Bringelly both had green trigger levels exceeded but water levels have either stabilised or are decreasing gradually and should continue to be monitored.
- SWD-TU150-22010-VWP02 in Orchard Hills has levels exceeding the red trigger level and continued to show a gradual decreasing trend based on data up to June 2024.

Groundwater levels in nearby SBT-GW-1042 at the end of January 2024, and vegetation monitoring in June 2024 indicate that the main woodlands area to the east of the Orchard Hills site has not been impacted by construction related drawdown.

The only groundwater quality trigger exceedance reported during this reporting period was for PFAS in SBT-W-1019_R. Only the shallow sample exceeding the trigger, with both deeper samples below the level of reporting (LOR) of 0.01 µg/L, indicating the vertical extent of impact was limited. This minor trigger exceedance is therefore not considered to indicate a change in conditions, or risk profile. Mann-Kendall statistical analysis used to assess trends for selected COPCs indicated the following trends:

- pH was observed to be statistically increasing at SBT-GW-1019_R and SMGW-BH-C330. However, the latest pH was less than the previous maximum reported (SBT-GW-1019_R) or the increase bought the pH into the neutral range (SMGW-BH-C330). The pH changes in these wells are therefore within the expected or desired range and no further action is required.
- Changes in concentrations of total nitrogen in MW1 and zinc in SBT-GW-1024 were either within the previous range or indicated an improvement in groundwater quality.
- The increase in laboratory-measured pH above the previous range in SMGW-BH-A107 in June 2024 (Figure 5-1) corresponds to construction of XP-N09, and significant drawdown of groundwater levels in the area.
- The concentration of zinc (filtered) in MW1 in March 2024 represented a threefold increase over the previous reported maximum. However, construction was occurring not within the area at the time the sample was taken.

Some changes in groundwater quality during cross passage construction at SMGW-BH-A360, SMGW-BH-A107, SBT-GW-1031, SBT-GW-4000 and SBT-GW-4010 were observed.

Assessment of water quality is relevant for the project, as outlined in the NSW Aquifer Interference Policy (AIP). Table 1 of *Minimal Impact Consideration for Aquifer Interference Activities* for fractured rock water sources indicates the relevant consideration with respect to water quality consists of: “Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity.”

Based on the results of the second six monthly monitoring event there has been no adverse change in groundwater conditions or the beneficial use of groundwater.

7.2 Recommendations

The following is recommended in relation to observed groundwater water quality trends:

- Post construction cross passage monitoring at SMGW-BH-A360 to include TPH due to increase in TOC.
- Post construction cross passage monitoring at SMGW-BH-A107 and SBT-GW-1031 to include sample for base suite to confirm return to pre-construction conditions.
- Post construction cross passage monitoring at SBT-GW-4000 to include sample for base suite and TPH to confirm return to pre-construction conditions.

The groundwater sampling compliance and quality control assessment is presented in the Quality Assurance Report in Annexure F. Recommendations from the assessment included:

- Sample turbidity should be considered when interpreting total metal and nutrient concentrations as the presence of particulates may result in higher total concentrations being reported.

- The number of triplicates collected in future monitoring rounds be increased to be compliant with the GMP.
- The number of trip and field blanks was less than required, however this is not considered to affect the useability of the dataset as no detections were reported in the blanks analysed, and volatile hydrocarbons are only COPCs at St Marys, where an appropriate number of blanks have been analysed (refer Annexure G).
- Addition field equipment rinsing be conducted with DI water to rinse off residual tap water used to wash equipment.

Recommendations for the next six-month monitoring period, and to groundwater level triggers include:

- Inspections of Claremont Creek stream flow (qualitative observations) and visual water level should be conducted periodically (monthly) until groundwater levels at SMGW-BH-A107 return to above trigger levels, to identify whether remaining pools are at risk of drying out.
- A red trigger exceedance has been identified at SWD-TU150-22010-VWP02 and levels continue to decrease. CPBG will continue implementing the current GDE vegetation monitoring at Orchard Hills, however GDE monitoring show no significant impact to GDE. Should outcomes of this monitoring indicate potential impacts to vegetation as a result of the decrease in water levels at SWD-TU150-22010-VWP02, the existing GDE vegetation monitoring methodology would be expanded to include additional survey sites in order to determine the potential extent of the impact.
- The EC logger in SBT-GW-1805 is malfunctioning. Maintenance to repair the logger is recommended, with monthly manual gauging and EC measurements in the interim.
- Attempts to repair SBT-GW-4008 should continue to allow for monitoring of recovery now that construction of XP-S20 is complete. Monitoring is required to provide data to assess the potential for construction related drawdown to have longer term effects on GDEs, i.e greater than 6 months, and other potential secondary impacts.
- Groundwater trigger levels be decreased by 0.5m at SBT-GW-4000 based on additional data available to define pre-construction groundwater level ranges.

8 References

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- Tetra Tech Major Projects (2023a) Sydney Metro Western Sydney Airport Station Boxes and Tunnelling Works Project-wide Groundwater Modelling Report Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040402
- Tetra Tech Major Projects (2023b) Former Dry Cleaner, 1-7 Queen St – Assessment of Human Health Risk and Mitigation Options report (Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040540)
- Tetra Tech (2023c); St Marys Station Remedial Action Plan (Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040521, RevA08 22/05/2023)
- Tetra Tech Major Projects (2023d) Baseline Groundwater Report (Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040405, Rev B, 29 August 2023)
- Tetra Tech Major Projects (2023d) Groundwater Monitoring Plan (Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040404, Rev 2.01, 30 August 2023)
- Tetra Tech Major Projects (2023e); Biannual Groundwater Monitoring Report 0 July to November 2023. (Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040410_A.02, 27 December 2023).
- Tetra Tech Major Projects (2024); St Marys Station Remedial Action Plan – Proposed revision to mitigation groundwater monitoring network (Ref: SMWSASBT-CPG-SWD-SW000-GE-MEM-040403_A.01Rev A, 26/03/2024).

Annexure A Water quality data summary December 2023 to June 2024

CHAIN OF COUNTY

ALS Laboratory: ***please tick →***

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CLIENT: CPBG		**TURNAROUND REQUIREMENTS :** (Standard TAT may be longer for some tests e.g.. Ultra Trace Organics)	☐ Standard TAT: **04/07/2024** ~~☐ Non Standard or urgent TAT (List due date):-~~
OFFICE: 14 Great Western Highway, Werrington			
PROJECT: WSA SBT Project	**PROJECT NO.:**	**ALS QUOTE NO.:** ES23CPBGHE0004	**COC SEQUENCE NUMBER (Circle)**
ORDER NUMBER:	**PURCHASE ORDER NO.:**	**COUNTRY OF ORIGIN:**	COC: 1 2 3 4 5 6 7
PROJECT MANAGER: Emma Kline	**CONTACT PH:** 0402 044 508		OF: 1 2 3 4 5 6 7
SAMPLER: Emily Fuda (EF); Joshua Cosier (JC)	**SAMPLER MOBILE:** 0412656685	**RELINQUISHED BY: CPBG**	**RECEIVED BY: ALS Environmental**
COC Emailed to ALS? YES / NO	**EDD FORMAT:** ESDAT and PDF	DATE/TIME:	DATE/TIME: 28/6/24 9:15
Email Reports to: Emily.Fuda@cpbg-sbt.com.au; Joshua.Cosier@cpbg-sbt.com.au			
Email Invoice to: Joshua.Cosier@cpbg-sbt.com.au; wsasbt.progressclaims@cpbg-sbt.com.au			

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Custody Seal Intact?	Yes	No	N/A
Free ice / frozen ice bricks present upon receipt?	Yes	No	N/A
Random Sample Temperature on Receipt:		°C	
Other comment:			

RELINQUISHED BY:	**RECEIVED BY:**
DATE/TIME:	DATE/TIME:

COMMENTS/SPECIAL HANDLING/STORAGE OR DISPOSAL:

Environmental Division
Sydney
Work Order Reference
ES2421298

Telephone : + 61-2-8784 8555

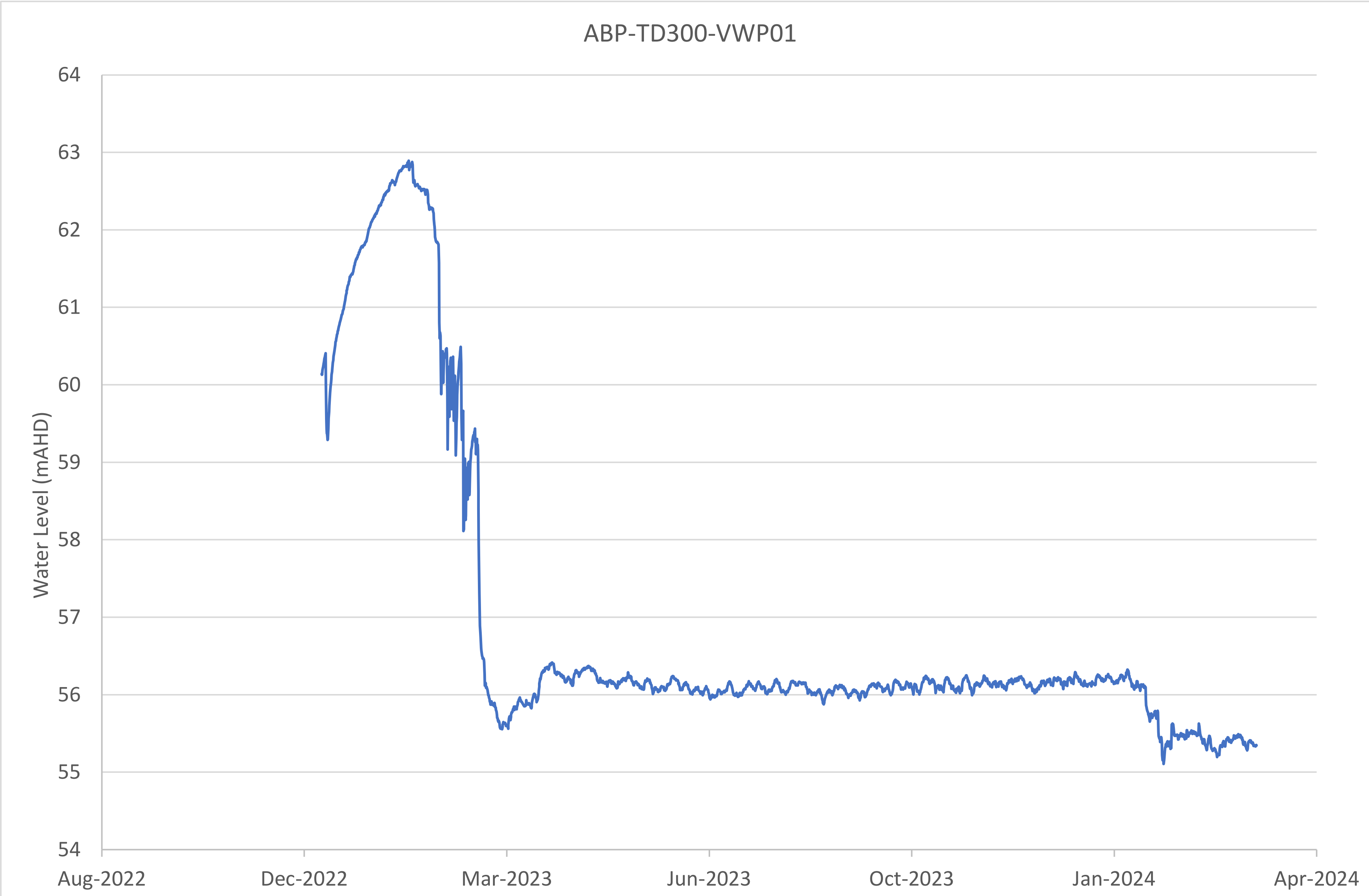
ANALYSIS REQUIRED including SUITES (NB. Suite Codes must be listed to attract suite price)
Where **Metals** are required, specify **Total** (unfiltered bottle required) or **Dissolved** (field filtered bottle required).

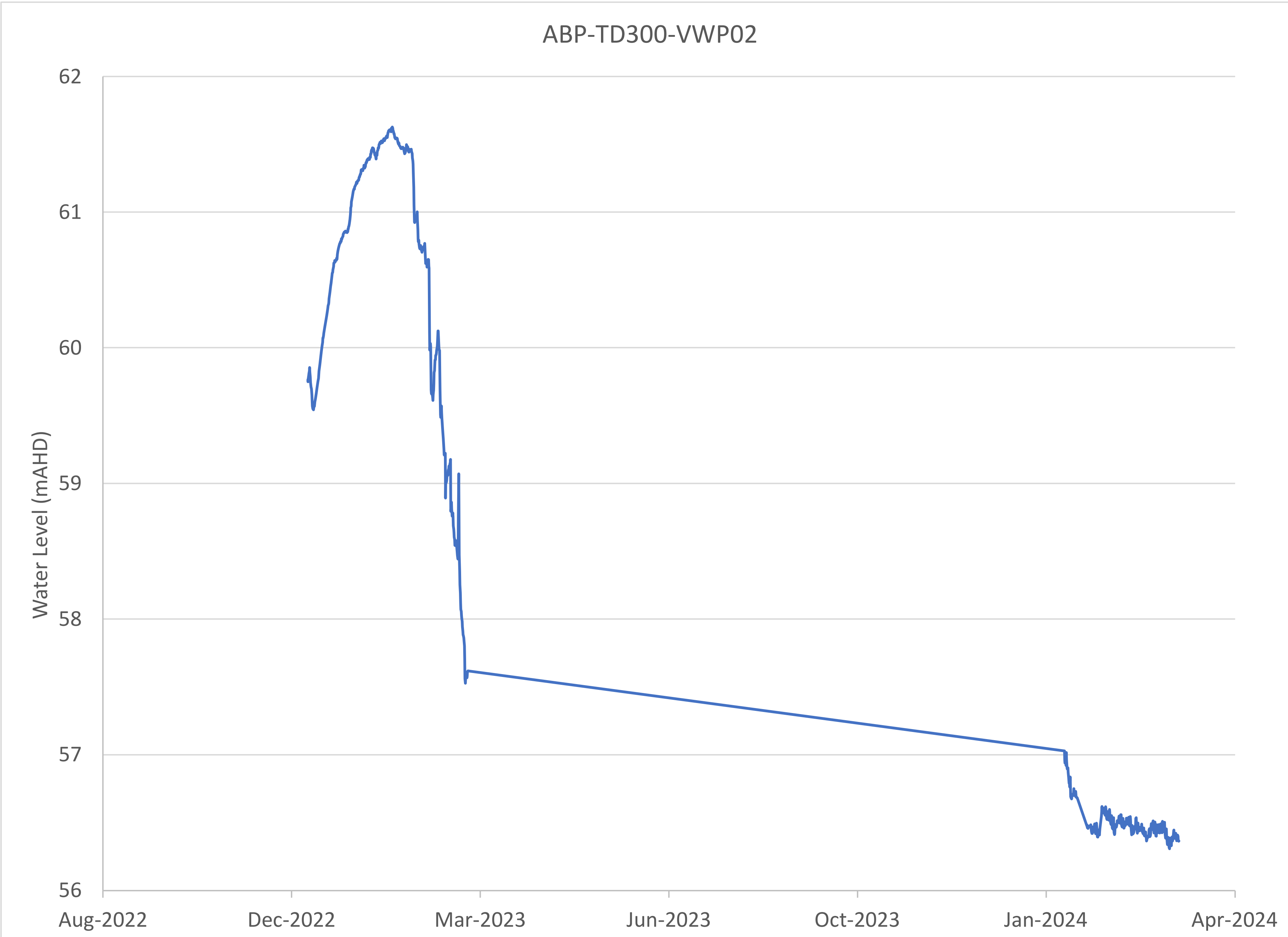
ALS USE ONLY: LAB ID	SAMPLE DETAILS MATRIX: Solid(S) Water(W): SAMPLE ID	DATE / TIME	MATRIX	CONTAINER INFORMATION: TYPE & PRESERVATIVE *(refer to codes below)*	TOTAL BOTTLES	EA005P - pH	EA010P - Electrical Conductivity	EA015H - Total Dissolved Solids	NT-01 & 02 - Ca, Mg, Na, K, Cl, SO4, Alkalinity	EP005 - Total Organic Carbon (TOC)	NT-08A - Total Nitrogen, NO2, NO3, NH3, Total P, Reactive P	EG020F - Dissolved Metals by ICP/MS (Al, As, Cd, Cr, Cu, Fe, Pb, Mn, Ni, Zn)	EG035F - Dissolved Mercury	EG020T - Total Metals by ICP/MS (Al, Co, Fe, Mn)	EP074 - Volatile Organic Compounds	TPH - TRH (C6-C40)	EP080 - BTEXN	W-04 - TRH/BTEXN	EP231 - Per- and Polyfleuralkyl Substances		Comments
	SMGW-BH-A360	27/06/2024 9:50AM	W		5			X		X	X	X		X							
	SMGW-BH-A107	27/06/2024 11:20AM	W		5			X		X	X	X		X							
	SBT-GW-1804	27/06/2024 10:50AM	W		5			X		X	X	X		X							
	SBT-GW-1030	27/06/2024 1:00PM	W		7			X		X	X	X		X					XX		**Bottles mislabelled as SBT-GW-1031. Correct sample ID: SBT-GW-1030**
	Rinsate	27/06/2024 11:00AM	W		4					X	XX	X		X							
				TOTAL	26																

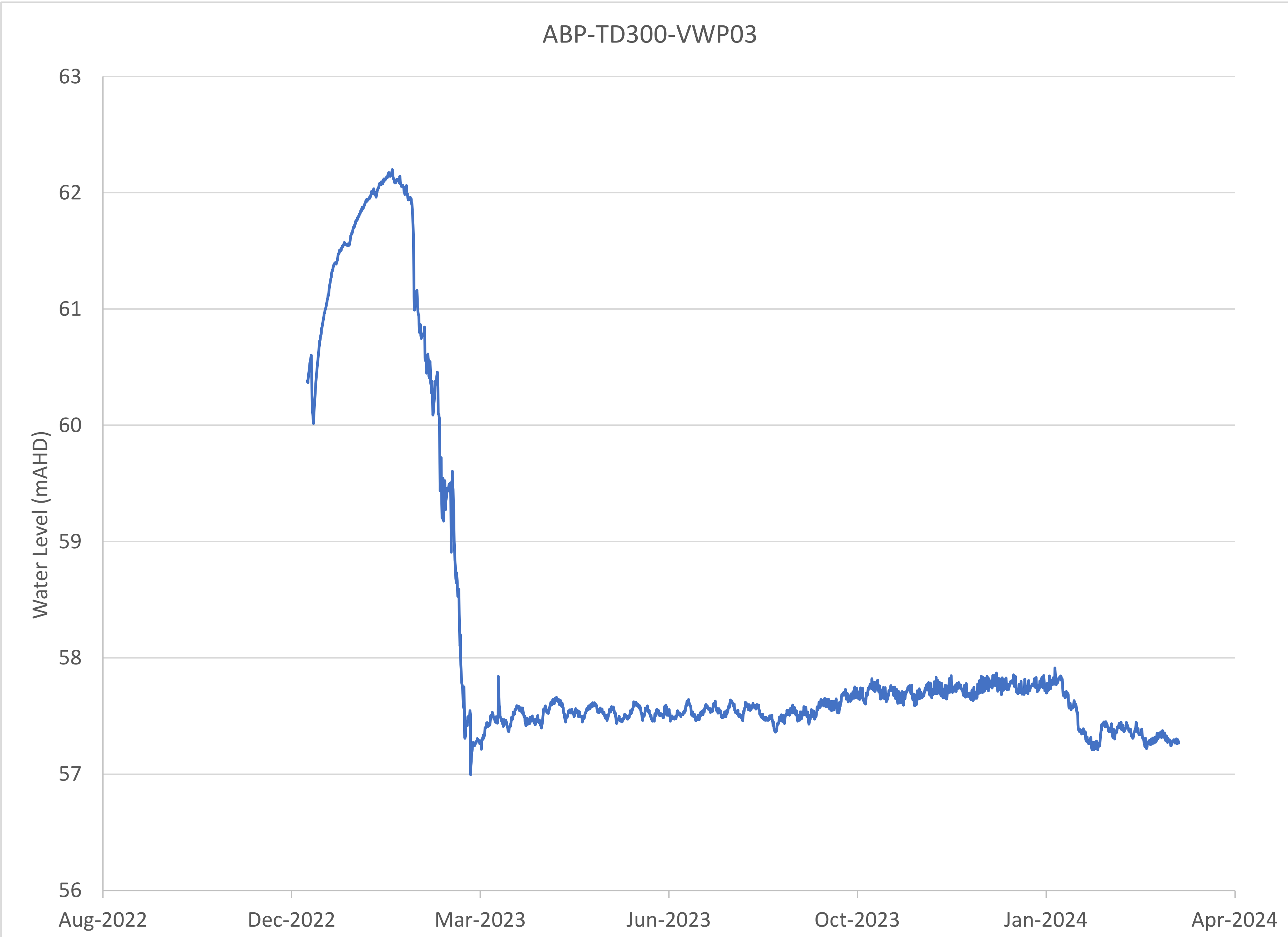
Water Container Codes: P = Unpreserved Plastic; N = Nitric Preserved Plastic; ORC = Nitric Preserved ORC; SH = Sodium Hydroxide/Cd Preserved; S = Sodium Hydroxide Preserved Plastic; AG = Amber Glass Unpreserved; AP - Airfreight Unpreserved Plastic
V = VOA Vial HCl Preserved; VB = VOA Vial Sodium Bisulphate Preserved; VS = VOA Vial Sulfuric Preserved; AV = Airfreight Unpreserved Vial SG = Sulfuric Preserved Amber Glass; H = HCl preserved Plastic; HS = HCl preserved Speciation bottle; SP = Sulfuric Preserved Plastic; F = Formaldehyde Preserved G[redacted]
Z = Zinc Acetate Preserved Bottle; E = EDTA Preserved Bottles; ST = Sterile Bottle; ASS = Plastic Bag for Acid Sulphate Soils; B = Unpreserved Bag; LI = Lugols Iodine Preserved Bottles; STT = Sterile Sodium Thiosulfate Preserved Bottles.

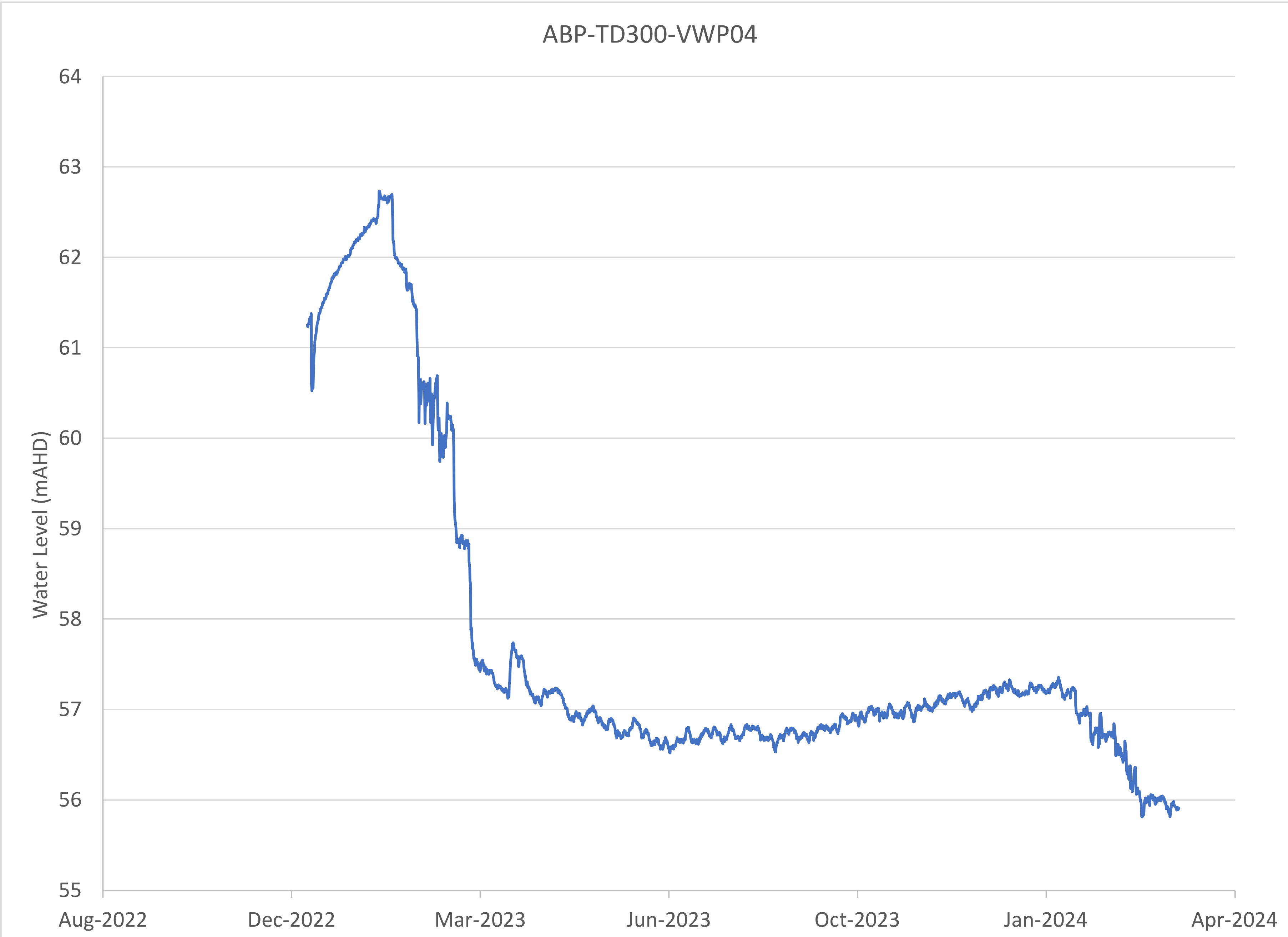
HT

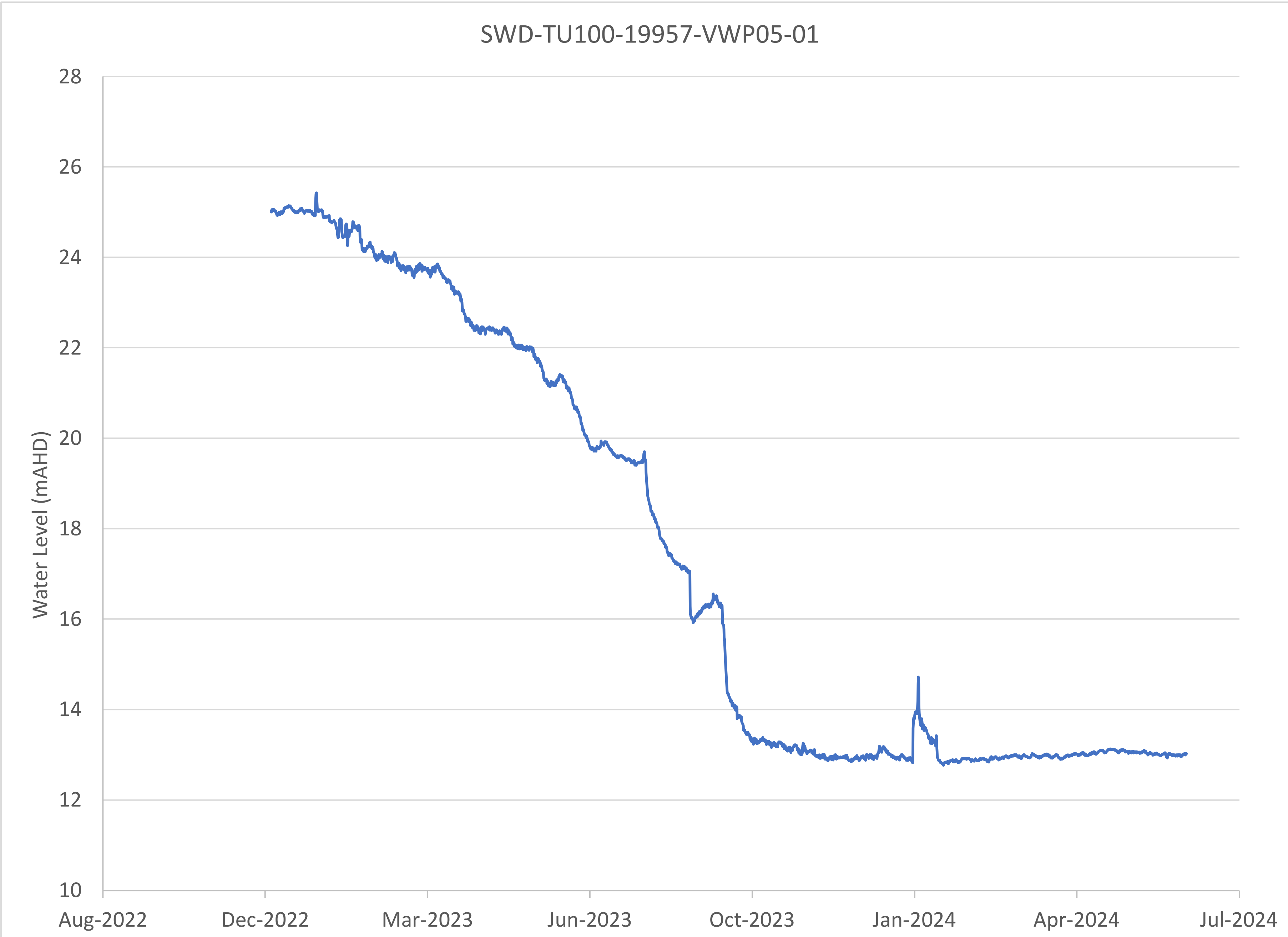
Annexure C VWP hydrographs to June 2024


ABP-TD300-VWP01
Water Level (mAHD)
64
63
62
61
60
59
58
57
56
55
54
Aug-2022
Dec-2022
Mar-2023
Jun-2023
Oct-2023
Jan-2024
Apr-2024

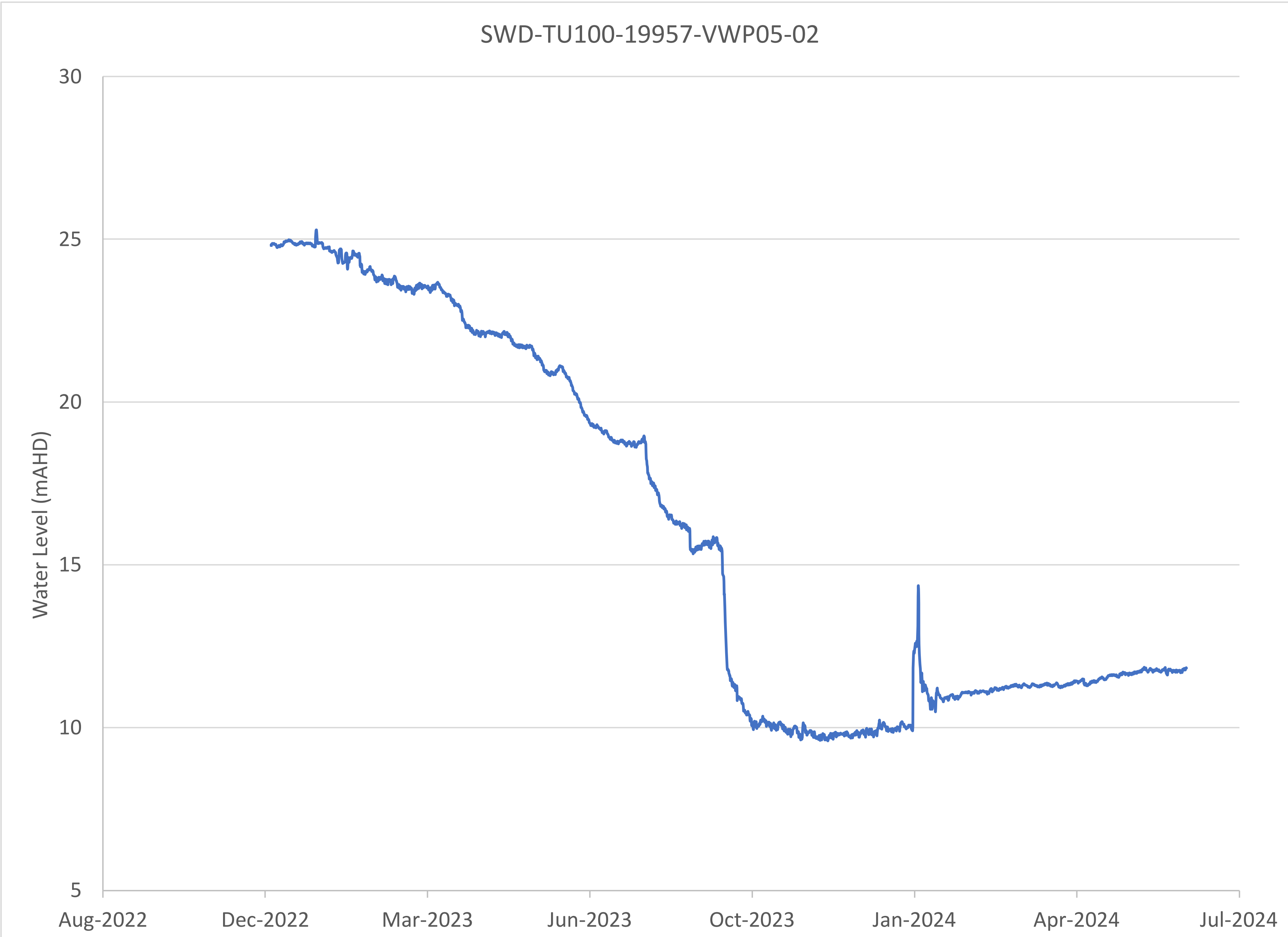

ABP-TD300-VWP02
Water Level (mAHD)
62
61
60
59
58
57
56
Aug-2022
Dec-2022
Mar-2023
Jun-2023
Oct-2023
Jan-2024
Apr-2024

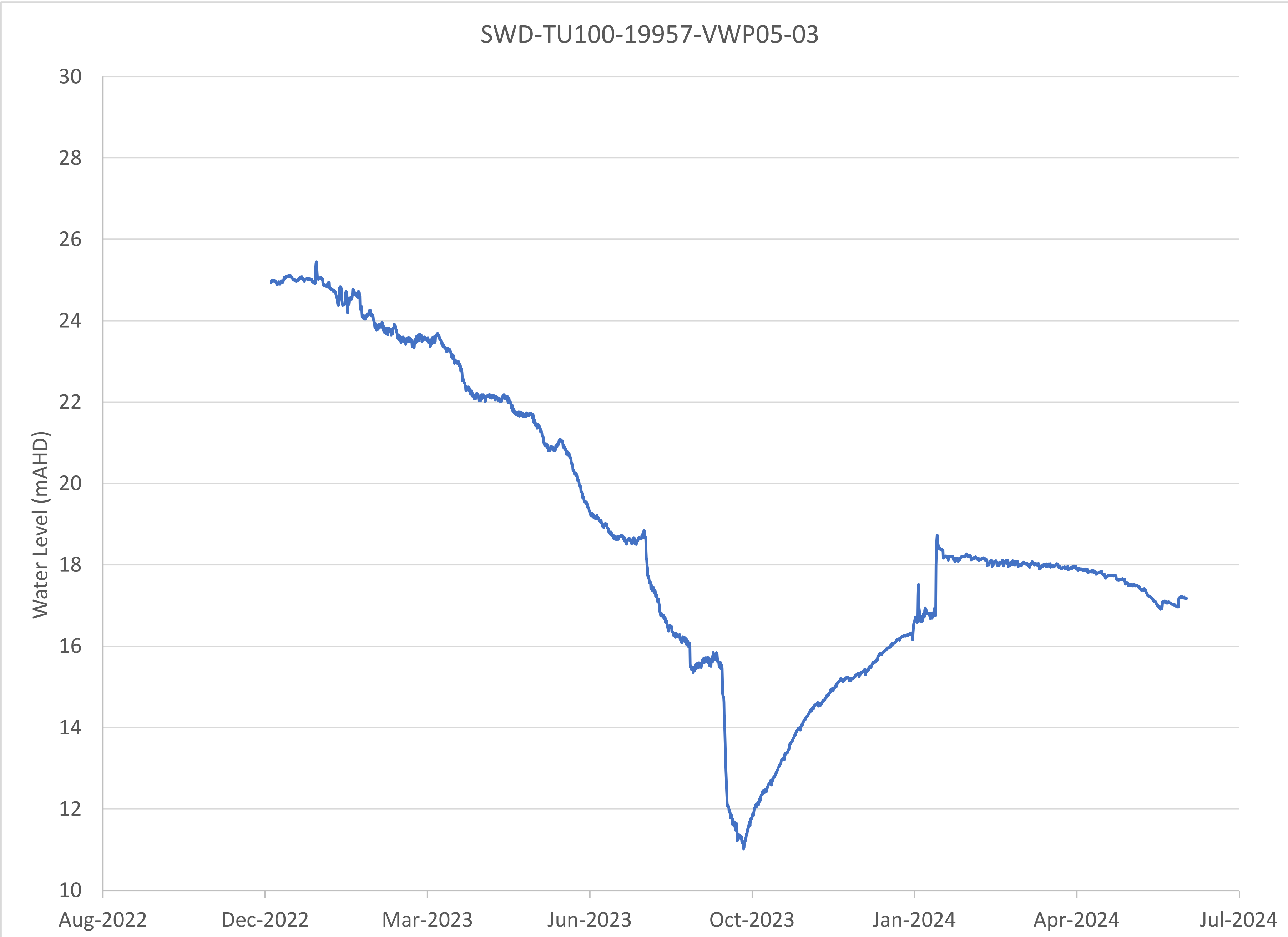

ABP-TD300-VWP03
Water Level (mAHD)
63
62
61
60
59
58
57
56
Aug-2022
Dec-2022
Mar-2023
Jun-2023
Oct-2023
Jan-2024
Apr-2024

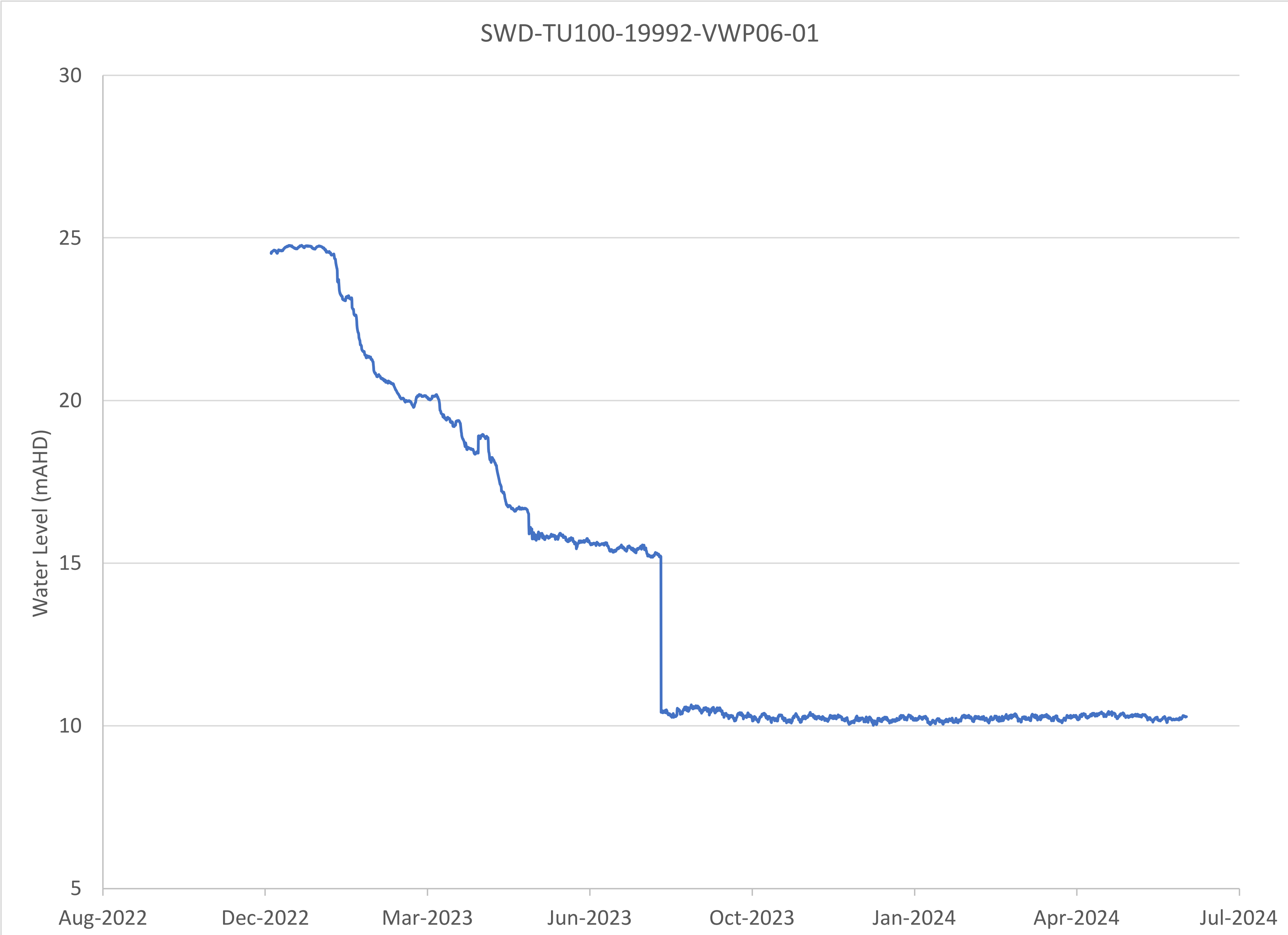

ABP-TD300-VWP04
Water Level (mAHD)
64
63
62
61
60
59
58
57
56
55
Aug-2022
Dec-2022
Mar-2023
Jun-2023
Oct-2023
Jan-2024
Apr-2024



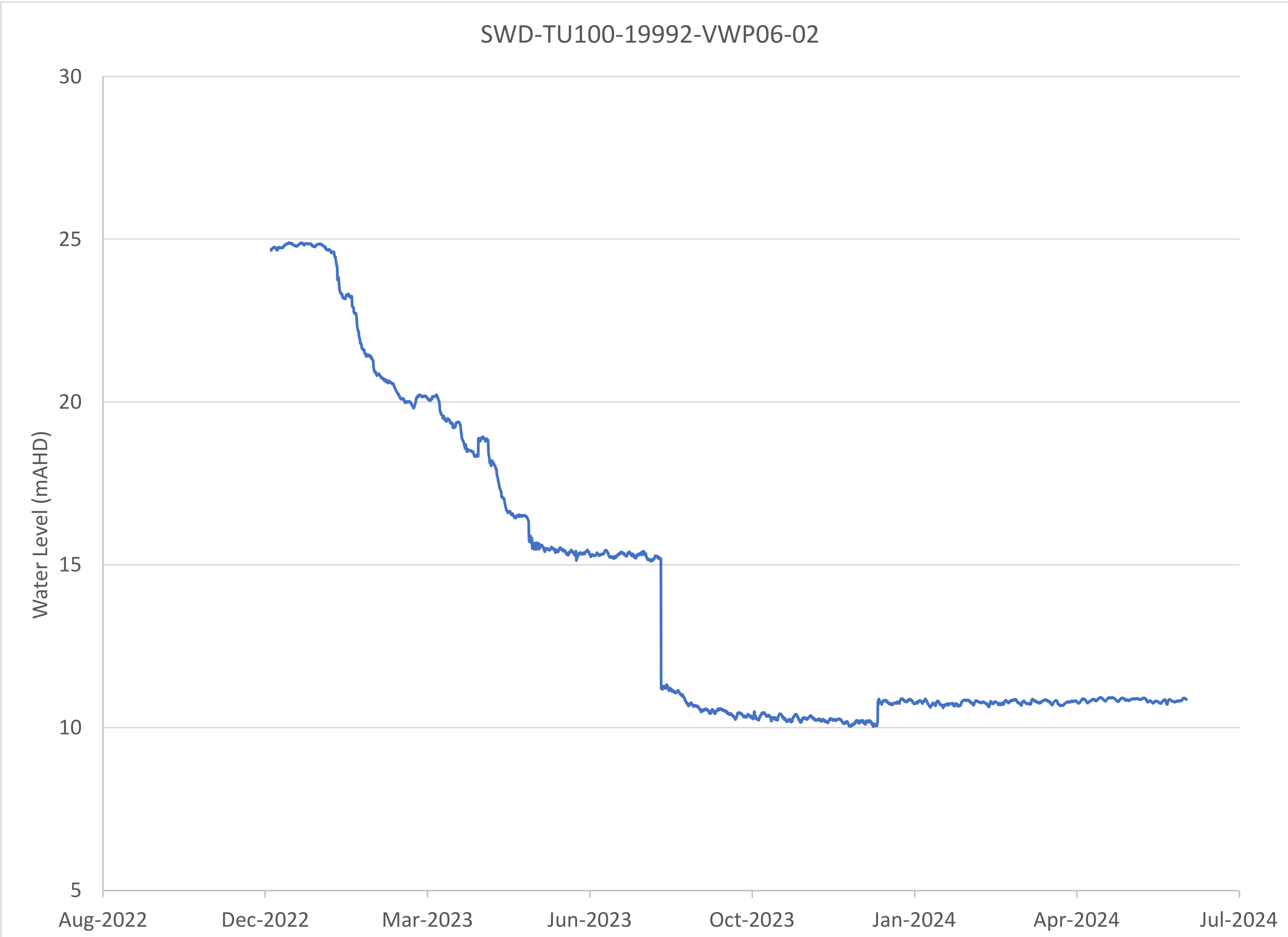
SWD-TU100-19957-VWP05-01
Water Level (mAHD)
28
26
24
22
20
18
16
14
12
10
Aug-2022
Dec-2022
Mar-2023
Jun-2023
Oct-2023
Jan-2024
Apr-2024
Jul-2024


SWD-TU100-19957-VWP05-02
Water Level (mAHD)
30
25
20
15
10
5
Aug-2022
Dec-2022
Mar-2023
Jun-2023
Oct-2023
Jan-2024
Apr-2024
Jul-2024

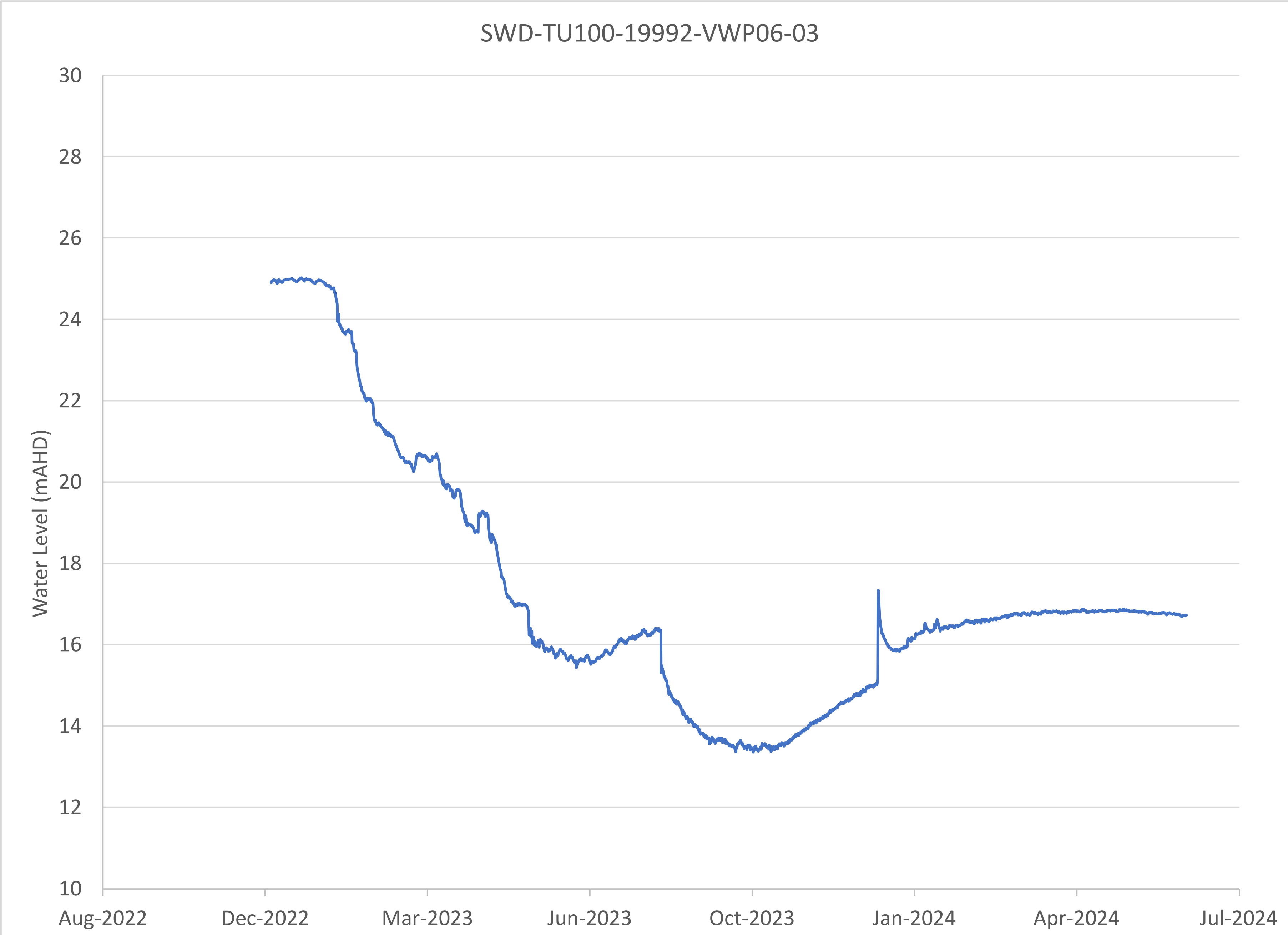

SWD-TU100-19957-VWP05-03
Water Level (mAHD)
30
28
26
24
22
20
18
16
14
12
10
Aug-2022
Dec-2022
Mar-2023
Jun-2023
Oct-2023
Jan-2024
Apr-2024
Jul-2024

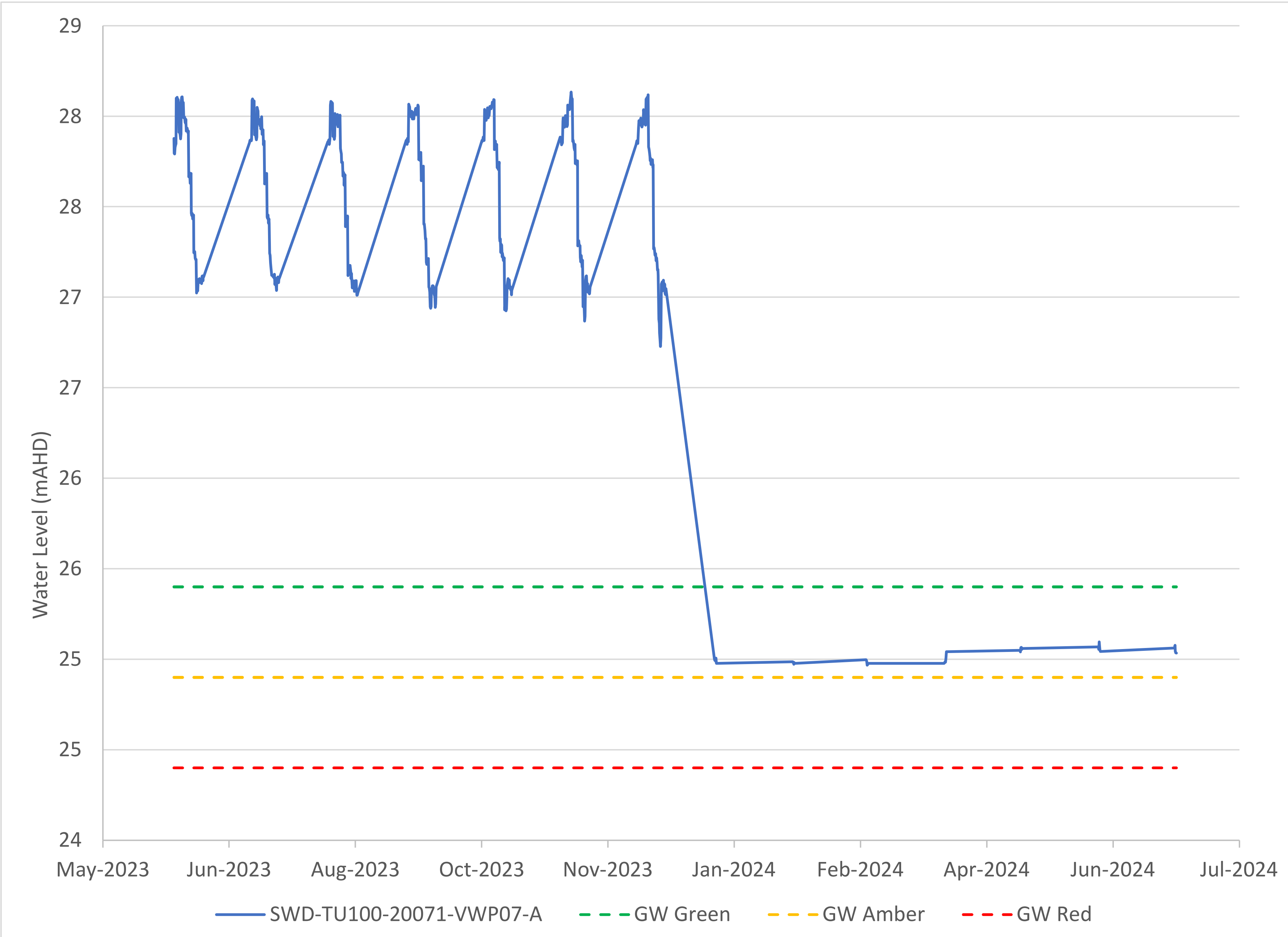


SWD-TU100-19992-VWP06-01
Water Level (mAHD)
30
25
20
15
10
5
Aug-2022
Dec-2022
Mar-2023
Jun-2023
Oct-2023
Jan-2024
Apr-2024
Jul-2024



SWD-TU100-19992-VWP06-02
Water Level (mAHD)
30
25
20
15
10
5
Aug-2022
Dec-2022
Mar-2023
Jun-2023
Oct-2023
Jan-2024
Apr-2024
Jul-2024

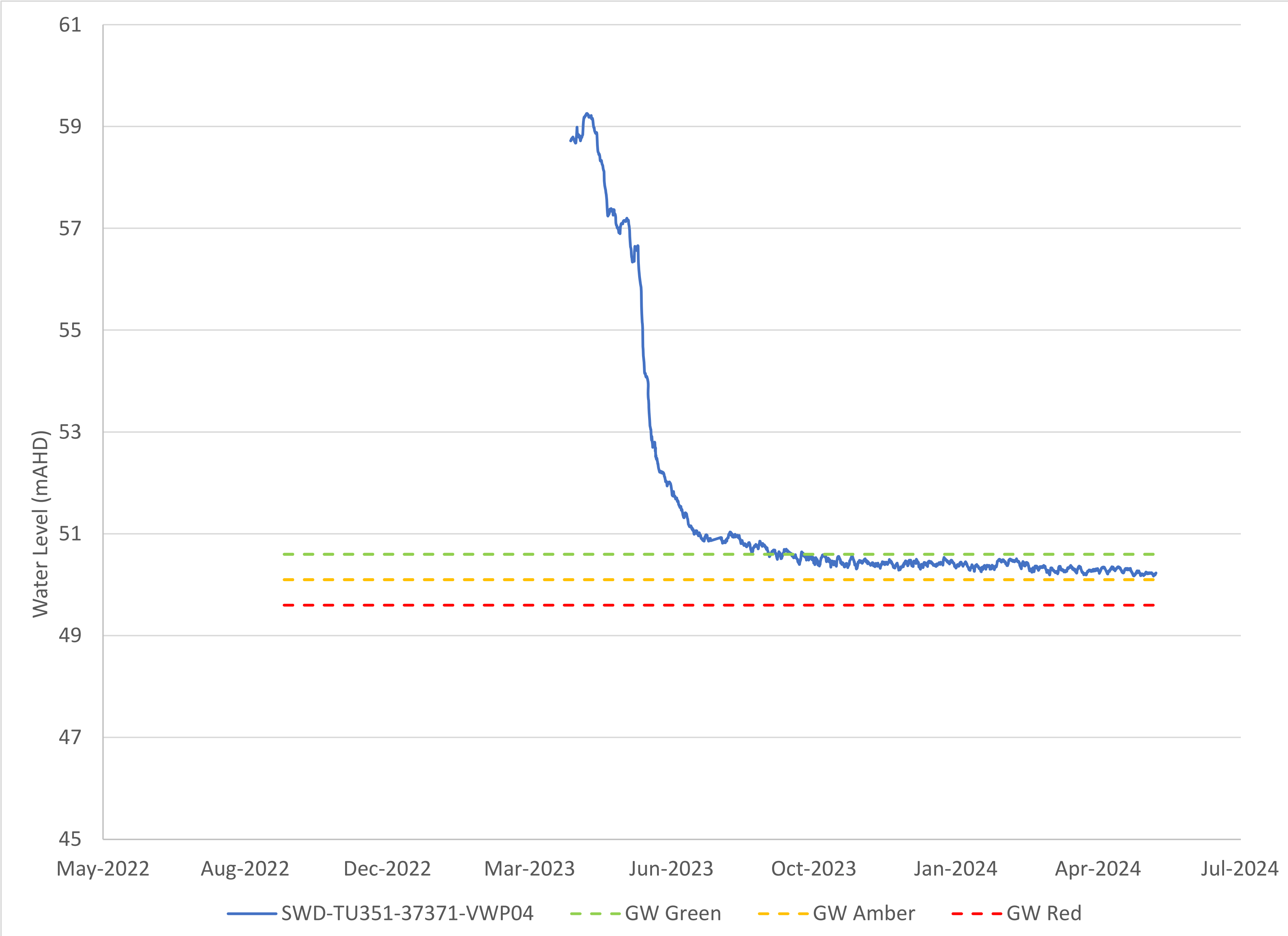

SWD-TU100-19992-VWP06-03
Water Level (mAHD)
30
28
26
24
22
20
18
16
14
12
10
Aug-2022
Dec-2022
Mar-2023
Jun-2023
Oct-2023
Jan-2024
Apr-2024
Jul-2024



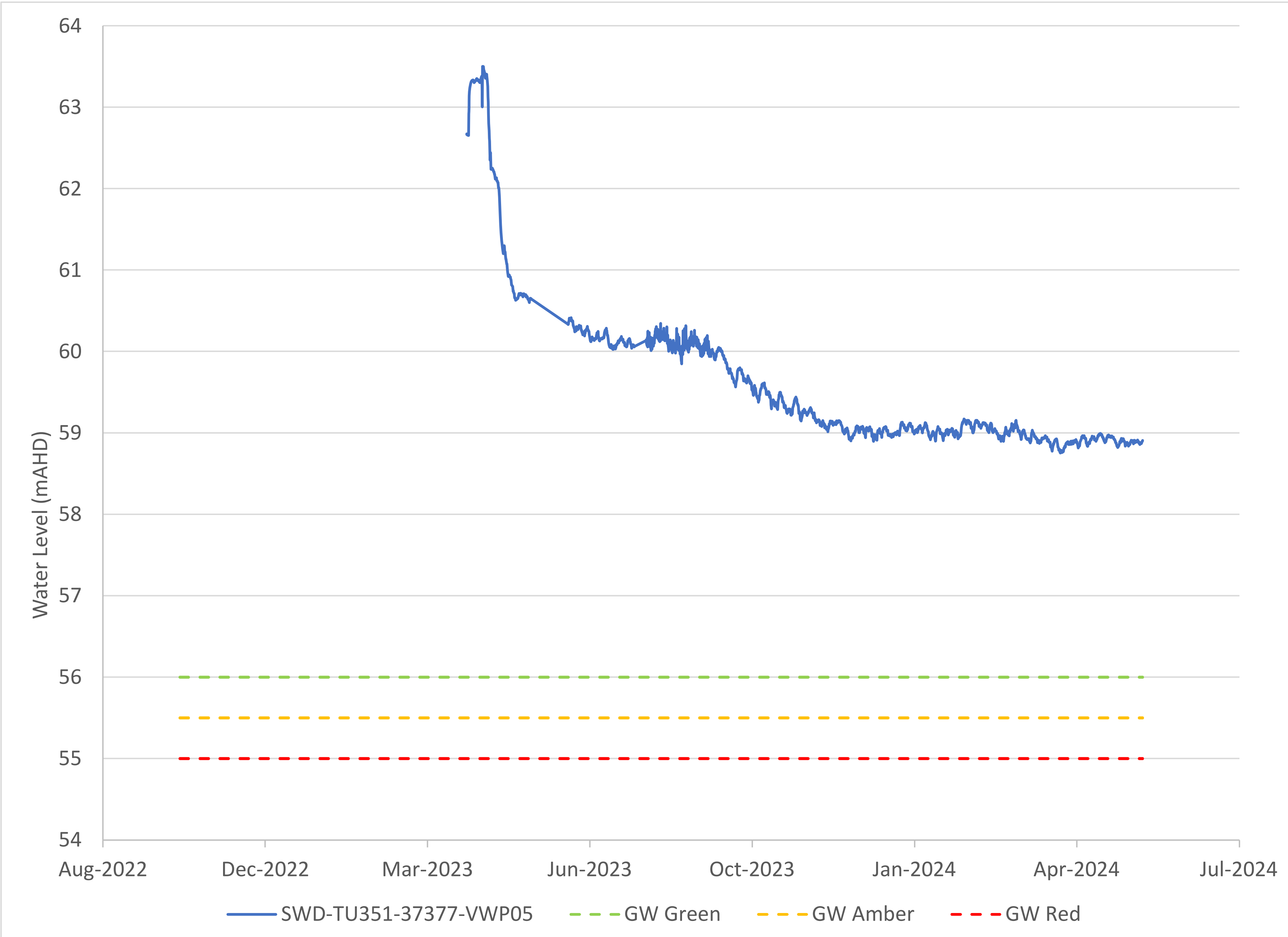
Water Level (mAHD)
29
28
28
27
27
26
26
25
25
24
May-2023
Jun-2023
Aug-2023
Oct-2023
Nov-2023
Jan-2024
Feb-2024
Apr-2024
Jun-2024
Jul-2024
SWD-TU100-20071-VWP07-A
GW Green
GW Amber
GW Red


28
28
27
27
26
26
25
25
24
Water Level (mAHD)
May-2023
Jun-2023
Aug-2023
Oct-2023
Nov-2023
Jan-2024
SWD-TU100-20071-VWP07-B
GW Green
GW Amber
GW Red

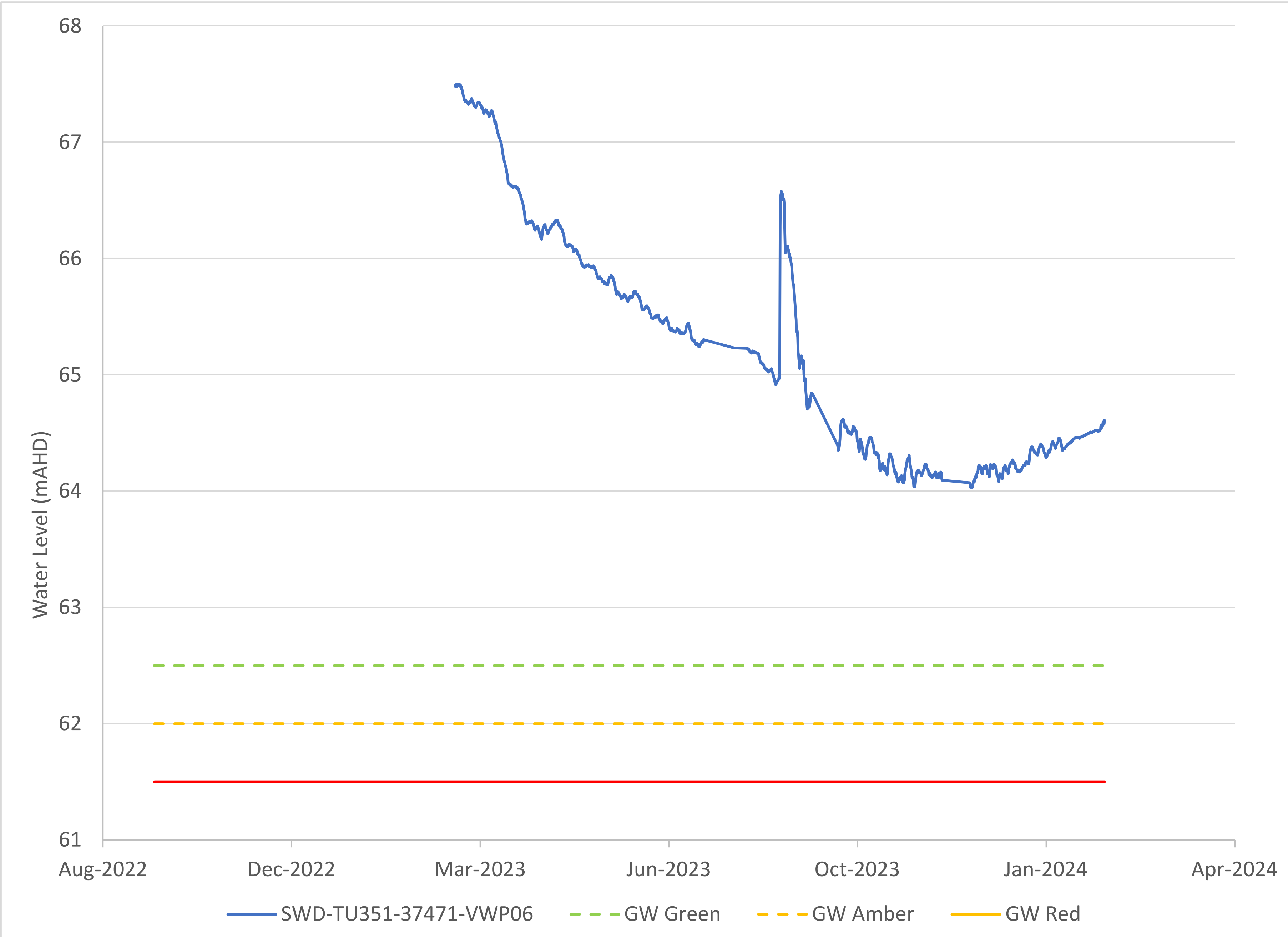
36
35
34
33
32
31
30
29
28
Water Level (mAHD)
Oct-2022
Jan-2023
Apr-2023
Jul-2023
Oct-2023
Dec-2023
Mar-2024
Jun-2024
SWD-TU150-22010-VWP02
GW Green
GW Amber
GW Red



Water Level (mAHD)
61
59
57
55
53
51
49
47
45
May-2022
Aug-2022
Dec-2022
Mar-2023
Jun-2023
Oct-2023
Jan-2024
Apr-2024
Jul-2024
SWD-TU351-37371-VWP04
GW Green
GW Amber
GW Red



64
63
62
61
60
59
58
57
56
55
54
Water Level (mAHD)
Aug-2022
Dec-2022
Mar-2023
Jun-2023
Oct-2023
Jan-2024
Apr-2024
Jul-2024
SWD-TU351-37377-VWP05
GW Green
GW Amber
GW Red



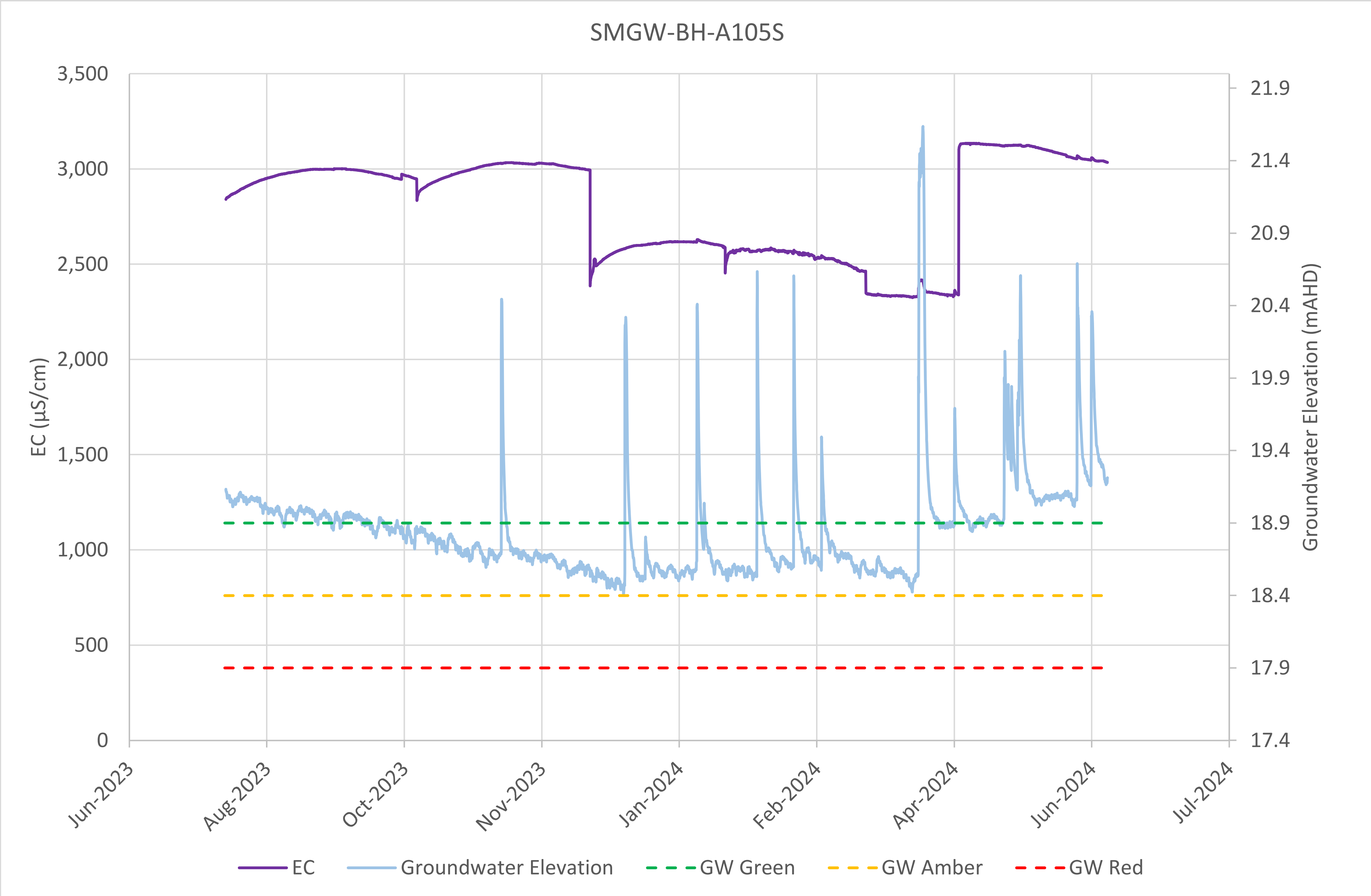
68
67
66
65
64
63
62
61
Water Level (mAHD)
Aug-2022
Dec-2022
Mar-2023
Jun-2023
Oct-2023
Jan-2024
Apr-2024
SWD-TU351-37471-VWP06
GW Green
GW Amber
GW Red

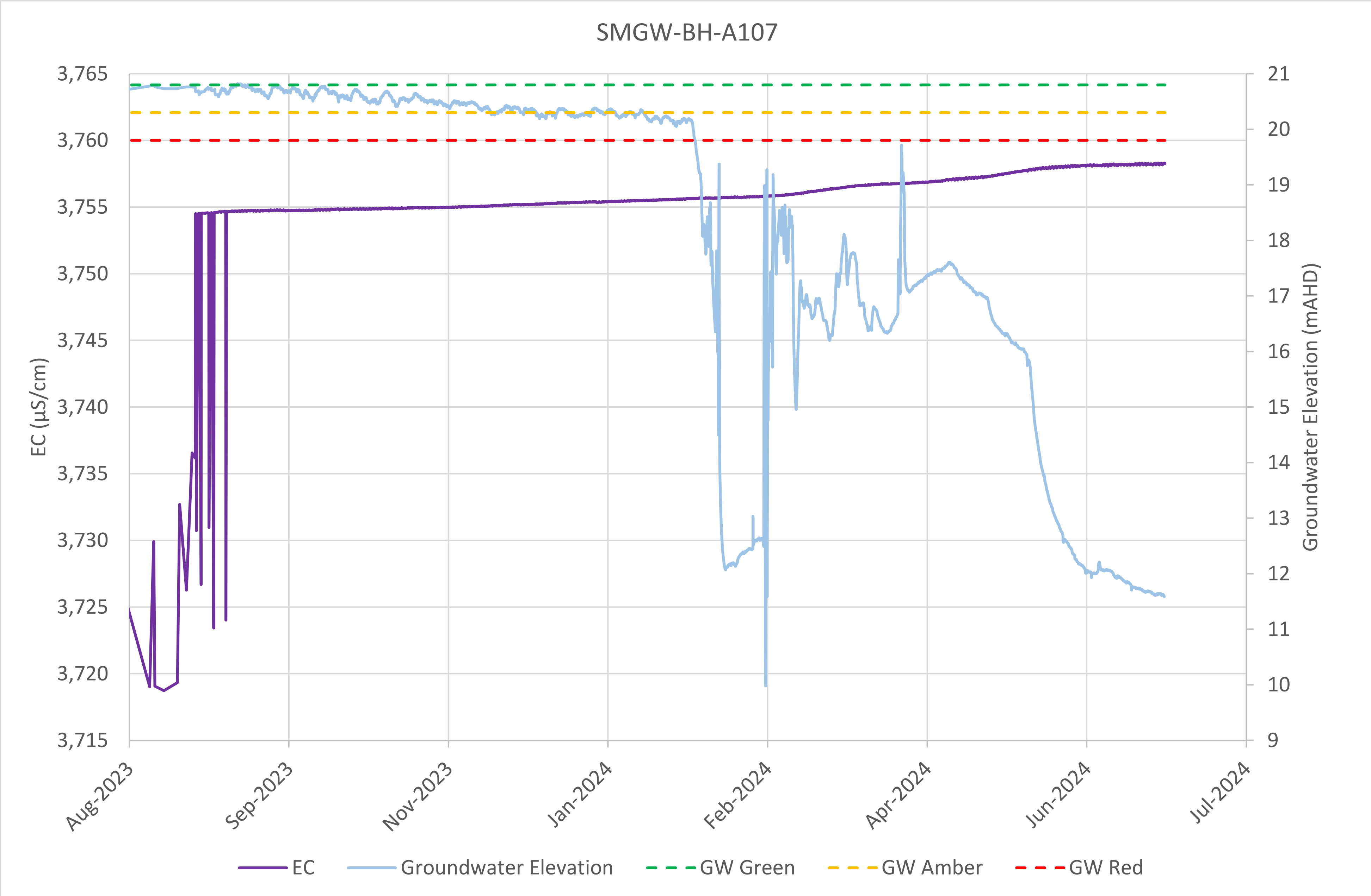

Water Level (mAHD)
40
39
38
37
36
35
34
Aug-2022
Oct-2022
Dec-2022
Jan-2023
Mar-2023
May-2023
Jun-2023
Aug-2023
Oct-2023
Nov-2023
Jan-2024
SWD-TU150-21965-VWP01-A
GW Green
GW Amber
GW Red

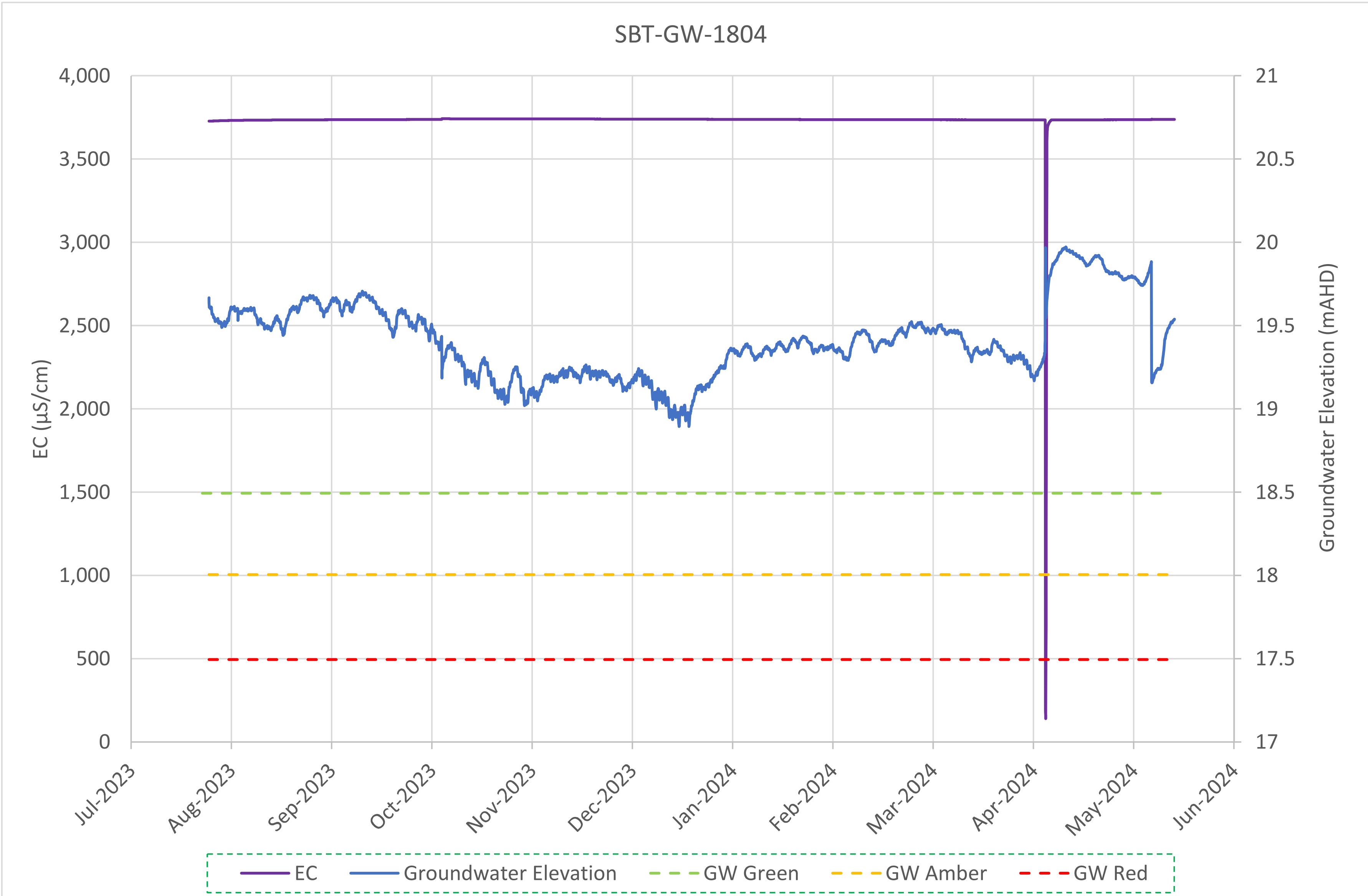
39
38
37
36
35
34
33
Water Level (mAHD)
Aug-2022
Oct-2022
Dec-2022
Jan-2023
Mar-2023
May-2023
Jun-2023
Aug-2023
Oct-2023
Nov-2023
Jan-2024
SWD-TU150-21965-VWP01-B
GW Green
GW Amber
GW Red

65
63
61
59
57
55
53
51
49
47
Water Level (mAHD)
Oct-2022
Oct-2022
Nov-2022
Dec-2022
Dec-2022
Jan-2023
Feb-2023
Feb-2023
Mar-2023
SWD-TU300-33565-VWP02
GW Green
GW Amber
GW Red

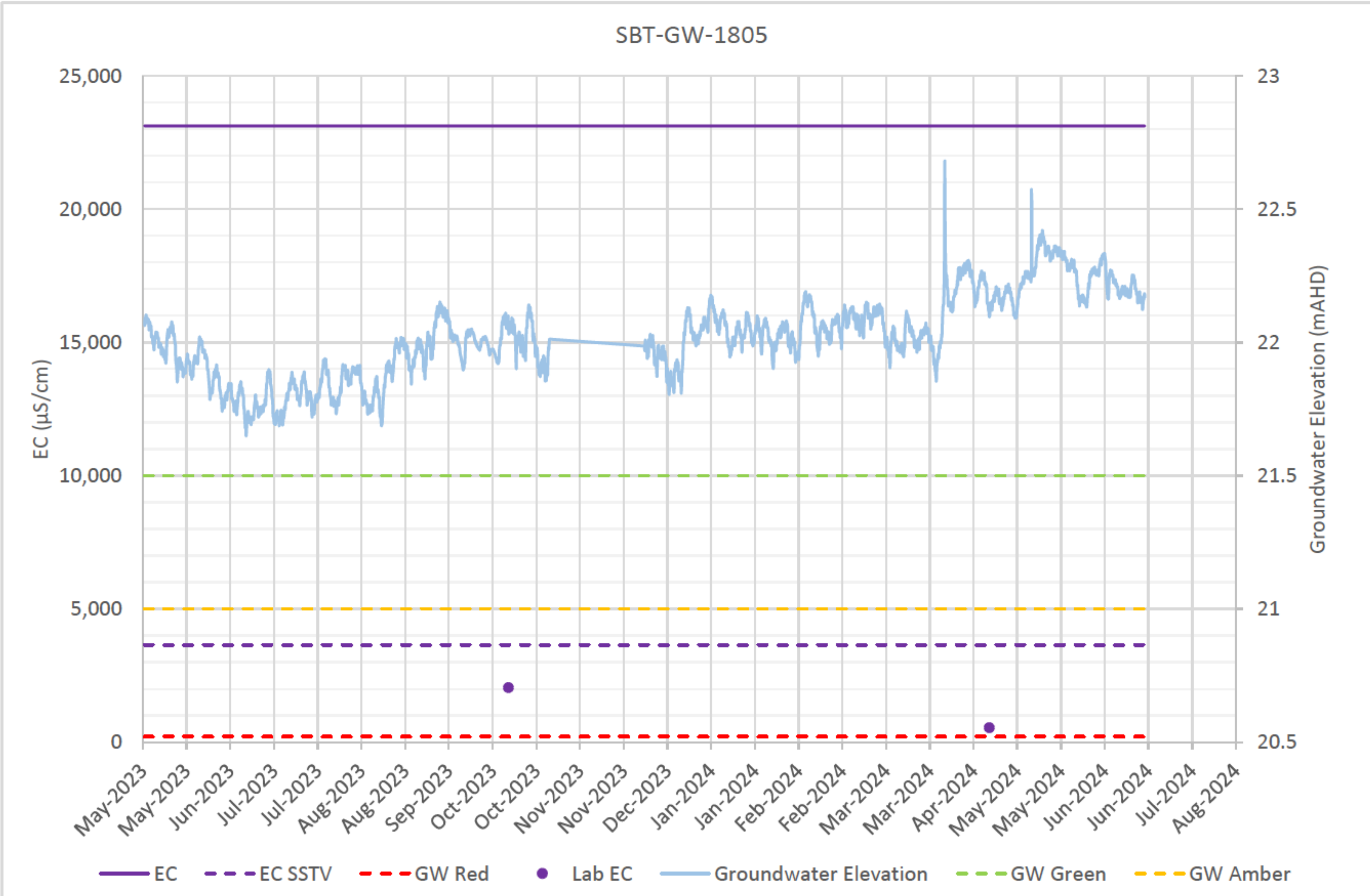
Annexure D GDE groundwater and EC data


SMGW-BH-A105S
3,500
3,000
2,500
2,000
1,500
1,000
500
0
EC (µS/cm)
21.9
21.4
20.9
20.4
19.9
19.4
18.9
18.4
17.9
17.4
Groundwater Elevation (mAHD)
Jun-2023
Aug-2023
Oct-2023
Nov-2023
Jan-2024
Feb-2024
Apr-2024
Jun-2024
Jul-2024
EC
Groundwater Elevation
GW Green
GW Amber
GW Red

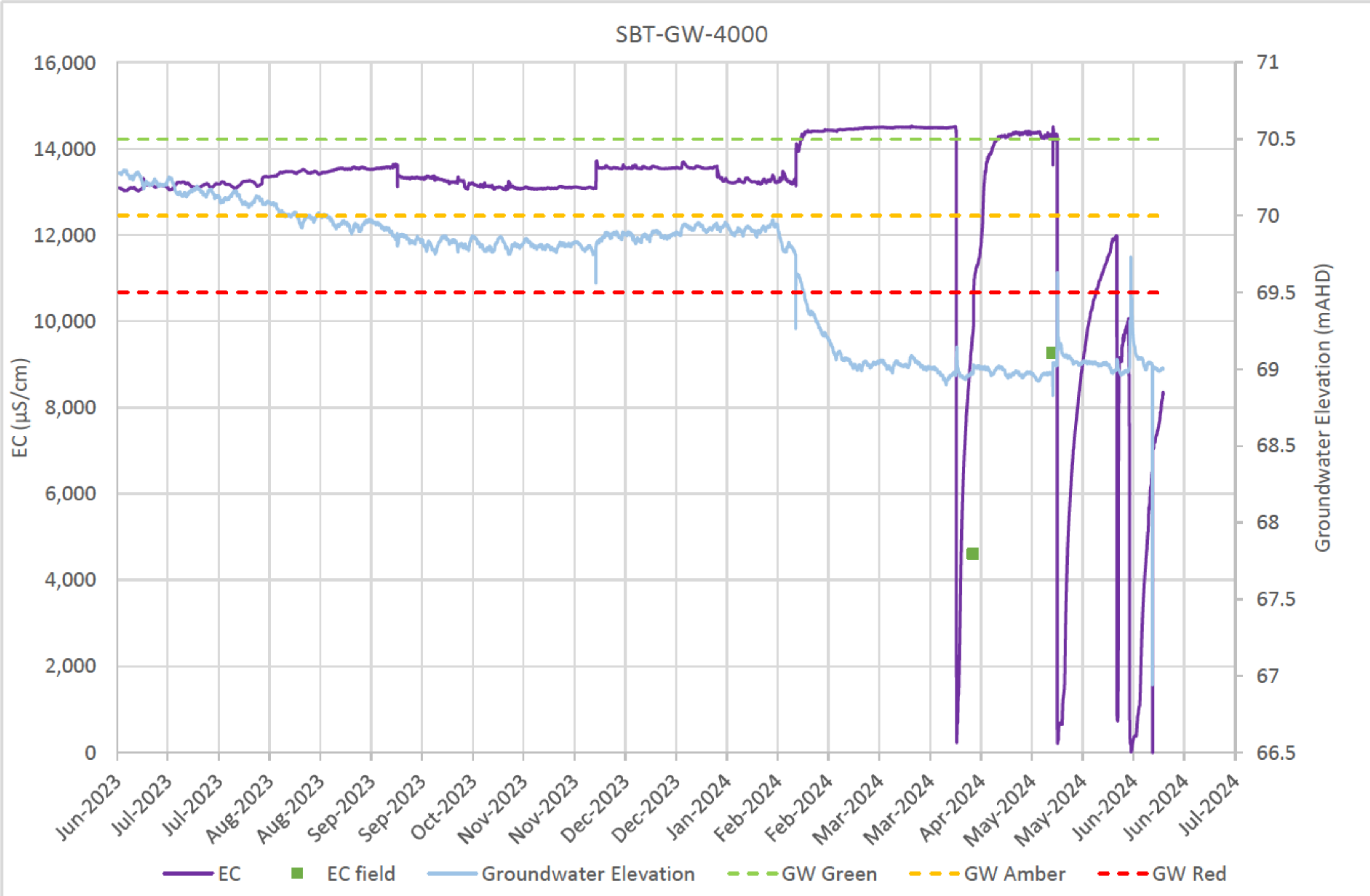

SMGW-BH-A107
EC (µS/cm)
Groundwater Elevation (mAHD)
3,765
3,760
3,755
3,750
3,745
3,740
3,735
3,730
3,725
3,720
3,715
21
20
19
18
17
16
15
14
13
12
11
10
9
Aug-2023
Sep-2023
Nov-2023
Jan-2024
Feb-2024
Apr-2024
Jun-2024
Jul-2024
EC
Groundwater Elevation
GW Green
GW Amber
GW Red



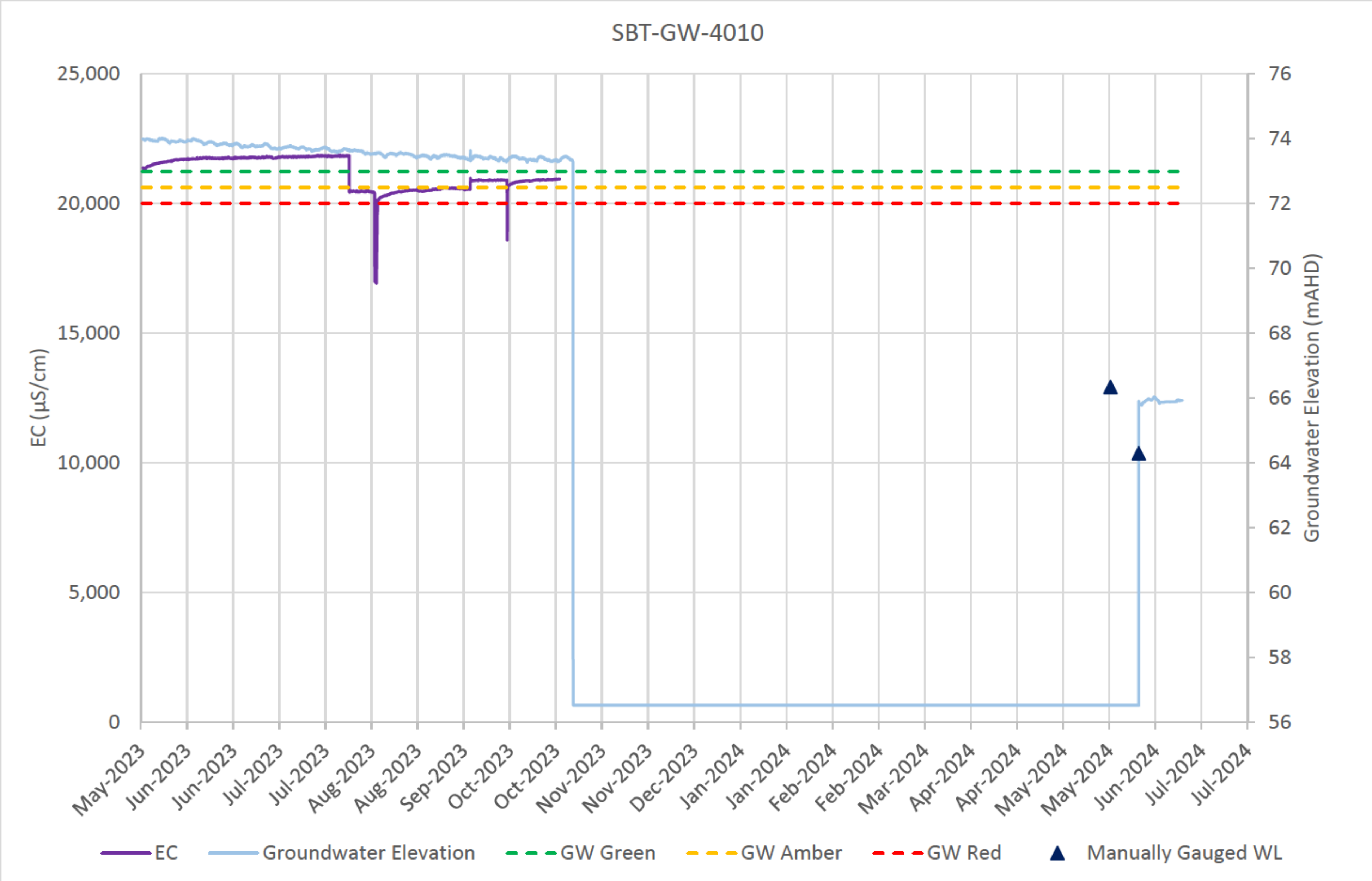
SBT-GW-1804
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
EC (µS/cm)
21
20.5
20
19.5
19
18.5
18
17.5
17
Groundwater Elevation (mAHD)
Jul-2023
Aug-2023
Sep-2023
Oct-2023
Nov-2023
Dec-2023
Jan-2024
Feb-2024
Mar-2024
Apr-2024
May-2024
Jun-2024
EC
Groundwater Elevation
GW Green
GW Amber
GW Red



SBT-GW-1805
25,000
20,000
15,000
10,000
5,000
0
EC (µS/cm)
23
22.5
22
21.5
21
20.5
Groundwater Elevation (mAHD)
May-2023
May-2023
Jun-2023
Jul-2023
Jul-2023
Aug-2023
Aug-2023
Sep-2023
Oct-2023
Oct-2023
Nov-2023
Nov-2023
Dec-2023
Jan-2024
Jan-2024
Feb-2024
Feb-2024
Mar-2024
Mar-2024
Apr-2024
May-2024
May-2024
Jun-2024
Jun-2024
Jul-2024
Aug-2024
EC
EC SSTV
GW Red
Lab EC
Groundwater Elevation
GW Green
GW Amber



SBT-GW-4000
EC (µS/cm)
Groundwater Elevation (mAHD)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
71
70.5
70
69.5
69
68.5
68
67.5
67
66.5
Jun-2023
Jul-2023
Jul-2023
Aug-2023
Aug-2023
Sep-2023
Sep-2023
Oct-2023
Nov-2023
Nov-2023
Dec-2023
Dec-2023
Jan-2024
Feb-2024
Feb-2024
Mar-2024
Mar-2024
Apr-2024
May-2024
May-2024
Jun-2024
Jun-2024
Jul-2024
EC
EC field
Groundwater Elevation
GW Green
GW Amber
GW Red


SBT-GW-4010
25,000
20,000
15,000
10,000
5,000
0
EC (µS/cm)
76
74
72
70
68
66
64
62
60
58
56
Groundwater Elevation (mAHD)
May-2023
Jun-2023
Jun-2023
Jul-2023
Jul-2023
Aug-2023
Aug-2023
Sep-2023
Oct-2023
Oct-2023
Nov-2023
Nov-2023
Dec-2023
Jan-2024
Jan-2024
Feb-2024
Feb-2024
Mar-2024
Apr-2024
Apr-2024
May-2024
May-2024
Jun-2024
Jul-2024
Jul-2024
EC
Groundwater Elevation
GW Green
GW Amber
GW Red
Manually Gauged WL

Annexure E Statistical trend analysis – groundwater quality

Annexure E
Trend Analysis based on Mann Kendall Statistics

Monitoring Zone	Location ID	Aluminium	C10 - C40 (Sum of total)	C6 - C9	Cadmium	Copper	Naphthalene	Nitrogen (Total)	pH (Lab)	Phenol	Phosphorus total	Sum of PFASs (n=28)	Tetrachloroethene	Toluene	Zinc
Orchard Hills	SBT-GW-1042	Grey	Grey	Grey	Green	Green	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Green
		1410 ug/L	100 ug/L	20 ug/L	0.2 ug/L	15 ug/L	1 ug/L	150 mg/L	4.94 pH_unit	2 µg/L	0.2 mg/L	0.01 µg/L	0.005 mg/L	2 ug/L	166 ug/L
Bringelly	SBT-GW-4003	Grey	Grey	Green	Green	Green	Grey	Green	Grey	Grey	Green	Grey	Grey	Green	Green
		10 ug/L	100 ug/L	20 ug/L	0.1 ug/L	6 ug/L	1 ug/L	3.7 mg/L	7.61 pH_unit	2 µg/L	0.35 mg/L	0.0035 µg/L	0.005 mg/L	2 ug/L	8 ug/L
	SBT-GW-4005	Grey	Grey	Grey	Grey	Grey	Green	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey
		600 ug/L	100 ug/L	20 ug/L	0.1 ug/L	6 ug/L	1 ug/L	4.7 mg/L	9.62 pH_unit	2 µg/L	0.34 mg/L	0.0157 µg/L	0.005 mg/L	2 ug/L	21 ug/L
	SBT-GW-4800	Grey	Grey	Grey	Grey	Grey	Green	Grey	Grey	Grey	Grey	Green	Grey	Grey	Grey
		10 ug/L	100 ug/L	20 ug/L	0.1 ug/L	1 ug/L	1 ug/L	3.4 mg/L	7.61 pH_unit	2 µg/L	0.66 mg/L	0.01 µg/L	0.005 mg/L	2 ug/L	37 ug/L
	SBT-GW-4802	Grey	Grey	Grey	Grey	Grey	Green	Grey	Grey	Grey	Grey	Green	Grey	Grey	Grey
		10 ug/L	100 ug/L	20 ug/L	0.1 ug/L	3 ug/L	1 ug/L	9.1 mg/L	7.28 pH_unit	2 µg/L	0.12 mg/L	0.01 µg/L	0.005 mg/L	2 ug/L	67 ug/L
St Marys	MW1	Green	Grey	Red	Green	Green	Green	Red	Green	Green	Green	Grey	Red	Green	Red
		30 ug/L	100 ug/L	3770 ug/L	0.1 ug/L	3 ug/L	1 ug/L	8.6 mg/L	6.78 pH_unit	2 µg/L	0.39 mg/L	1.05 µg/L	3.57 mg/L	5 ug/L	65 ug/L
	MW2	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
		10 ug/L	100 ug/L	20 ug/L	0.1 ug/L	30 ug/L	1 ug/L	0.5 mg/L	7.99 pH_unit	2 µg/L	0.51 mg/L	0.01 µg/L	3.06 mg/L	2 ug/L	38 ug/L
	SBT-GW-1019_R	Green	Grey	Green	Grey	Green	Green	Green	Red	Grey	Green	Grey	Green	Grey	Green
		10 ug/L	100 ug/L	30 ug/L	0.1 ug/L	1 ug/L	1 ug/L	1.5 mg/L	7.68 pH_unit	2 µg/L	0.07 mg/L	0.0066 µg/L	0.006 mg/L	2 ug/L	14 ug/L
	SBT-GW-1021	Grey	Green	Green	Green	Green	Green	Green	Grey	Green	Green	Grey	Green	Green	Green
		230 ug/L	100 ug/L	20 ug/L	0.1 ug/L	2 ug/L	1 ug/L	5.3 mg/L	6.95 pH_unit	2 µg/L	0.11 mg/L	2.3 µg/L	0.005 mg/L	2 ug/L	35 ug/L
	SBT-GW-1022	Green	Grey	Grey	Green	Green	Grey	Green	Green	Grey	Green	Green	Grey	Green	Green
		50 ug/L	100 ug/L	20 ug/L	0.1 ug/L	3 ug/L	1 ug/L	1.3 mg/L	5.92 pH_unit	2 µg/L	0.12 mg/L	0.01 µg/L	0.005 mg/L	2 ug/L	51 ug/L
Claremont Meadows	SBT-GW-1024	Green	Green	Green	Green	Green	Grey	Green	Green	Grey	Green	Green	Grey	Green	Amber
		170 ug/L	100 ug/L	20 ug/L	0.1 ug/L	3 ug/L	2 ug/L	5.4 mg/L	6.26 pH_unit	2 µg/L	0.54 mg/L	0.01 µg/L	0.005 mg/L	2 ug/L	104 ug/L
	SBT-GW-1031	Green	Green	Green	Green	Green	Green	Green	Green	Grey	Green	Green	Grey	Green	Green
		530 ug/L	100 ug/L	20 ug/L	0.3 ug/L	2 ug/L	1 ug/L	1.4 mg/L	5.7 pH_unit	2 µg/L	0.1 mg/L	0.01 µg/L	0.005 mg/L	2 ug/L	168 ug/L
	SBT-GW-1805	Green	Grey	Grey	Green	Green	Green	Green	Green	Grey	Green	Green	Grey	Grey	Green
		10 ug/L	100 ug/L	20 ug/L	0.1 ug/L	3 ug/L	1 ug/L	7.6 mg/L	6.77 pH_unit	2 µg/L	2.47 mg/L	0.01 µg/L	0.005 mg/L	2 ug/L	10 ug/L
Aerotropolis	SBT-GW-4010	Grey	Green	Green	Grey	Grey	Green	Grey	Grey	Green	Grey	Green	Green	Green	Grey
		30 ug/L	100 ug/L	20 ug/L	0.3 ug/L	5 ug/L	1 ug/L	14.1 mg/L	7.91 pH_unit	2 µg/L	2.21 mg/L	0.01 µg/L	0.005 mg/L	2 ug/L	40 ug/L
Northern Tunnels	SBT-GW-1020	Green	Grey	Grey	Green	Green	Grey	Green	Green	Grey	Green	Grey	Green	Grey	Green
		20 ug/L	100 ug/L	20 ug/L	0.1 ug/L	1 ug/L	1 ug/L	0.5 mg/L	5.37 pH_unit	2 µg/L	0.08 mg/L	0.0327 µg/L	0.005 mg/L	2 ug/L	49 ug/L
	SBT-GW-1804	Green	Grey	Grey	Green	Green	Grey	Green	Green	Grey	Green	Green	Grey	Grey	Green
		10 ug/L	100 ug/L	20 ug/L	0.1 ug/L	1 ug/L	1 ug/L	2.2 mg/L	7.4 pH_unit	2 µg/L	0.26 mg/L	0.01 µg/L	0.005 mg/L	2 ug/L	11 ug/L
	SMGW-BH-A107	Green	Grey	Grey	Green	Green	Grey	Green	Red	Grey	Green	Green	Grey	Grey	Green
		100 ug/L	100 ug/L	20 ug/L	0.1 ug/L	1 ug/L	1 ug/L	7.9 mg/L	9.01 pH_unit	2 µg/L	1.1 mg/L	0.01 µg/L	0.005 mg/L	2 ug/L	10 ug/L
	SMGW-BH-A360	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Grey	Green	Grey	Grey	Grey
		10 ug/L	100 ug/L	20 ug/L	0.5 ug/L	3 ug/L	1 ug/L	6.8 mg/L	7.45 pH_unit	2 µg/L	3.38 mg/L	0.01 µg/L	0.005 mg/L	2 ug/L	165 ug/L
Southern Tunnels	SBT-BH-4008	Grey	Green	Green	Grey	Grey	Green	Grey	Grey	Grey	Grey	Green	Grey	Green	Grey
		10 ug/L	100 ug/L	20 ug/L	0.1 ug/L	1 ug/L	1 ug/L	9.2 mg/L	7.46 pH_unit	2 µg/L	0.06 mg/L	0.01 µg/L	0.005 mg/L	2 ug/L	37 ug/L
Cross passage / Tunnel (XPN13)	SBT-GW-1030	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Grey	Green	Green	Green
		250 ug/L	100 ug/L	20 ug/L	0.2 ug/L	3 ug/L	1 ug/L	4.7 mg/L	5.75 pH_unit	2 µg/L	0.55 mg/L	0.07 µg/L	0.005 mg/L	2 ug/L	111 ug/L
Airport Terminal	SBT-GW-4000	Green	Green	Green	Green	Green	Green	Green	Green	Grey	Green	Green	Grey	Green	Green
		10 ug/L	410 ug/L	20 ug/L	0.2 ug/L	4 ug/L	1 ug/L	3.3 mg/L	7.52 pH_unit	2 µg/L	0.65 mg/L	0.01 µg/L	0.005 mg/L	2 ug/L	5 ug/L
WSI	SMGW-BH-C320	Green	Grey	Grey	Green	Green	Grey	Grey	Green	Grey	Grey	Grey	Grey	Grey	Green
		10 ug/L	100 ug/L	20 ug/L	0.1 ug/L	1 ug/L	1 ug/L	0.8 mg/L	7.7 pH_unit	2 µg/L	0.13 mg/L	0.005 µg/L	0.005 mg/L	2 ug/L	5 ug/L
	SMGW-BH-C321	Grey	Grey	Grey	Green	Green	Green	Grey	Green	Grey	Grey	Grey	Grey	Grey	Green
		10 ug/L	100 ug/L	20 ug/L	0.5 ug/L	4 ug/L	1 ug/L	8.5 mg/L	6.82 pH_unit	2 µg/L	0.71 mg/L	0.0195 µg/L	0.005 mg/L	2 ug/L	320 ug/L
	SMGW-BH-C330	Green	Grey	Grey	Green	Green	Grey	Green	Amber	Grey	Green	Green	Grey	Grey	Green
		20 ug/L	100 ug/L	20 ug/L	0.4 ug/L	4 ug/L	1 ug/L	10 mg/L	7.34 pH_unit	2 µg/L	0.91 mg/L	0.01 µg/L	0.005 mg/L	2 ug/L	284 ug/L

Legend
- Red - Review trigger and system operation if
- Amber - Review data if required
- Green - No action required
- Grey - Insufficient data for trend

Annexure F QAQC Report

F.1 Introduction

All groundwater quality monitoring was undertaken by CPBG trained personnel, and is understood to have been completed in accordance with the methodology detailed in Section 7.4 of the GMP.

Quality assurance (QA) and quality control (QC) measures during sampling and field data collection to ensure data integrity are detailed in Section 7 of the GMP. The measures outlined in the GMP included:

- Use of NATA accredited laboratories for sample analysis;
- Use of Chain of Custody (CoC) procedures between sample collection in the field and subsequent reception of the sample by the laboratory. CoC documentation included the sample type and code, analysis required, collection data, sampler and sample receiver(s);
- Appropriate sample handling and storage including using laboratory supplied containers, keeping samples chilled during storage and transport, ensuring samples are received in good condition within specified holding times by the laboratory;
- A consistent program of quality control sampling was adopted for fieldwork, including:
  - Collection of duplicate and triplicate samples at an average frequency of one sample per twenty primary samples (an overall ratio of 1:10 where PFAS sampled in accordance with NEMP 2.0);
  - Collection of rinsate blanks to measure the effectiveness of decontamination procedures; and
  - Collection of trip blanks to assess the adequacy of sample storage and transport procedures in preventing cross contamination.
  -

F.2 Quality Control

The steps in the sampling and analysis process are subject to natural and inherent variability, and this can affect the results produced, and the overall quality of the data sets generated. In order to minimise the effect of this, standard procedures are used for works carried out in the field, and in the laboratory. The use of such procedures represents one aspect of the quality assurance process. To measure the effectiveness of the quality assurance process, quality control samples can be tested, and other quality control tests can be conducted during the analysis of samples taken in the field.

Quality control (QC) samples and tests can be used to assess both the accuracy and the precision of the results produced.

Measures of ACCURACY provide information on how close the reported result is to the true result. For practical reasons, measures of accuracy are usually confined to the laboratory steps in the overall process.

Measures of PRECISION provide information on the variability in the results. Precision can be assessed as:

- “repeatability” or intra-laboratory variation – the degree of variation in a result when the same laboratory analyses a sample (or blind replicate) several times, and;
- “reproducibility” or inter-laboratory variation – the degree of variation in a result when a different laboratory separately analyses a sample.

In addition, blank samples can be used to assess whether extraneous materials and factors have contributed to the results obtained from the sampling and analysis process.

QC testing can be conducted for all steps of the sampling and analysis process (referred to as Field QC in this report), or just one portion of the process, such as the laboratory steps (referred to as Laboratory QC in this report).

F.2.1 Field Quality Control

Precision of the sample collection, transport and analysis process is measured by the relative percent difference (RPD) between duplicate and triplicate results.

As detailed in the Section 7.7 of the GMP the relative percentage difference (RPD) acceptance limits adopted were:

- No limit analytical results <10 times Level of reporting (LOR)
- 50% analytical results 10-20 times LOR
- 30% analytical results >20 times LOR.

F.2.1 Laboratory Quality Control

Laboratories are accredited by the National Association of Testing Authorities, Australia (NATA) on the basis of their ability to provide quantitative evidence of their ability and competence to produce reliable results against recognised benchmarks. Both the primary laboratory Australian Laboratory Services (ALS) and secondary laboratory Eurofins are accredited by the National Association of Testing Authorities (NATA).

NATA accredited laboratories are able to demonstrate the ability to produce reliable, repeatable results for a range of parameters within a range of sample matrices. Each laboratory method used undergoes a validation process before it is adopted by the laboratory and accredited by NATA. As part of the validation process, the precision and accuracy of the method are established.

In addition, laboratories conduct their own quality control testing to indicate their performance on each reported batch of samples. The results of this testing are compared with the validated precision and accuracy.

Precision of results is measured by the RPD between replicate samples selected at the laboratory.

Accuracy of results is assessed in a number of ways:

- **Method blanks:** An analyte free matrix, which is carried through the complete preparation and analytical procedure.
- **Matrix spikes**: Known amounts of targeted analytes are added to the samples to be analysed, and the spiked samples are processed through the analytical process. The recoveries of the spiked analytes are evaluated to determine accuracy in a given matrix.
- **Surrogate spikes:** Known amounts of chemical compounds with similar properties to the targeted analytes are added to the samples to be analysed, and the spiked samples are processed through the analytical process. The recoveries of the surrogate spikes are evaluated to determine extraction efficiency.
- **Laboratory control samples (LCS)**: A clean matrix (not containing any of the analyte of interest) spiked with known concentrations of the analytes of interest. LCS samples are

analysed to determine if the procedure is working within established control limits where matrix interference is not an issue.

Schedule B(3) of the National Environment Protection Measure (NEPM) for contaminated sites states that, in general, at least 70% recovery should be achievable from a reference method. Additionally, standard methods prepared by international agencies such as the US EPA and APHA, frequently have performance data such as expected spike recovery incorporated within the method. Where these vary from 70% as indicated in NEPM, they are noted in the discussion of results.

A default acceptable range of 70% - 130% for metals and inorganics, and 60% - 140% for organics, was adopted for matrix spike recovery results (Table F-1).

F.2.1 Summary of data quality acceptance targets for groundwater QC samples

Data quality acceptance targets for groundwater field and laboratory QC samples are summarised in Table F-1 below.

Table F.1: Data quality acceptance targets for field and analytical results for groundwater water samples

QC sample type	
Duplicate and Triplicate Samples (applies to both field and lab duplicates)	Relative Percentage Difference (RPD) within 50% for groundwater.
Spike and surrogate recoveries	Spike and surrogate recoveries between the laboratory lower control limit and upper control limit and where not defined the following range to be adopted: 70% - 130% for inorganics / metals; and 60% - 140% for organics.
Lab control samples	Refer to internal laboratory control limits
Blanks	Analytes not detected, i.e., below the level of reporting (LOR).

F.3 Analytical Laboratory Processes

Table F-2: Summary of analytical laboratory processes

Analytical laboratory processes	YES	NO
1. Was a NATA registered laboratory used?	☒	☐
2. Did the laboratory perform the requested analysis?	☒	☐
3. Were the laboratory methods adopted NATA endorsed?	☒	☐
4. Were the appropriate test procedures followed?	☒	☐
5. Were the reporting limits satisfactory?	☒	☐
6. Was the NATA seal on the reports?	☒	☐
7. Were the reports signed by an authorised person?	☒	☐

COMMENTS

Nil.

Precision/Accuracy of the Laboratory Report		
Satisfactory ☒	Partially Satisfactory ☐	Unsatisfactory ☐

F.4 Sample Handling Procedures

Table F-3: Summary of sample handling procedures

Sample handling	YES	NO
1. Were the sample holding times met for COPC?	☒	☐
2. Were the samples in proper custody between the field and laboratory?	☒	☐
3. Were the samples properly and adequately preserved? (This includes chilling the samples where appropriate)	☒	☐
4. Were the samples received by the laboratory in good condition?	☒	☐

COMMENTS

Sample Handling Procedure		
Satisfactory ☒	Partially Satisfactory ☐	Unsatisfactory ☐

Analysis Holding Time Outliers

Nil.

F.4 Field QA/QC sampling and procedures

F.5.1 Field QA/QC Summary

The monitoring event occurred over 141 days between 1st December 2023 and 28 June 2024. A summary of QC samples collected during the GME is provided in Table F-4 below, and results for Primary to QC samples RPDs, rinsate samples and trip blank samples are presented in Tables 1 through 3 attached.

Table F-4: QA/QC sample summary

Sample Type	QC sample frequency requirements	Number of samples required	Number of samples collected
Primary Samples		-	91
QA/QC Samples	Field Duplicate pairs (1 in 20 primary samples)	5	7
	Field triplicate pairs (1 in 20 primary samples)	5	2
	Trip Blanks (1 / sample batch)	22	4
	Field Blanks (1 / sampling event)	22	2
	Equipment Rinsates (1 / person / day where non-disposable equipment used for sampling)	22 (if non-disposable equipment used)	11

F.5.1 Field QA/QC Summary

Field replicates collected over the monitoring period are summarised in Table F-5.

Table F-5: QA/QC samples

Primary sample ID	Duplicate IDs (ALS)	Duplicate IDs (Envirolab	Triplicate ID (Secondary Laboratory)
SBT-GW-1019R M	SBT-GW-1019R M Duplicate	-	-
SBT-GW-1022	SBT-GW-1022 DUP	-	-
SBT-GW-1024	SBT-GW-1024_duplicate	-	-

Primary sample ID	Duplicate IDs (ALS)	Duplicate IDs (Envirolab	Triplicate ID (Secondary Laboratory)
SBT-GW-1030	SBT-GW-1030_duplicate	-	-
SBT-GW-1031	SBT-GW-1031 (DUPLICATE)	-	-
SBT-GW-4000	SBT-GW-4000-DUP	-	-
SBT-GW-4003	SBT-GW-4003	SBT-GW-4003	SBT-GW-4003
SBT-GW-4801	SBT-GW-4801		SBT-GW-4801

	YES	NO	N/A
1. Were an adequate number of field replicates analysed for each chemical?	☐	☒	☐
2. Were RPD's for replicate samples within control limits?	☐	☒	☐

Where RPDs were outside the acceptable range, sampling procedures, laboratory analytical methods and laboratory results were investigated. The results of this review are presented in Table F-6.

Table F-6: Replicate RPD exceedance summary

Primary Sample	Duplicate / Triplicate Sample ID	Lab report	Analyte	RPD %	See Comment
SBT-GW-1031	SBT-GW-1031 (DUPLICATE)	ES2415975	Copper (filtered)	67	3
			Bicarbonate Alkalinity as CaCO3	67	3
SBT-GW-4000	SBT-GW-4000-DUP	ES2411960, ES2411960	Manganese	37	3
			Manganese (filtered)	73	3
			Carbonate Alkalinity as CaCO3	61	4
			Sulfate as SO4 - Turbidimetric (filtered)	42	3
			Calcium (filtered)	67	3
			Chloride	65	2
			Sodium (filtered)	53	2
			Electrical Conductivity @ 25C (lab)	53	3
			Total Dissolved Solids (TDS)	52	3
			Ammonia as N	78	2
			Nitrogen (Total)	104	2
			Total Kjeldahl Nitrogen (TKN)	102	2
			Phosphorus total	59	2

Primary Sample	Duplicate / Triplicate Sample ID	Lab report	Analyte	RPD %	See Comment
SBT-GW-4801	SBT-GW-4801	ES2418886, 353698	Iron	64	1
			Aluminium	39	1
			Manganese	59	1
			Ammonia as N	88	2
			Nitrogen (Total)	41	2
			Total Kjeldahl Nitrogen (TKN)	167	2

Comments

1) Poor RPDs identified in total but not filtered metals, indicating that poor reproducibility was associated with metals sorbed to particulates rather than issues with sampling or analysis.
2) RPD exceedances are associated with ammonia or organically bound nitrogen, which are included in nitrogen as TKN or Total Nitrogen. These forms of nitrogen are typically bound or sorbed to particulates, and therefore poor RPDs are due to particulates (i.e turbid samples) rather than issues with sampling or analysis.
3) RPDs reported outside the acceptable range are where the primary result is higher than the duplicate/triplicate reported result.
4) RPDs reported outside the acceptable range are where the primary result is lower than the duplicate/triplicate reported result.

In total 22 of 320 duplicate pairs of analysis exceeded adopted RPD acceptance limits (6.9%). The precision of the field investigation is not considered to be materially affected by non-compliant RPDs, as the highest concentration reported in QC replicates pairs has been adopted for interpretation, and most of the RPD exceedances are associated with analytes which are influenced by the presence of particulates. As the adopted criteria and performance criteria are mostly based on dissolved (i.e filtered) concentrations, which did not exceed the acceptance limits, the RPD exceedances are not considered to represent an issue with data quality.

Duplicate pair for well SBT-GW-4000 sampled on 12 April 2024 has a large number (12) of analyte results, including major ions and TDS which do not meet RPD criteria. This sample represents 55% of the RPD issues identified for the entire program. It is possible that there is a field or lab quality issue with this duplicate paring and potentially these samples are not a duplicate pair.

If questionable duplicate pair SBT-GW-4000 sampled on 12 April 2024 is excluded from the analysis then there are 10 of 290 duplicate pairs of analysis exceeding the adopted limits for RPD which equates to 3.4%.

F.5.1 Field Blanks Summary

Blank field quality control samples include trip blanks, field blanks and equipment rinsates.

Trip blanks are used to assess whether sample storage and transport procedures minimised the introduction of contamination during storage and transport. Trip blanks are typically collected and analysed where volatile contaminants of concern are being assessed in the sample batch.

Trip blanks are laboratory prepared vials of distilled water that remained with the sample containers during sampling and transport to the laboratory. At no time during these procedures are the blanks opened.

Field blank samples are collected to assess if sampling procedures were conducted appropriately to minimise the potential impact of environmental factors during sample collection.

The blank are typically prepared by pouring laboratory supplied distilled water into sampling bottles, which were then stored (with lids off) with other samples throughout sampling activities.

Equipment rinsates are collected to assess if procedures for decontamination of non-disposable sampling equipment were adequate to minimise for cross-contamination between sampling points.

Rinsate samples are prepared in the field using laboratory supplied bottles and the distilled water used for the cleaning of non-disposable sampling equipment. Rinsate samples are typically collected at a rate of one per field operator per day where non-disposable sampling equipment was used.

Trip Blanks

	Yes	No (see comment)
Were an adequate number of trip blanks collected?	☐	☒
Were trip blanks free of contaminants?	☒	☐

Comments

Although the number of trip blanks collected was non-compliant, as volatile contaminants have not been identified as COPC along the alignment, apart from St Marys where there is a targeted mitigation monitoring program, the lack of trip blanks is not considered to have impacted the useability of the dataset.

Rinsates

	Yes	No (See comment)
Were an adequate number of rinsate blanks collected?	☐	☒
Were rinsate blanks free of contaminants?	☐	☒

Comments

Where analytes were detected in rinsate samples, laboratory results were investigated. The results of this review are presented in Table F-7.

Table F-7: Rinsate results summary

Rinsate Sample ID	Lab report	Analyte detect
RINSATE	ES2408366	Aluminium Total (20 µg/L, LOR 10u/L). Dissolved aluminium <LOR
		Bicarbonate Alkalinity as CaCO3 (7mg/L, LOR 1mg/L)
		Chloride (5 mg/L, LOR 1mg/L)
		Sodium filtered (2 mg/L, LOR 1mg/L)
		Orthophosphate as P (20 µg/L, LOR 10 µg/L)
		Ammonia as N (40 µg/L, LOR 10 µg/L)
		Phosphorus total (30 µg/L, LOR 10 µg/L)
RINSATE	ES2411960	Iron Total (1,000 µg/L, LOR 50 µg/L). Dissolved iron <LOR
		Aluminium (550 µg/L, LOR 10 µg/L). Dissolved aluminium <LOR
		Manganese (28 µg/L, LOR 1 µg/L). Dissolved manganese <LOR)
		Toluene (20 µg/L, LOR 1 µg/L)
		Bicarbonate Alkalinity as CaCO3 (14m/L, LOR 1mg/L)
		Sulfate as SO4 filtered (2 mg/L, LOR 1mg/L)
		Chloride (17 mg/L, LOR 1mg/L)
		Sodium filtered (6 mg/L, LOR 1mg/L)
		Ammonia as N (20 µg/L, LOR 10 µg/L)
		Nitrate as NO3-N (10 µg/L, LOR 10 µg/L)
		Nitrogen Total (200 µg/L, LOR 100 µg/L)
		Total Kjeldahl Nitrogen (200 µg/L, LOR 100 µg/L)
		Phosphorus total (40 µg/L, LOR 10 µg/L)
Rinsate	ES2413514	Aluminium (10 µg/L, LOR 10 µg/L)
		Ammonia as N (20 µg/L, LOR 10 µg/L)
		Nitrate as NO3-N (10 µg/L, LOR 10 µg/L)
		Nitrogen Total (200 µg/L, LOR 100 µg/L)
		Total Kjeldahl Nitrogen (200 µg/L, LOR 100 µg/L)
		Phosphorus total (10 µg/L, LOR 10 µg/L)
Rinsate	ES2414085	Aluminium (20 µg/L, LOR 10 µg/L)
		Manganese (2 µg/L, LOR 1 µg/L)
		Manganese filtered (1 µg/L, 1 µg/L)
Rinsate	ES2415197	Aluminium filtered (10 µg/L, LOR 10 µg/L)
		Manganese filtered (15 µg/L, LOR 1 µg/L)

Rinsate Sample ID	Lab report	Analyte detect
		Ammonia as N (20 µg/L, LOR 10 µg/L)
		Nitrate as NO3-N (30 µg/L, LOR 10 µg/L)
		Nitrogen Total (100 µg/L, LOR 100 µg/L)
		Total Kjeldahl Nitrogen (100 µg/L, LOR 100 µg/L)
		Phosphorus total (10 µg/L, LOR 10 µg/L)
RINSATE	ES2415975	Magnesium filtered (1mg/L, LOR 1mg/L)
		Copper filtered (2 µg/L, LOR 1 µg/L)
		Iron (260 µg/L, LOR 50 µg/L)
		Iron filtered (60 µg/L, LOR 50 µg/L)
		Nickel filtered (2 µg/L, LOR 1 µg/L)
		Zinc filtered (22 µg/L, LOR 5 µg/L)
		Aluminium Total (280 µg/L, LOR 10 µg/L)
		Aluminium filtered (60 µg/L, LOR 10 µg/L)
		Manganese (24 µg/L, LOR 1 µg/L)
		Manganese filtered (9 µg/L, LOR 1 µg/L)
		Alkalinity total as CaCO3 (3mg/L, LOR 1mg/L)
		Sulfate as SO4 filtered (3 mg/L, LOR 1mg/L)
		Calcium filtered (1 mg/L, LOR 1mg/L)
		Chloride (7 mg/L, LOR 1mg/L)
		Potassium filtered (1 mg/L, LOR 1mg/L)
		Sodium filtered (8 mg/L, LOR 1mg/L)
		Ammonia as N (20 µg/L, LOR 10 µg/L)
		Nitrate as NO3-N (70 µg/L, LOR 10 µg/L)
		Nitrogen Total (500 µg/L, LOR 100 µg/L)
		Total Kjeldahl Nitrogen (400 µg/L, LOR 100 µg/L)
		Phosphorus total (80 µg/L, LOR 10 µg/L)
Rinsate	ES2419474	Iron (60 µg/L, LOR 10 µg/L)
		Aluminium (130 µg/L, LOR 10 µg/L)
		Manganese (2 µg/L, LOR 1 µg/L)
		Nitrate as NO3-N (20 µg/L, LOR 10 µg/L)
Rinsate	ES2421298	Manganese (1 µg/L, LOR 1 µg/L)

Rinsate Sample ID	Lab report	Analyte detect
		Nitrate as NO3-N (90 µg/L, LOR 10 µg/L)
		Nitrogen Total (500 µg/L, LOR 100 µg/L)
		Total Kjeldahl Nitrogen (400 µg/L, LOR 100 µg/L)
		Phosphorus total (20 µg/L, LOR 10 µg/L)

The detection of analytes in the rinsate samples collected implies that at times, procedures for rinsing of non-disposable sampling equipment were possibly not adequate to minimise for cross-contamination and/or residual tap water remaining between sampling points. This is particularly highlighted in two rinsate samples collected (lab report numbers ES2411960 and ES2415975) where total metal concentrations (but not dissolved metals) were detected in concentrations were more than an order of magnitude larger than the detection limits.

Although detectable concentrations were reported for many analytes in the rinsate samples, concentrations were mostly at or just above the LOR, and analytes indicative of tap water used to wash the equipment, rather than COPCs or cross contamination from previous samples.

Blanks and Rinsate Sampling and Analysis		
Satisfactory ☒	Partially Satisfactory ☐	Unsatisfactory ☐

F.5.1 Laboratory Quality Control Procedures

As noted in Section F.2, laboratories conduct their own quality control testing to indicate their performance on each reported batch of samples. An assessment of the adequacy of these procedures is provided in Tables F-8 and F-9.

Table F-8: Acceptability of laboratory quality controls

	YES	NO
Were laboratory method blanks free of contamination?	☒	☐
Were the matrix spike recoveries within control limits?	☐	☒ See comment
Were the Lab control samples within control limits?	☐	☒ See comment
Were the RPD's of the laboratory duplicates within control limits?	☐	☒ See comment

Were the surrogate recoveries within laboratory control limits?	☒	☐

Table F-9: Summary of laboratory quality controls results

Sample Type	Total Number of Analyses	Number of Identified Issues	% of Analyses with Identified Issues	Comment/Issues Identified
Method blank	1,466	0	0%	All results <LOR
Matrix spike % recovery	685	3	0.5%	The following analytes were outside laboratory control limits: • Mercury • Sulfate as SO4
Laboratory control sample % recovery	1,724	5	0.3%	The following analytes were outside laboratory control limits: • Nitroaromatics • Phenols • Anilines • PAHs
Laboratory duplicates	2,438	14	0.6%	The following analytes were outside laboratory control limits: • Arsenic • Nickel • Copper • Cadmium • Magnesium • Chromium • Nickel • Chromium hexavalent • Cobalt • Aluminium
Surrogate % recovery	203	0	0	-
Total	**6,516**	**22**	**0.34%**	

Based on the low percentage of non-compliant matrix spikes, laboratory control samples, laboratory duplicates and surrogates, the data set is considered to be acceptable for use.

F.7 Field Data Useability

Overall, of the 6,516 individual analyses conducted in association with the quality assessment, issues were identified in 22 analyses (0.34%). A summary of the total analyses and proportion with issues is provided in Table F-9 below.

Table F-9: Quality Control Program Summary

Sample Type	Total Number of Analyses	Number of Identified Issues	% of Analyses with Identified Issues	Issues Identified
Field Duplicate/ Triplicates samples	320	22	6.9%	RPDs outside acceptable range
Field quality control samples (rinsates, field blanks and trip blanks)	428	64	14.9%	All due to analyte detections in rinsate samples, which were mostly at or just above LOR, and indicative of tap water rather than cross contamination
Internal laboratory analyses	6,516	22	0.34%	Laboratory quality control results outside of control limits
Total	**7,174**	**138**	**1.5%**	

Recommendations for interpretation and future monitoring events include:

- Sample turbidity should be considered when interpreting total metal and nutrient concentrations as the presence of particulates may result in higher total concentrations being reported.
- Increase the collection of QAQC triplicate samples to be in line with the GMP criteria.
- Review decontamination procedures and ensure sampling equipment is rinsed of tap water prior to rinsate collection.

Overall, the percentage of issues identified in the quality assessment (1.5%) is considered acceptable, and therefore the data is considered to be of appropriate quality for use.

Annexure F QAQC Report

F.1 Introduction

All groundwater quality monitoring was undertaken by CPBG trained personnel, and is understood to have been completed in accordance with the methodology detailed in Section 7.4 of the GMP.

Quality assurance (QA) and quality control (QC) measures during sampling and field data collection to ensure data integrity are detailed in Section 7 of the GMP. The measures outlined in the GMP included:

- Use of NATA accredited laboratories for sample analysis;
- Use of Chain of Custody (CoC) procedures between sample collection in the field and subsequent reception of the sample by the laboratory. CoC documentation included the sample type and code, analysis required, collection data, sampler and sample receiver(s);
- Appropriate sample handling and storage including using laboratory supplied containers, keeping samples chilled during storage and transport, ensuring samples are received in good condition within specified holding times by the laboratory;
- A consistent program of quality control sampling was adopted for fieldwork, including:
  - Collection of duplicate and triplicate samples at an average frequency of one sample per twenty primary samples (an overall ratio of 1:10 where PFAS sampled in accordance with NEMP 2.0);
  - Collection of rinsate blanks to measure the effectiveness of decontamination procedures; and
  - Collection of trip blanks to assess the adequacy of sample storage and transport procedures in preventing cross contamination.
  -

F.2 Quality Control

The steps in the sampling and analysis process are subject to natural and inherent variability, and this can affect the results produced, and the overall quality of the data sets generated. In order to minimise the effect of this, standard procedures are used for works carried out in the field, and in the laboratory. The use of such procedures represents one aspect of the quality assurance process. To measure the effectiveness of the quality assurance process, quality control samples can be tested, and other quality control tests can be conducted during the analysis of samples taken in the field.

Quality control (QC) samples and tests can be used to assess both the accuracy and the precision of the results produced.

Measures of ACCURACY provide information on how close the reported result is to the true result. For practical reasons, measures of accuracy are usually confined to the laboratory steps in the overall process.

Measures of PRECISION provide information on the variability in the results. Precision can be assessed as:

- "repeatability" or intra-laboratory variation – the degree of variation in a result when the same laboratory analyses a sample (or blind replicate) several times, and;
- "reproducibility" or inter-laboratory variation – the degree of variation in a result when a different laboratory separately analyses a sample.

In addition, blank samples can be used to assess whether extraneous materials and factors have contributed to the results obtained from the sampling and analysis process.

QC testing can be conducted for all steps of the sampling and analysis process (referred to as Field QC in this report), or just one portion of the process, such as the laboratory steps (referred to as Laboratory QC in this report).

F.2.1 Field Quality Control

Precision of the sample collection, transport and analysis process is measured by the relative percent difference (RPD) between duplicate and triplicate results.

As detailed in the Section 7.7 of the GMP the relative percentage difference (RPD) acceptance limits adopted were:

- No limit analytical results <10 times Level of reporting (LOR)
- 50% analytical results 10-20 times LOR
- 30% analytical results >20 times LOR.

F.2.1 Laboratory Quality Control

Laboratories are accredited by the National Association of Testing Authorities, Australia (NATA) on the basis of their ability to provide quantitative evidence of their ability and competence to produce reliable results against recognised benchmarks. Both the primary laboratory Australian Laboratory Services (ALS) and secondary laboratory Eurofins are accredited by the National Association of Testing Authorities (NATA).

NATA accredited laboratories are able to demonstrate the ability to produce reliable, repeatable results for a range of parameters within a range of sample matrices. Each laboratory method used undergoes a validation process before it is adopted by the laboratory and accredited by NATA. As part of the validation process, the precision and accuracy of the method are established.

In addition, laboratories conduct their own quality control testing to indicate their performance on each reported batch of samples. The results of this testing are compared with the validated precision and accuracy.

Precision of results is measured by the RPD between replicate samples selected at the laboratory.

Accuracy of results is assessed in a number of ways:

- **Method blanks:** An analyte free matrix, which is carried through the complete preparation and analytical procedure.
- **Matrix spikes**: Known amounts of targeted analytes are added to the samples to be analysed, and the spiked samples are processed through the analytical process. The recoveries of the spiked analytes are evaluated to determine accuracy in a given matrix.
- **Surrogate spikes:** Known amounts of chemical compounds with similar properties to the targeted analytes are added to the samples to be analysed, and the spiked samples are processed through the analytical process. The recoveries of the surrogate spikes are evaluated to determine extraction efficiency.
- **Laboratory control samples (LCS)**: A clean matrix (not containing any of the analyte of interest) spiked with known concentrations of the analytes of interest. LCS samples are

analysed to determine if the procedure is working within established control limits where matrix interference is not an issue.

Schedule B(3) of the National Environment Protection Measure (NEPM) for contaminated sites states that, in general, at least 70% recovery should be achievable from a reference method. Additionally, standard methods prepared by international agencies such as the US EPA and APHA, frequently have performance data such as expected spike recovery incorporated within the method. Where these vary from 70% as indicated in NEPM, they are noted in the discussion of results.

A default acceptable range of 70% - 130% for metals and inorganics, and 60% - 140% for organics, was adopted for matrix spike recovery results (Table F-1).

F.2.1 Summary of data quality acceptance targets for groundwater QC samples

Data quality acceptance targets for groundwater field and laboratory QC samples are summarised in Table F-1 below.

Table F.1: Data quality acceptance targets for field and analytical results for groundwater water samples

QC sample type	Acceptance limit
Duplicate and Triplicate Samples (applies to both field and lab duplicates)	Relative Percentage Difference (RPD) within 50% for groundwater.
Spike and surrogate recoveries	Spike and surrogate recoveries between the laboratory lower control limit and upper control limit and where not defined the following range to be adopted: 70% - 130% for inorganics / metals; and 60% - 140% for organics.
Lab control samples	Refer to internal laboratory control limits
Blanks	Analytes not detected, i.e., below the level of reporting (LOR).

F.3 Analytical Laboratory Processes

Table F-2: Summary of analytical laboratory processes

Analytical laboratory processes	YES	NO
1. Was a NATA registered laboratory used?	☒	☐
2. Did the laboratory perform the requested analysis?	☒	☐
3. Were the laboratory methods adopted NATA endorsed?	☒	☐
4. Were the appropriate test procedures followed?	☒	☐
5. Were the reporting limits satisfactory?	☒	☐
6. Was the NATA seal on the reports?	☒	☐
7. Were the reports signed by an authorised person?	☒	☐

COMMENTS

Nil.

Precision/Accuracy of the Laboratory Report		
Satisfactory ☒	Partially Satisfactory ☐	Unsatisfactory ☐

F.4 Sample Handling Procedures

Table F-3: Summary of sample handling procedures

Sample handling	YES	NO
1. Were the sample holding times met for COPC?	☒	☐
2. Were the samples in proper custody between the field and laboratory?	☒	☐
3. Were the samples properly and adequately preserved? (This includes chilling the samples where appropriate)	☒	☐
4. Were the samples received by the laboratory in good condition?	☒	☐

COMMENTS

Sample Handling Procedure		
Satisfactory ☒	Partially Satisfactory ☐	Unsatisfactory ☐

Analysis Holding Time Outliers

Nil.

F.4 Field QA/QC sampling and procedures

F.5.1 Field QA/QC Summary

The monitoring event occurred over 141 days between 1st December 2023 and 28 June 2024. A summary of QC samples collected during the GME is provided in Table F-4 below, and results for Primary to QC samples RPDs, rinsate samples and trip blank samples are presented in Tables 1 through 3 attached.

Table F-4: QA/QC sample summary

Sample Type	QC sample frequency requirements	Number of samples required	Number of samples collected
Primary Samples		-	91
QA/QC Samples	Field Duplicate pairs (1 in 20 primary samples)	5	7
	Field triplicate pairs (1 in 20 primary samples)	5	2
	Trip Blanks (1 / sample batch)	22	4
	Field Blanks (1 / sampling event)	22	2
	Equipment Rinsates (1 / person / day where non-disposable equipment used for sampling)	22 (if non-disposable equipment used)	11

F.5.1 Field QA/QC Summary

Field replicates collected over the monitoring period are summarised in Table F-5.

Table F-5: QA/QC samples

Primary sample ID	Duplicate IDs (ALS)	Duplicate IDs (Envirolab	Triplicate ID (Secondary Laboratory)
SBT-GW-1019R M	SBT-GW-1019R M Duplicate	-	-
SBT-GW-1022	SBT-GW-1022 DUP	-	-
SBT-GW-1024	SBT-GW-1024_duplicate	-	-

Primary sample ID	Duplicate IDs (ALS)	Duplicate IDs (Envirolab	Triplicate ID (Secondary Laboratory)
SBT-GW-1030	SBT-GW-1030_duplicate	-	-
SBT-GW-1031	SBT-GW-1031 (DUPLICATE)	-	-
SBT-GW-4000	SBT-GW-4000-DUP	-	-
SBT-GW-4003	SBT-GW-4003	SBT-GW-4003	SBT-GW-4003
SBT-GW-4801	SBT-GW-4801		SBT-GW-4801

	YES	NO	N/A
1. Were an adequate number of field replicates analysed for each chemical?	☐	☒	☐
2. Were RPD's for replicate samples within control limits?	☐	☒	☐

Where RPDs were outside the acceptable range, sampling procedures, laboratory analytical methods and laboratory results were investigated. The results of this review are presented in Table F-6.

Table F-6: Replicate RPD exceedance summary

Primary Sample	Duplicate / Triplicate Sample ID	Lab report	Analyte	RPD %	See Comment
SBT-GW-1031	SBT-GW-1031 (DUPLICATE)	ES2415975	Copper (filtered)	67	3
			Bicarbonate Alkalinity as CaCO3	67	3
SBT-GW-4000	SBT-GW-4000-DUP	ES2411960, ES2411960	Manganese	37	3
			Manganese (filtered)	73	3
			Carbonate Alkalinity as CaCO3	61	4
			Sulfate as SO4 - Turbidimetric (filtered)	42	3
			Calcium (filtered)	67	3
			Chloride	65	2
			Sodium (filtered)	53	2
			Electrical Conductivity @ 25C (lab)	53	3
			Total Dissolved Solids (TDS)	52	3
			Ammonia as N	78	2
			Nitrogen (Total)	104	2
			Total Kjeldahl Nitrogen (TKN)	102	2
			Phosphorus total	59	2

Primary Sample	Duplicate / Triplicate Sample ID	Lab report	Analyte	RPD %	See Comment
SBT-GW-4801	SBT-GW-4801	ES2418886, 353698	Iron	64	1
			Aluminium	39	1
			Manganese	59	1
			Ammonia as N	88	2
			Nitrogen (Total)	41	2
			Total Kjeldahl Nitrogen (TKN)	167	2

Comments

1) Poor RPDs identified in total but not filtered metals, indicating that poor reproducibility was associated with metals sorbed to particulates rather than issues with sampling or analysis.
2) RPD exceedances are associated with ammonia or organically bound nitrogen, which are included in nitrogen as TKN or Total Nitrogen. These forms of nitrogen are typically bound or sorbed to particulates, and therefore poor RPDs are due to particulates (i.e turbid samples) rather than issues with sampling or analysis.
3) RPDs reported outside the acceptable range are where the primary result is higher than the duplicate/triplicate reported result.
4) RPDs reported outside the acceptable range are where the primary result is lower than the duplicate/triplicate reported result.

In total 22 of 320 duplicate pairs of analysis exceeded adopted RPD acceptance limits (6.9%). The precision of the field investigation is not considered to be materially affected by non-compliant RPDs, as the highest concentration reported in QC replicates pairs has been adopted for interpretation, and most of the RPD exceedances are associated with analytes which are influenced by the presence of particulates. As the adopted criteria and performance criteria are mostly based on dissolved (i.e filtered) concentrations, which did not exceed the acceptance limits, the RPD exceedances are not considered to represent an issue with data quality.

Duplicate pair for well SBT-GW-4000 sampled on 12 April 2024 has a large number (12) of analyte results, including major ions and TDS which do not meet RPD criteria. This sample represents 55% of the RPD issues identified for the entire program. It is possible that there is a field or lab quality issue with this duplicate paring and potentially these samples are not a duplicate pair.

If questionable duplicate pair SBT-GW-4000 sampled on 12 April 2024 is excluded from the analysis then there are 10 of 290 duplicate pairs of analysis exceeding the adopted limits for RPD which equates to 3.4%.

F.5.1 Field Blanks Summary

Blank field quality control samples include trip blanks, field blanks and equipment rinsates.

Trip blanks are used to assess whether sample storage and transport procedures minimised the introduction of contamination during storage and transport. Trip blanks are typically collected and analysed where volatile contaminants of concern are being assessed in the sample batch.

Trip blanks are laboratory prepared vials of distilled water that remained with the sample containers during sampling and transport to the laboratory. At no time during these procedures are the blanks opened.

Field blank samples are collected to assess if sampling procedures were conducted appropriately to minimise the potential impact of environmental factors during sample collection.

The blank are typically prepared by pouring laboratory supplied distilled water into sampling bottles, which were then stored (with lids off) with other samples throughout sampling activities.

Equipment rinsates are collected to assess if procedures for decontamination of non-disposable sampling equipment were adequate to minimise for cross-contamination between sampling points.

Rinsate samples are prepared in the field using laboratory supplied bottles and the distilled water used for the cleaning of non-disposable sampling equipment. Rinsate samples are typically collected at a rate of one per field operator per day where non-disposable sampling equipment was used.

Trip Blanks

	Yes	No (see comment)
Were an adequate number of trip blanks collected?	☐	☒
Were trip blanks free of contaminants?	☒	☐

Comments

Although the number of trip blanks collected was non-compliant, as volatile contaminants have not been identified as COPC along the alignment, apart from St Marys where there is a targeted mitigation monitoring program, the lack of trip blanks is not considered to have impacted the useability of the dataset.

Rinsates

	Yes	No (See comment)
Were an adequate number of rinsate blanks collected?	☐	☒
Were rinsate blanks free of contaminants?	☐	☒

Comments

Where analytes were detected in rinsate samples, laboratory results were investigated. The results of this review are presented in Table F-7.

Table F-7: Rinsate results summary

Rinsate Sample ID	Lab report	Analyte detect
RINSATE	ES2408366	Aluminium Total (20 µg/L, LOR 10u/L). Dissolved aluminium <LOR
		Bicarbonate Alkalinity as CaCO3 (7mg/L, LOR 1mg/L)
		Chloride (5 mg/L, LOR 1mg/L)
		Sodium filtered (2 mg/L, LOR 1mg/L)
		Orthophosphate as P (20 µg/L, LOR 10 µg/L)
		Ammonia as N (40 µg/L, LOR 10 µg/L)
		Phosphorus total (30 µg/L, LOR 10 µg/L)
RINSATE	ES2411960	Iron Total (1,000 µg/L, LOR 50 µg/L). Dissolved iron <LOR
		Aluminium (550 µg/L, LOR 10 µg/L). Dissolved aluminium <LOR
		Manganese (28 µg/L, LOR 1 µg/L). Dissolved manganese <LOR)
		Toluene (20 µg/L, LOR 1 µg/L)
		Bicarbonate Alkalinity as CaCO3 (14m/L, LOR 1mg/L)
		Sulfate as SO4 filtered (2 mg/L, LOR 1mg/L)
		Chloride (17 mg/L, LOR 1mg/L)
		Sodium filtered (6 mg/L, LOR 1mg/L)
		Ammonia as N (20 µg/L, LOR 10 µg/L)
		Nitrate as NO3-N (10 µg/L, LOR 10 µg/L)
		Nitrogen Total (200 µg/L, LOR 100 µg/L)
		Total Kjeldahl Nitrogen (200 µg/L, LOR 100 µg/L)
		Phosphorus total (40 µg/L, LOR 10 µg/L)
Rinsate	ES2413514	Aluminium (10 µg/L, LOR 10 µg/L)
		Ammonia as N (20 µg/L, LOR 10 µg/L)
		Nitrate as NO3-N (10 µg/L, LOR 10 µg/L)
		Nitrogen Total (200 µg/L, LOR 100 µg/L)
		Total Kjeldahl Nitrogen (200 µg/L, LOR 100 µg/L)
		Phosphorus total (10 µg/L, LOR 10 µg/L)
Rinsate	ES2414085	Aluminium (20 µg/L, LOR 10 µg/L)
		Manganese (2 µg/L, LOR 1 µg/L)
		Manganese filtered (1 µg/L, 1 µg/L)
Rinsate	ES2415197	Aluminium filtered (10 µg/L, LOR 10 µg/L)
		Manganese filtered (15 µg/L, LOR 1 µg/L)

Rinsate Sample ID	Lab report	Analyte detect
		Ammonia as N (20 µg/L, LOR 10 µg/L)
		Nitrate as NO3-N (30 µg/L, LOR 10 µg/L)
		Nitrogen Total (100 µg/L, LOR 100 µg/L)
		Total Kjeldahl Nitrogen (100 µg/L, LOR 100 µg/L)
		Phosphorus total (10 µg/L, LOR 10 µg/L)
RINSATE	ES2415975	Magnesium filtered (1mg/L, LOR 1mg/L)
		Copper filtered (2 µg/L, LOR 1 µg/L)
		Iron (260 µg/L, LOR 50 µg/L)
		Iron filtered (60 µg/L, LOR 50 µg/L)
		Nickel filtered (2 µg/L, LOR 1 µg/L)
		Zinc filtered (22 µg/L, LOR 5 µg/L)
		Aluminium Total (280 µg/L, LOR 10 µg/L)
		Aluminium filtered (60 µg/L, LOR 10 µg/L)
		Manganese (24 µg/L, LOR 1 µg/L)
		Manganese filtered (9 µg/L, LOR 1 µg/L)
		Alkalinity total as CaCO3 (3mg/L, LOR 1mg/L)
		Sulfate as SO4 filtered (3 mg/L, LOR 1mg/L)
		Calcium filtered (1 mg/L, LOR 1mg/L)
		Chloride (7 mg/L, LOR 1mg/L)
		Potassium filtered (1 mg/L, LOR 1mg/L)
		Sodium filtered (8 mg/L, LOR 1mg/L)
		Ammonia as N (20 µg/L, LOR 10 µg/L)
		Nitrate as NO3-N (70 µg/L, LOR 10 µg/L)
		Nitrogen Total (500 µg/L, LOR 100 µg/L)
		Total Kjeldahl Nitrogen (400 µg/L, LOR 100 µg/L)
		Phosphorus total (80 µg/L, LOR 10 µg/L)
Rinsate	ES2419474	Iron (60 µg/L, LOR 10 µg/L)
		Aluminium (130 µg/L, LOR 10 µg/L)
		Manganese (2 µg/L, LOR 1 µg/L)
		Nitrate as NO3-N (20 µg/L, LOR 10 µg/L)
Rinsate	ES2421298	Manganese (1 µg/L, LOR 1 µg/L)

Rinsate Sample ID	Lab report	Analyte detect
		Nitrate as NO3-N (90 µg/L, LOR 10 µg/L)
		Nitrogen Total (500 µg/L, LOR 100 µg/L)
		Total Kjeldahl Nitrogen (400 µg/L, LOR 100 µg/L)
		Phosphorus total (20 µg/L, LOR 10 µg/L)

The detection of analytes in the rinsate samples collected implies that at times, procedures for rinsing of non-disposable sampling equipment were possibly not adequate to minimise for cross-contamination and/or residual tap water remaining between sampling points. This is particularly highlighted in two rinsate samples collected (lab report numbers ES2411960 and ES2415975) where total metal concentrations (but not dissolved metals) were detected in concentrations were more than an order of magnitude larger than the detection limits.

Although detectable concentrations were reported for many analytes in the rinsate samples, concentrations were mostly at or just above the LOR, and analytes indicative of tap water used to wash the equipment, rather than COPCs or cross contamination from previous samples.

Blanks and Rinsate Sampling and Analysis		
Satisfactory ☒	Partially Satisfactory ☐	Unsatisfactory ☐

F.5.1 Laboratory Quality Control Procedures

As noted in Section F.2, laboratories conduct their own quality control testing to indicate their performance on each reported batch of samples. An assessment of the adequacy of these procedures is provided in Tables F-8 and F-9.

Table F-8: Acceptability of laboratory quality controls

	YES	NO
Were laboratory method blanks free of contamination?	☒	☐
Were the matrix spike recoveries within control limits?	☐	☒ See comment
Were the Lab control samples within control limits?	☐	☒ See comment
Were the RPD's of the laboratory duplicates within control limits?	☐	☒ See comment

Were the surrogate recoveries within laboratory control limits?	☒	☐

Table F-9: Summary of laboratory quality controls results

Sample Type	Total Number of Analyses	Number of Identified Issues	% of Analyses with Identified Issues	Comment/Issues Identified
Method blank	1,466	0	0%	All results <LOR
Matrix spike % recovery	685	3	0.5%	The following analytes were outside laboratory control limits: • Mercury • Sulfate as SO4
Laboratory control sample % recovery	1,724	5	0.3%	The following analytes were outside laboratory control limits: • Nitroaromatics • Phenols • Anilines • PAHs
Laboratory duplicates	2,438	14	0.6%	The following analytes were outside laboratory control limits: • Arsenic • Nickel • Copper • Cadmium • Magnesium • Chromium • Nickel • Chromium hexavalent • Cobalt • Aluminium
Surrogate % recovery	203	0	0	-
Total	**6,516**	**22**	**0.34%**	

Based on the low percentage of non-compliant matrix spikes, laboratory control samples, laboratory duplicates and surrogates, the data set is considered to be acceptable for use.

F.7 Field Data Useability

Overall, of the 6,516 individual analyses conducted in association with the quality assessment, issues were identified in 22 analyses (0.34%). A summary of the total analyses and proportion with issues is provided in Table F-9 below.

Table F-9: Quality Control Program Summary

Sample Type	Total Number of Analyses	Number of Identified Issues	% of Analyses with Identified Issues	Issues Identified
Field Duplicate/ Triplicates samples	320	22	6.9%	RPDs outside acceptable range
Field quality control samples (rinsates, field blanks and trip blanks)	428	64	14.9%	All due to analyte detections in rinsate samples, which were mostly at or just above LOR, and indicative of tap water rather than cross contamination
Internal laboratory analyses	6,516	22	0.34%	Laboratory quality control results outside of control limits
Total	**7,174**	**138**	**1.5%**	

Recommendations for interpretation and future monitoring events include:

- Sample turbidity should be considered when interpreting total metal and nutrient concentrations as the presence of particulates may result in higher total concentrations being reported.
- Increase the collection of QAQC triplicate samples to be in line with the GMP criteria.
- Review decontamination procedures and ensure sampling equipment is rinsed of tap water prior to rinsate collection.

Overall, the percentage of issues identified in the quality assessment (1.5%) is considered acceptable, and therefore the data is considered to be of appropriate quality for use.

SYDNEY METRO - WESTERN SYDNEY AIRPORT
STATION BOXES AND TUNNELLING WORKS

Annexure G

St Marys Station Monthly Mitigation Monitoring Report 12 – June 2024

Document Number: SMWSASBT-CPG-SWD-SW000-GE-RPT-040418
(19 August 2024)

St Marys Station Monthly Mitigation Monitoring Report 12 – June 2024

Sydney Metro Western Sydney Airport Station Boxes and Tunnelling Works

Project number	WSA-200-SBT
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Revision date	19/08/2024
Revision	A.01

Document approval

Rev	Date	Prepared by	Reviewed by	Remarks
Rev A.01	19/08/2024	[redacted]	[redacted]	Provided to CPBG for internal review

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Annexures

Abbreviations

Abbreviation	Definition
AHD	Australian height datum (0 mAHD corresponds roughly to mean sea level)
btoc	Below the top of casing
Cis 1,2 DCE	Cis 1,2 dichloroethene
COC	Chain of Custody
CPBG	CPB Contractors Ghella Joint Venture
CV	Co-efficient of variation
EC	Electrical conductivity
HHRA	Human Health Risk Assessment
m	Metre
LNAPL	Light Non Aqueous Phase Liquid
LOR	Limit of Reporting
mg/L	Milligram per litre
NSW	New South Wales
NATA	National Association of Testing Authorities
PCE	Tetrachloroethene
PRB	Permeable Reactive Barrier
QA	Quality Assurance
QC	Quality Control
RAP	Remedial Action Plan
RPD	Relative Percentage Difference
SBT	Station Boxes and Tunnelling Works
SOP	Standard Operating Procedures
TBM	Tunnelling boring machine
TCE	Trichloroethene
TfNSW	Transport for New South Wales
TTMP	Tetra Tech Major Projects Pty Ltd (Coffey)
µg/L	Micro gram per litre
VC	Vinyl chloride
WSA	Western Sydney Airport

1. Introduction

Sydney Metro has engaged the CPB Ghella Joint Venture (CPBG) for the design and construction of the Station Boxes and Tunnelling Works (SBT Works) for the Sydney Metro Western Sydney Airport project (the 'Project').

CPBG has engaged Tetra Tech Major Projects Pty Ltd (Tetra Tech) to provide geotechnical, hydrogeological and contaminated land consultancy services associated with the design and construction of the SBT Works.

Groundwater contaminated with chlorinated hydrocarbons from a former dry cleaner located at 1-7 Queen St, St Marys has been identified approximately 200m west of the St Marys Station Box. Construction related dewatering during station box construction was predicted to draw down groundwater in the vicinity, reversing the existing westerly groundwater flow direction, potentially drawing the contamination toward the excavation (Tetra Tech 2023a).

A permeable reactive barrier (PRB) was installed on 16 May to 19 May 2023 to the west of St Marys Station to intercept potential migration of chlorinated hydrocarbons in groundwater due to construction associated drawdown. Given the potential for unacceptable inhalation or direct contact risk, a targeted multi-level groundwater monitoring and contingency mitigation approach has been applied, to allow contingency mitigation to be implemented before an unacceptable risk occurs.

In addition to monitoring for potential contaminant mobilisation due to station construction, the mitigation monitoring program was expanded in mid-March 2024 to incorporate assessment for potential impacts due to rail tunnel construction. Tunnel boring machine (TBM) monitoring was established to monitor groundwater conditions in the vicinity of the former dry cleaner when the TBMs progress through the area. The TBMs broke through at St Marys Station Box in May and June 2024.

Pre-construction groundwater conditions across the St Marys Station area have been assessed through a Detailed Site Investigation (DSI) (Tetra Tech, 2022), and the Baseline Groundwater Report (Tetra Tech, 2023b) and as detailed in the Groundwater Monitoring Program (GMP).

The remediation strategy is outlined in the remedial action plan (RAP) for the SBT Works at St Marys:

- Tetra Tech (2023c); *St Marys Station Remedial Action Plan* (Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040521. 22/05/2023. Rev A08).

Details of the installation of the PRB and mitigation monitoring are detailed in:

- Tetra Tech (2023d); *Implementation of Permeable Reactive Barrier* (Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040561. 02/08/2023. Rev A).

An outline of the TBM monitoring program is provided in:

- Tetra Tech (2024); *St Marys Station Remedial Action Plan – Proposed revision to mitigation groundwater monitoring network* (Ref: SMWSASBT-CPG-SWD-SW000-GE-MEM-040403_A.01. 26/03/2024. Rev A).

This report documents the twelfth month (June 2024) of the groundwater sampling to monitor the mitigation of potential risks due to construction related mobilisation of groundwater impacted with chlorinated hydrocarbons.

1.1. Purpose and objectives

The purpose of the monitoring works was to:

- Monitor the effectiveness of the PRB;
- Identify if an adverse change in risk profile is likely which requires contingency mitigation measures to be implemented as outlined in Section 11.6 of the RAP, and;

- Assess groundwater conditions in the vicinity of the contamination source area when the TBMs pass through the area.

The objectives of the works were to:

- Undertake groundwater monitoring from nominated monitoring wells to measure the groundwater level and quality between the source area and the Station box (as shown in Figure 1);
- Assess the monitoring results relative to the trigger values outlined in the RAP;
- Where detectable concentrations of chlorinated ethenes are reported in monitoring wells between the station and the PRB, review the model predictions outlined in the Human Health Risk Assessment (HHRA) (Tetra Tech, 2023a) to assess whether concentrations exceeding the trigger values are likely to reach the excavation before sealing occurs.
- Assess potential impacts due to tunnelling beneath the suspected source area at the rear of the former dry cleaner on chlorinated hydrocarbon concentrations and trends in groundwater.

The locations of the PRB injection wells and associated monitoring well network, and wells monitored in the source area in June 2024 are shown in Figure 1.

CPB CONTRACTORS
Ghella 1894 5 Generations of Tunnelers

LEGEND

- PRB mitigation monitoring
- TBM monitoring well
- PRB injection well
- Tunnel Alignment
- Tunnel Alignment - Chainage
- Railway
- Minor Road
- Path
- STM Site Boundary
- Cadastral Boundary

SOURCE
Mitigation Monitoring Wells, PRB Wells and boundary from Tetra Tech Coffey.
Existing investigations, site layout, station box and alignment supplied by CPBG.
Cadastre from DFSI.
Aerial imagery from Nearmap (capture date 30-03-2023).

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PROJECTION: **GDA2020 MGA Zone 56**

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STATION BOXES AND TUNNELLING WORKS

FIGURE 1

Mitigation monitoring wells – St Marys

TETRA TECH COFFEY

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2. Scope of Works

The mitigation monitoring works consists of sampling and analysis of the groundwater monitoring well network located between the contamination source and the Station box (PRB monitoring), and in the suspected source area (TBM monitoring).

The works entailed sampling of PRB mitigation monitoring wells on a fortnightly basis, and weekly sampling of TBM monitoring locations. Well installation details for the network are provided in Table A1, Annexure A.

The PRB mitigation monitoring program, as outlined in Section 11 of the RAP, began at the commencement of bulk excavation beneath the groundwater table at the western end of the St Marys Station box (Zone 4), which commenced on 16 June 2023.

The typical pre-construction groundwater level in the upper Bringelly Shale was 32.5 to 33mAHD, based on Section 14.5.1 of the Hydrogeological Interpretive Report (Tetra Tech 2023f). Baseline groundwater conditions were established in mitigation monitoring wells through groundwater sampling between 20 January 2023 and 14 April 2023.

PRB well monitoring was undertaken on a weekly basis from June to December 2023. In December 2023, after six months of weekly monitoring, the frequency of monitoring was reviewed and revised to fortnightly as the groundwater gradient in the vicinity of the former dry cleaner had not changed, and chlorinated hydrocarbon concentrations in all monitoring wells were below the level of reporting (LOR). The revision was outlined in the *Memorandum: St Marys Station Remedial Action Plan - Proposed revision to mitigation groundwater sampling frequency'*, dated 19 December 2023 (Tetra Tech 2023e), and agreed to by the auditor on 21 December 2023, and Sydney Metro on 22 December 2023.

The mitigation monitoring program was again revised in March 2024 to incorporate weekly monitoring of wells in the suspected source area prior to, during, and after the TBMs passing beneath the site. In advance of the TBMs passing through both the contaminant source area and the PRB area, monitoring wells within 3m of the tunnels required grouting as the TBMs are pressurised, and groundwater wells provide potential pathways to the surface which may result in depressurisation. The program was therefore also adjusted as numerous monitoring wells from the PRB mitigation program were decommissioned (Tetra Tech 2024).

The initial and revised monitoring scope is detailed in the following subsection.

2.1. Groundwater Monitoring

The mitigation monitoring program consists of groundwater level gauging and sampling from nominated monitoring wells and comprises:

- PRB mitigation monitoring (fortnightly, as detailed in Table 1) and;
- TBM monitoring (weekly, as detailed in Table 2).

Table 1: Construction Phase Groundwater Monitoring Schedule – Initial PRB mitigation monitoring

Monitoring Well			
SBT-GW-0001 **SBT-GW-0001b**	Fortnightly	Volatile chlorinated hydro-carbons	**Trigger Values:** PCE 0.3mg/L TCE 0.055mg/L cis 1,2 DCE 0.25mg/L VC 0.2mg/L Refer HHRA for determination of trigger values **Contingency Plan**: Refer to Section 11.6 of the RAP
SBT-GW-1012 [1] SBT-GW-1013 [1] SBT-GW-1014 [1]	Fortnightly		
SBT-GW-1347a [2] SBT-GW-1347b [2] **SBT-GW-1347c** [2] SBT-GW-1348a [2] SBT-GW-1348b [2] SBT-GW-1348c [2]	Fortnightly for 'c' interval wells (at ~18mAHD) *If contingency mitigation implemented, then all multi-level wells monitored weekly*		

1. SBT-GW-1012, SBT-GW-1013 and SBT-GW-1014 are screened from the pre-construction water table to 20mAHD with a saturated interval of 12m. Three hydrasleeves placed in each well at 30mAHD, 27mAHD and 24mAHD.

2. SBT-GW-1347a, SBT-GW-1347b, SBT-GW-1347c, SBT-GW-1348a, SBT-GW-1348b, SBT-GW-1348c are multi-level groundwater wells, with details provided in Table A1.

The TBM monitoring program initially comprised five groundwater wells in the vicinity of the contaminant source area as outlined in Table 2. Monitoring commenced on 15 March 2024, four weeks before TBM-1 passed through the suspected source area (starting 12 April 2024).

Table 2: Initial Source Area/TBM Groundwater Monitoring Schedule

Monitoring Well	Monitoring frequency	Analytes	Assessment
MW1 **MW2** SBT-GW-1019_R SBT-CM-1020 **SMGW-GW02**	Weekly from mid-March to four weeks after TBM-2 reaches St Marys Station	Volatile chlorinated hydro-carbons	Comparison to previous concentration ranges for PCE, TCE, cis 1,2 DCE and vinyl chloride, and trends over TBM monitoring period

Groundwater monitoring in bold were to be sampled in June 2024, the remaining wells were decommissioned in April 2024.

Due to the decommissioning of monitoring wells in April 2024 prior to the TBM passing through the area, the PRB and TBM/source area monitoring programs have been combined into an ongoing mitigation monitoring program as detailed in the *St Marys Station Remedial Action Plan – Proposed revision to mitigation groundwater monitoring network* (Tetra Tech, 2024).

The revised ongoing monitoring program based on the seven wells which were not decommissioned is outlined in Table 3 and shown on Figure 2. The revised monitoring scope was implemented from 8 April 2024.

Table 3: Ongoing Mitigation Monitoring Network

Monitoring Well			
SBT-GW-1347a	Fortnightly	Volatile chlorinated hydro-carbons	Shallow well downgradient of PRB
SBT-GW-1347c			Deep well downgradient of PRB
SBT-GW-0001			Shallow well upgradient of PRB and downgradient of suspected source area
SBT-GW-0001B			Mid-level well upgradient of PRB and downgradient of suspected source area
MW1	Weekly until four weeks after TBM-2 reaches St Marys Station. TBM-2 reached the Station on 20 June, therefore monitoring will continue until 12 July 2024.		Shallow well in vicinity of source
MW2			Shallow (impacted) well to north of source area
SMGW-GW02			Shallow (impacted) well to south of source area

2.1.1. Adopted Trigger Values

Risk based trigger values developed in the HHRA (Tetra Tech, 2023a) for the PRB monitoring wells are summarised in Table 1.

Where detectable concentrations of chlorinated ethenes are reported in mitigation monitoring wells between the station and the PRB, model predictions outlined in the HHRA (Tetra Tech, 2023a) will be reviewed. The review will assess whether concentrations exceeding the trigger values are likely to reach the excavation before sealing occurs, and whether contingency mitigation needs to be implemented.

Chlorinated hydrocarbon concentrations in groundwater wells in the source area will be assessed compared to historical ranges, and trends over the TBM monitoring period.

CPB CONTRACTORS

Ghella 1894 5 Generations of Tunnelers

LEGEND

- Ongoing mitigation monitoring
- PRB monitoring well - To be decommissioned
- TBM monitoring well - To be decommissioned
- PRB injection well - To be decomissioned
- Tunnel Alignment
- Tunnel Alignment - Chainage
- Railway
- Minor Road
- Path
- STM Site Boundary
- Cadastral Boundary

NOTE

SBT-GW-1347b has been decommissioned.

SOURCE

Mitigation Monitoring Wells, PRB Wells and boundary from Tetra Tech Coffey.

Existing investigations, site layout, station box and alignment supplied by CPBG.

Cadastre from DFSI.

Aerial imagery from Nearmap (capture date 30-03-2023).

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CPB - GHELLA

WESTERN SYDNEY AIRPORT
STATION BOXES AND TUNNELLING WORKS

FIGURE 2

Ongoing Mitigation Monitoring Wells – St Marys

TETRA TECH COFFEY

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2.2. Monitoring Methodology

2.2.1 Groundwater Level Monitoring

Groundwater levels were manually gauged in all wells prior to sampling for groundwater quality.

Gauging was undertaken using an electronic groundwater level interface probe (IP) measuring from a surveyed set point at the top of the well casing to the top of the water table. Measurements were taken to the nearest mm, and recorded as metres below the top of casing (mBTOC).

2.2.2 Groundwater Sampling Procedure

Groundwater sampling was conducted by suitably qualified and experienced personnel from Tetra Tech.

Groundwater samples were collected using the Hydrasleeve™ method. A Hydrasleeve™ captures a core of water, typically 1 litre, from the screened interval of the well. The Hydrasleeve™ is deployed to a target depth based on the screened interval and rationale for sampling, and left until conditions are considered to have stabilised. The time to stabilisation depends on the transmissivity of the aquifer, with more transmissive aquifers stabilising more rapidly. Typically, at least 5 days was allowed for stabilisation, which is considered appropriate given many of the wells are screened within the bedrock aquifer.

The Hydrasleeve™ is sealed except during sample collection when it is pulled up through the sampling interval, and re-seals once full. Therefore, only groundwater from the target depth interval is sampled and recovered.

Groundwater samples were collected in appropriate laboratory supplied bottles and sent to a laboratory for analysis under the Chain of Custody (COC) process. The laboratories contracted to undertake the analysis included ALS (primary samples) and Eurofins (interlab triplicate samples). Both ALS and Eurofins hold analytical methods accredited by the National Association of Testing Authorities (NATA) for a range of volatile halogenated hydrocarbons (VHC), including the chlorinated hydrocarbons of interest on this site.

To reduce volatile losses samples were collected as rapidly as practicable with minimal agitation and zero headspace in sample bottles. Once the laboratory supplied bottles were filled, water quality parameters were measured using the remainder of the Hydrasleeve™ sample with a calibrated field water quality meter. Parameters measured include pH (pH units), electrical conductivity (mS/cm), redox potential (mV), dissolved oxygen content (µg/L), temperature (°C). The sample's visual appearance, whether Light Non Aqueous Phase Liquid (LNAPL) was present and/or any odours were also recorded on the field sheets. Field measurements were recorded digitally, with the digital data imported to the electronic database using an in-house GIS application.

Samples were submitted as soon as practicable to the laboratories to also minimise volatile losses while in storage or transit, and were analysed within recommended holding times. Sample containers were placed directly into an ice filled cooler and transported to the nominated laboratories under COC processes. Samples are required to be documented as received by the laboratory chilled and intact. All samples were analysed for a broad range of VHC.

Re-usable equipment used in more than one location (limited to the IP) was decontaminated between each sampling location. Equipment was rinsed with tap water, cleaned with Liquinox (or equivalent), further again rinsed with tap water, and then deionised water. Equipment was then allowed to dry before being used at another location.

3. Results

3.1. Groundwater Monitoring Activities and Observations

Four groundwater monitoring events were conducted in June 2024 (the twelfth month of PRB groundwater mitigation monitoring), in accordance with the methodology described in Section 2.2.

Table 4 provides a summary of the monitoring activities and observations recorded during fieldworks.

Table 4: Groundwater Monitoring Details and Observations for June 2024

Activity	Detail/Comments
Date of field activities	Sampling events were carried out on 7 June, 14 June, 21 June and 28 June 2024.
Gauged and sampled	The following monitoring bores were gauged and then sampled for VHC analysis: • SBT-GW-0001 (14 June and 28 June 2024) • SBT-GW-0001b (14 June and 28 June 2024) • SBT-GW-1347a (14 June and 28 June 2024) • SBT-GW-1347c (14 June and 28 June 2024) • MW1 (7 June, 14 June, 21 June and 28 June 2024) • MW2 (7 June, 14 June, 21 June and 28 June 2024)
Standing water level	Standing water level (mBTOC) ranged between: • 0.305 mBTOC (MW1 on 7 June 2024) and 10.831 mBTOC (SBT-GW-1347c on 14 June 2024)
Presence of LNAPL	LNAPL was not detected in any monitoring well.
Field observations (odours, colour, turbidity)	Samples from MW1 were noted to be 'cloudy' and of 'pale grey' colour on 7 June and 21 June 2024. A 'slight sulfidic' odour was noted at SBT-GW-1347a on 28 June 2024, and a sheen was observed in the sample collected from SBT-GW-0001 on 14 June 2024, but not on 28 June 2024.
Deviations from scope	Deviations from the scope as outlined in Section 2 for the June 2024 monitoring period included: • No samples collected from SMGW-GW02 as the location was not accessible.

3.2. Field Parameters

Field water quality parameters are summarised in Table 5, with all available field data provided in Table A2 of Annexure A.

In general, field water quality parameters at most wells were relatively stable throughout the June 2024 monitoring events. Some variability in the field water quality parameters was noted between monitoring wells, consistent with previous monitoring events.

Table 5: Field Water Quality Parameters – 7 June 2024 to 28 June 2024

	Minimum	Maximum	Comment
pH	3.16 SBT-GW-0001 & SBT-GW-1347a 28 June 2024	6.95 MW1 14 June 2024	The pH reported in groundwater mostly ranged from 4.9 to 6.8, indicating groundwater was slightly acidic to neutral. The pH typically increased with depth. In SBT-GW-1347c the pH ranged from 6.3 to 6.6, indicating the groundwater pH was neutral at depth.
Electrical conductivity	0.812mS/cm MW1 28 June 2024	24.474mS/cm SBT-GW-1347c 14 June 2024	The groundwater EC mostly ranged from 0.8mS/cm to 24mS/cm. EC measurements have fluctuated at all locations since the monitoring started (shown on Figure 3), and was generally much lower in contaminant source area wells (MW1 and MW2) than those between the PRB and the station box. Groundwater EC in the source area was consistent with values recorded in the April and May monitoring periods and previous investigations (Tetra Tech 2023a). Groundwater EC however appeared to be increasing in wells closest to the station box (SBT-GW-1347a and SBT-GW-1347c) throughout May and June 2024.
Dissolved Oxygen	860 µg/L MW2 7 June 2024	2,370 µg/L SBT-GW-0001 14 June 2024	Dissolved oxygen (DO) concentrations were typically low, and mostly ranged from 1,000 µg/L to 2,300 µg/L. There was no apparent trend over time or with depth.
Redox potential	31 mV SBT-GW-1347c 28 June 2024	464 mV MW2 21 June 2024	The redox potential reported in groundwater has been highly variable during the monitoring program. Redox potential typically decreased with depth. Shallow locations (SBT-GW-0001 and SBT-GW-1347a) typically reported higher values (up to 357 mV), while in deeper monitoring well SBT-GW-1347c conditions were more reducing (up to 137 mV)
Temperature	15.5°C MW2 21 June 2024	20.3°C SBT-GW-1347c 14 June 2024	Water temperatures were consistent across the sampling locations, within the range expected for June, and the ambient air temperature at the time of sampling.

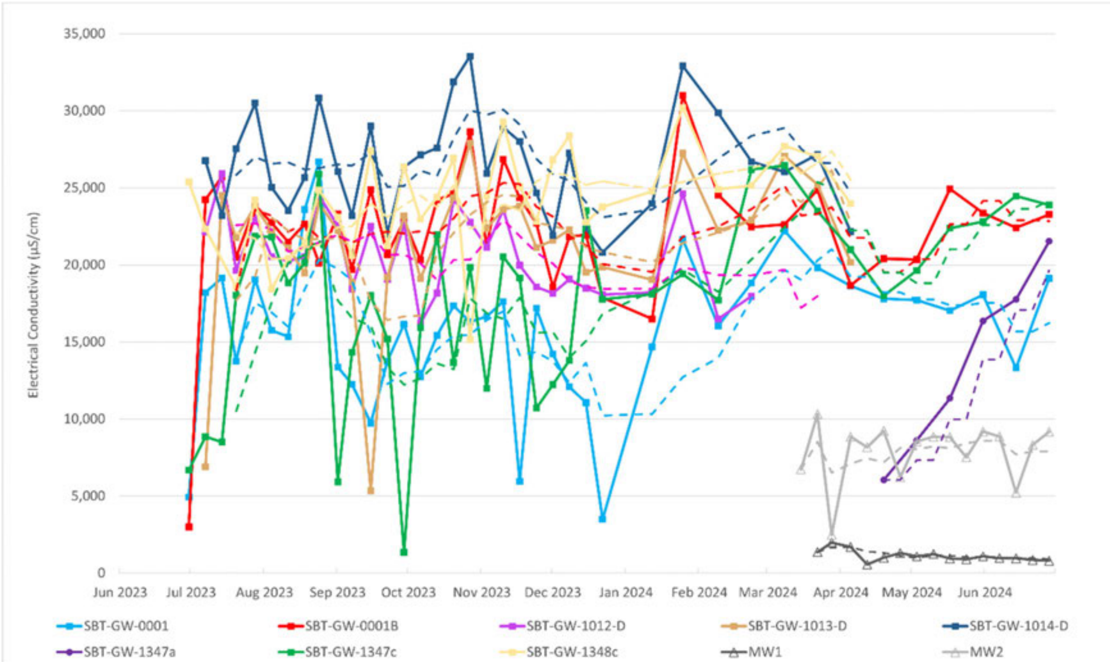

Figure 3: Electrical Conductivity of groundwater in PRB mitigation (squares) and source area (triangles) wells

Note: EC measurements shown for all sampling locations, except shallow- and mid-level samples from; SBT-GW-1012, SBT-GW-1013 and SBT-GW-1014, which were excluded to limit noise in the graph. Rolling averages over four events shown as dashed lines.

3.3. Groundwater levels

Gauged groundwater levels are tabulated in Table A2, Annexure A, and presented in Figure 4.

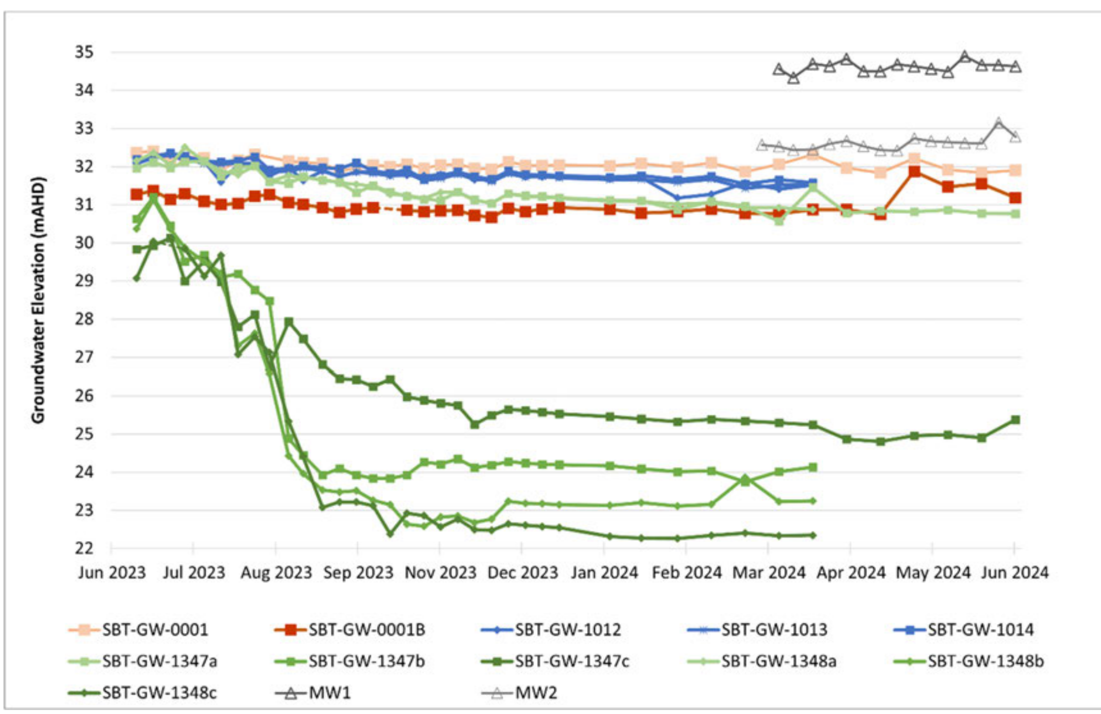

Figure 4: Manually gauged groundwater levels in PRB mitigation (squares) and source area (triangles) wells

The standing water level remained relatively stable at most monitoring locations throughout June 2024, except in MW2 and SBT-GW-1347c where levels increased by approximately 0.5m in the second half of June when TBM-2 was passing through the area.

Groundwater levels at deeper monitoring locations SBT-GW-1347c and SBT-GW-1348c have decreased by approximately 7m since PRB monitoring commenced on 30 June 2023. The groundwater levels at shallow monitoring locations closest to the station box, SBT-GW-1347a (and previously in SBT-GW-1348a, the pale green line in Figure 4), have gradually decreased by approximately 1.5m since the commencement of PRB monitoring. Groundwater levels in deeper wells closest to the excavation decreased rapidly initially (mostly in August and September 2023), with the decrease slowly continuing over the past eight months. Groundwater levels in the vicinity of the PRB have only decreased slightly over the same period.

Gauging results up to 5 April 2024, when wells used to calculate the gradient were decommissioned, indicated that excavation and dewatering associated with construction of St Marys Station box had not yet resulted in a change in groundwater levels and gradient between the PRB and the station box (Figure 5).

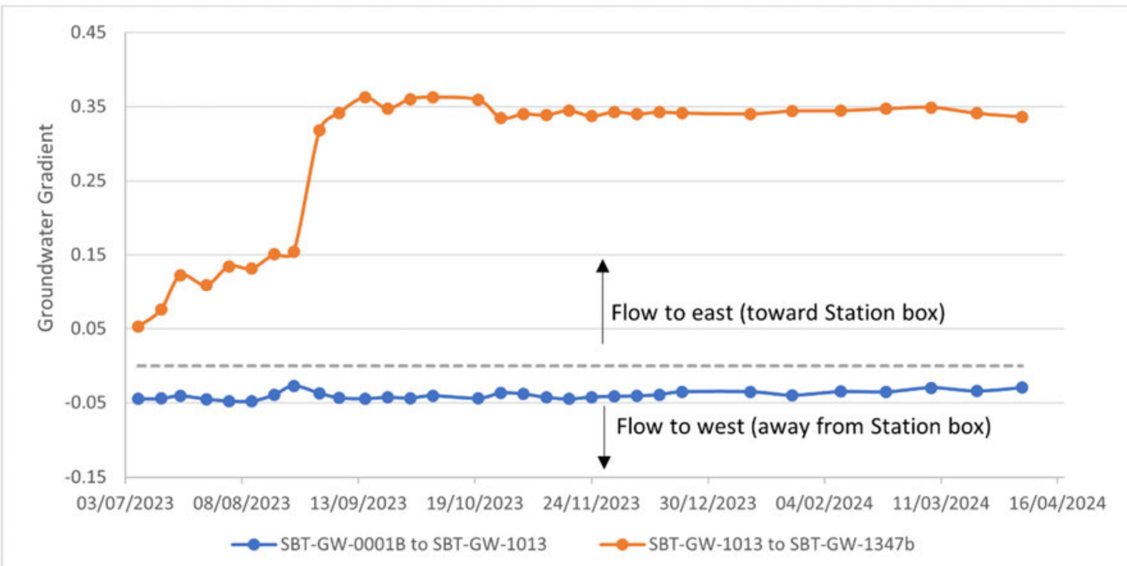

Figure 5: Groundwater gradients from SBT-GW-1013 to SBT-GW-1347b (toward Station) and SBT-GW-0001B (near PRB)

Groundwater levels in the source area (MW1 and MW2) have been relatively stable since TBM monitoring commenced in March 2024 (Figure 4).

With the reduction in the number of monitoring wells in the network in April 2024, gradients have since been assessed based on levels in shallow groundwater between the source area and the PRB (MW1 and SBT-GW-0001), and between the PRB and St Marys Station Box in shallow and deeper groundwater, as shown in Figure 6.

While these gradients indicate that groundwater is flowing to the east, toward the station box, the flow regime is more complex:

- The easterly shallow flow from the source area (MW1) to the PRB (SBT-GW-0001), as shown by the blue line in Figure 6, is attributed to mounding in the source area due to leakage from subsurface infrastructure (refer HHRA, Tetra Tech 2023a).
- Previous data from SBT-GW-1012, SBT-GW-1013 and SBT-GW-1014, midway between the PRB and the multi-level wells closer to where drawdown has been significant, has consistently shown that groundwater levels are higher in this area, hindering migration to the east from the PRB (and source area).

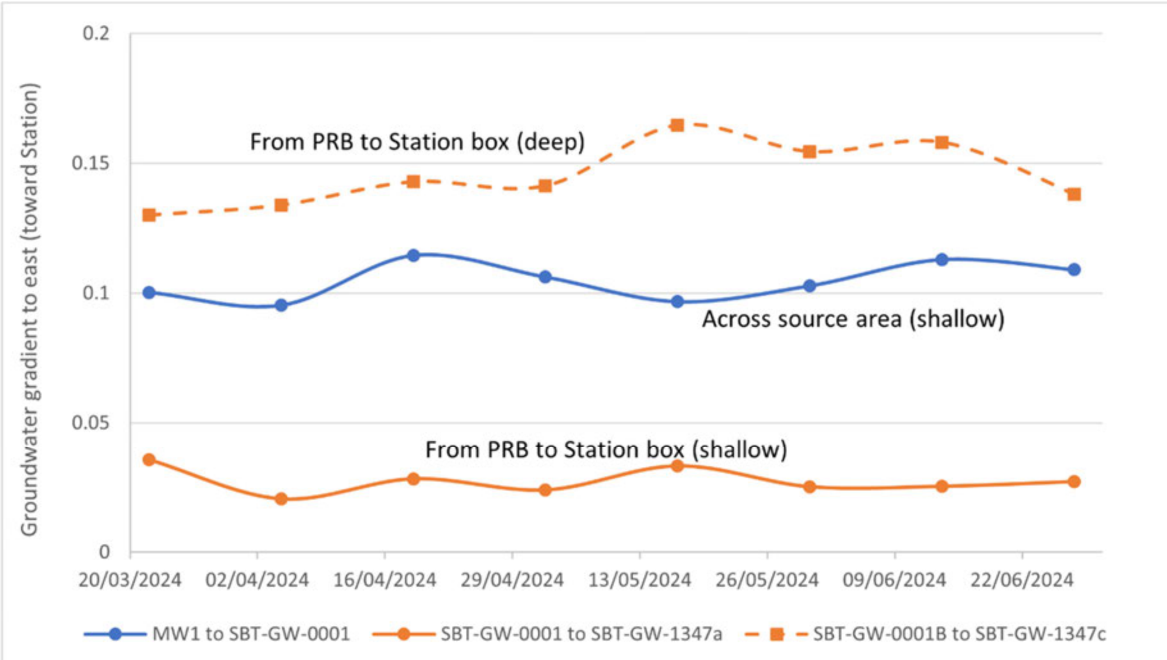

Figure 6: Groundwater gradients in shallow groundwater across the source area, and in shallow and deep groundwater from PRB to station box

In the absence of ongoing data from SBT-GW-1012, SBT-GW-1013 and SBT-GW-1014, changes in migration potential can be assessed via the gradient in shallow groundwater to the east of the PRB (SBT-GW-0001 to SBT-GW-1347a, as shown in solid orange line in Figure 6). An increase in this gradient may indicate that the groundwater high in the vicinity of SBT-GW-1013 has dissipated, and impacted groundwater may potentially flow toward the station box. The gradient remained relatively stable in June 2024, indicating the groundwater high remains between the PRB and SBT-GW-1347a. The slight increase in the deeper groundwater gradient from the PRB to Station Box (orange dashed line) in early May to early June is attributable to the transient increase in levels in SBT-GW-0001B as TBM-1 and TBM-2 passed beneath the PRB area.

Assessment of any changes in the groundwater flow regime will need to be considered along with results from ongoing groundwater quality monitoring in SBT-GW-0001 and SBT-GW-0001b, as discussed in Section 3.4 below.

3.4. Analytical Results

All available groundwater analytical data is tabulated and presented in Table A3 of Annexure A.

Laboratory analysis reports and COC documentation for the mitigation monitoring sampling completed in June 2024 are provided in Annexure B.

3.4.1 PRB Monitoring

A summary of the maximum concentrations of key chlorinated hydrocarbons reported in each PRB monitoring well during the two monitoring events completed in the June 2024 monitoring period is provided in Table 6.

Table 6: PRB monitoring wells - maximum chlorinated ethene concentrations reported in June 2024

Monitoring Location	Tetrachloroethene	Trichloroethene	Cis 1,2 DCE	Vinyl Chloride
SBT-GW-0001	<5ug/L	<5ug/L	<5ug/L	<50ug/L
SBT-GW-0001B	<5ug/L	<5ug/L	<5ug/L	<50ug/L
SBT-GW-1347A	<5ug/L	<5ug/L	<5ug/L	<50ug/L
SBT-GW-1347C	<5ug/L	<5ug/L	<5ug/L	<50ug/L

Concentrations of key chlorinated hydrocarbons were below the LOR, and the trigger values, in all groundwater samples collected between the PRB and the station box during the June 2024 monitoring events.

3.4.2 TBM Source Area Monitoring

The maximum concentration of chlorinated hydrocarbons detected in the two accessible monitoring wells in the contamination source area are summarised in Table 7. The highest chlorinated hydrocarbon concentrations were reported in MW1. Concentrations of Tetrachloroethene (PCE), Trichloroethene (TCE), cis 1,2 DCE and Vinyl Chloride were reported within the historical range at both monitoring locations during June 2024.

Table 7: TBM/Source area monitoring wells – maximum chlorinated ethene concentrations reported in June 2024

Monitoring Location	Tetrachloroethene	Trichloroethene	Cis 1,2 DCE	Vinyl Chloride
MW1	6,350ug/L (31ug/L – 13,000ug/L)	603ug/L (28ug/L – 959ug/L)	795ug/L (17ug/L – 4,220ug/L)	<200g/L (<10ug/L - 320ug/L)
MW2	4,900ug/L (1,960ug/L – 5,070 ug/L)	230ug/L (59ug/L - 365ug/L)	16ug/L (2ug/L -24ug/L)	<200ug/L (<1ug/L - <100ug/L)

() concentrations in brackets indicates historical range reported (Tetra Tech 2023a) including data to the end of May 2024

Concentrations of key chlorinated compounds in the two source area wells have been statistically analysed via Mann Kendall to assess trends. The test compares changes in signs between values collected at each time, with all of those collected later. A positive value indicates an increase in concentrations, and, conversely, a negative value indicates a decrease in concentrations. The strength of the trend is proportional to the magnitude of the statistic, with the confidence in the trend calculated using the Kendall probability table. A ‘no-trend’ result is reported where the trend is neither statistically increasing, nor decreasing. Evaluation of the variability of the data (co-efficient of variation, or ‘CV’), can also be used to determine if the trend is stable. Where a ‘no-trend’ result is reported in the absence of a positive Mann Kendall statistic, and the CV is equal or less than one, concentrations can be considered stable.

Trend analysis indicates that TCE and cis 1,2 DCE concentrations have statistically increased in MW2, cis 1,2 DCE concentrations have statistically decreased in MW1, TCE and Vinyl Chloride concentrations are stable in MW1, and all other chlorinated ethene concentrations show no statistically significant trend (Table 8).

Table 8: Statistical analysis of chlorinated ethene concentrations in TBM monitoring wells since 15 March to 28 June 2024

	MW1				MW2		
Calculation	**PCE**	**TCE**	**DCE**	**VC**	**PCE**	**TCE**	**DCE**
Trend	No trend	Stable	Decreasing	Stable	No trend	Increasing	Increasing
CV	0.39	0.22	0.27	0.32	0.27	0.28	0.48
Mann-Kendall Statistic (S)	8	-19	-35	-1	20	46	41
Confidence Factor	63.3%	81%	95.4%	50%	80.1%	97.9%	96.5%

Although statistically increasing, concentrations of TCE and cis 1,2 DCE in MW2 remain relatively close to historical values (Figure 7). Concentrations in MW2 appear to have been decreasing since the maximum concentrations reported when sampled on 5 May 2024, when vinyl chloride was also detected in MW2.

While the maximums correlate with TBM-1 and, to a lesser extent TBM-2, passing beneath the source area, the increases were transient, and concentrations in following monitoring events were within the historically reported ranges. The short-term increases are not considered to indicate a major change in conditions, or an adverse change in the risk profile, particularly as the maximum concentrations were not dissimilar to those historically reported. The transient nature of the increases will continue to be assessed in the two rounds of post-TBM monitoring to be completed in July 2024.

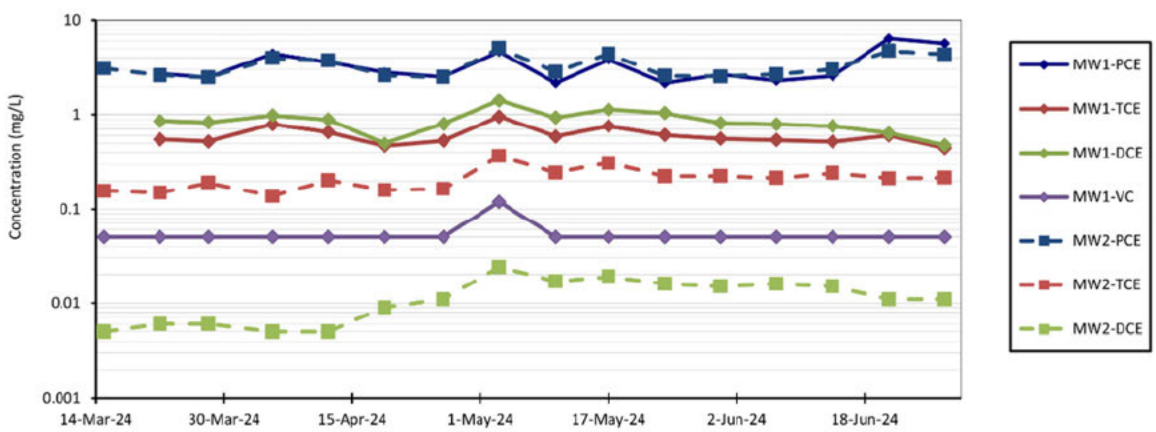

Figure 7: Chlorinated ethene concentrations in MW1 and MW2 – 15 March to 28 June 2024

3.5. Data Quality and Control

The quality assurance (QA) steps and quality control (QC) results have been reviewed and assessed according to Tetra Tech's Standard Operating Procedures (SOPs). This included examining laboratory accreditation, sample preservation methods and holding times, and a review of field and laboratory quality control sample results.

A detailed assessment of data quality is included in Annexure C. Overall, the quality assessment indicates that data is of appropriate quality for use.

4. Summary and Conclusions

Groundwater monitoring was conducted at St Marys in accordance with the mitigation monitoring program, as amended in March 2024.

The groundwater sampling results from the June 2024 monitoring period indicate:

- Concentrations of chlorinated hydrocarbons in groundwater samples between the PRB and the station box were below the LOR and the trigger values;
- Concentrations of TCE and cis 1,2 DCE are statistically increasing in one monitoring well (MW2) in the vicinity of the contaminant source, with all other key chlorinated hydrocarbons in source area wells are decreasing, stable, or show no trend, and are broadly consistent with previously reported concentrations;
- The maximum concentrations in MW2 where TCE and cis 1,2 DCE are statistically increasing were reported in early May and corresponded with TBM-1 passing beneath the source area. Lower concentrations within the historical range were reported in all following monitoring events in May and June 2024, indicating that the increase was transient. The short term increase is not considered to indicate a major change in conditions, or an adverse change in the risk profile;
- Groundwater levels close to the Station excavation have been drawn down by excavation, however Station construction activities do not appear to have changed the groundwater flow regime and gradient in the vicinity of the source area and PRB.;
- No additional assessment or contingency measures are currently required.

The revised groundwater mitigation monitoring program will continue on a weekly and fortnightly frequency throughout the St Marys SBT works as outlined in Section 2.1

Results of the monitoring program will continue to be provided to CPBG on a weekly/fortnightly basis, with monthly reports provided documenting works completed, field and analytical results, and a summary of groundwater levels and gradients between the Station box excavation and the PRB/source area, and concentration trends in the contaminant source area.

5. References

Tetra Tech (2022) *St Marys Station Detailed Site Investigation* (Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040513. 29/09/2022. Rev A03) ("St Marys DSI")

Tetra Tech (2023a) *St Marys Station Former Dry Cleaner, 1-7 Queen St – Assessment of Human Health Risk and Mitigation Options.* (Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040540. 26/4/2023. Rev A.05) ("Queen St HHRA")

Tetra Tech (2023b) *Baseline Groundwater Report (Project Wide)* (Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040405. 22/08/2023. Rev B.01) ("Baseline Groundwater Report")

Tetra Tech (2023c) *St Marys Station Remedial Action Plan* (Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040521. 23/5/2023. Rev A.08) ("St Marys RAP")

Tetra Tech (2023d) *Implementation of Permeable Reactive Barrier* (Ref: SMWSASBT-CPG-SWD-SW000-GE-RPT-040561. 02/08/2023. Rev A)

Tetra Tech

Tetra Tech

Tetra Tech (2024); *St Marys Station Remedial Action Plan – Proposed revision to mitigation groundwater monitoring network* (Ref: SMWSASBT-CPG-SWD-SW000-GE-MEM-040403_A.01. 26/03/2024. Rev A).

Annexure H
AMBS report – Survey 3

Orchard Hills Metro Station Vegetation Monitoring, Year 2: 3rd Survey. Draft report issued to CPBG, 25 June 2024.

AMBS Ref: 22039

25 June 2024

[redacted]
CPB Contractors
Western Sydney University
Werrington South Campus
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Orchard Hills Metro Station Vegetation Monitoring, Year 2: 3rd Survey

The CPB Contractors Ghella Joint Venture (CPBG) have been engaged by Sydney Metro to undertake detailed design and construction of the Station Boxes and Tunnelling Works (SBT Project) of the Sydney Metro Western Sydney Airport (the Project). The Project forms part of the broader Sydney Metro network. It involves the construction and operation of a new 23 km metro rail line that extends from the existing Sydney Trains suburban T1 Western Line (at St Marys) in the north and the Aerotropolis (at Bringelly) in the south. The Project has been granted approval under the *Environment Protection and Assessment Act 1979* (SSI 10051) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) (EPBC 2020/8687) and has an approved Flora and Fauna Management Plan (FFMP). CPBG has appointed AMBS Ecology & Heritage Pty Ltd (AMBS) as the Project Ecologist for the SBT Project.

The FFMP notes that a Groundwater Dependant Ecosystem (GDE) was identified in the Project Biodiversity Development and Assessment Report (BDAR) as occurring at the Orchard Hills box cut site. Modelled water table drawdown associated with construction of the Orchard Hills Metro Station was found to have the potential to impact areas of GDE outside of the approved Project Boundary. The FFMP defined a 6 monthly monitoring schedule to identify potential impacts of water drawdown associated with construction.

The Plant community Type (PCT) of the site is mapped as PCT 724 *Castlereagh shale - gravel transition forest* (CPBG, 2021). This PCT has since been decommissioned and replaced with PCT 3320 *Cumberland Shale Plains Woodland* (DPE, 2024) which is characterised by a canopy of *Eucalyptus tereticornis* (Forest Red Gum) and *Eucalyptus moluccana* (Grey Box), with Ironbarks *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Eucalyptus fibrosa* (Red Ironbark) occasionally present, although prominent in localised areas. This change of PCT does not impact the current or future study design or execution.

AMBS is pleased to provide the results of the third survey in the longitudinal vegetation monitoring for a potential GDE at Orchard Hills Metro Station. This survey will be compared to the data recorded in previous surveys and against future monitoring surveys.

Methods

Access issues during transect establishment and baseline surveys rendered the initially planned four transects north of Lansdowne Road inaccessible. Consequently, three alternative locations were selected. Two transects were located west of Kent Road, one located in the groundwater drawdown contour (study area) and the other transect located just outside the predicted drawdown area (control area), though in the same Plant Community Type (PCT) and within the construction area of impact (Figure 1). The third transect spans both the groundwater drawdown area (study area) and the control area, south of the draft four transects (Figure 1).

For the third monitoring survey, AMBS ecologist Mikayla Cashion visited Orchard Hills Metro Station on the 5th of June. Surveys revisited the three transects previously established in the baseline survey (Figure 1).

Monitoring points were resurveyed at each treatment area, positioned 10 metres (m) apart within a 100 m transect (Figure 1). At each canopy monitoring point, a fisheye lens camera on a tripod was used to take canopy photos aligned north-south. However, at Transect 3, the presence of a fence obstructed the images, prompting the surveyor to position the camera directly above the fence at an approximate 30-degree tilt. These canopy photos were subjected to analysis using the *coveR* R package (Chianucci *et al.* 2022) to determine percent canopy cover.

During the survey at each monitoring point, mature shrubs, if present, were methodically resurveyed, and observations of leaf condition, cover, disease prevalence, and flowering state were recorded (Plate 2). Additional photographs were taken to facilitate a comparative assessment of shrub condition for baseline and subsequent surveys.

Both control and study transects will continue to be monitored concurrently every 6 months for the duration of the project in order to compare any changes observed at each site. If similar changes in canopy cover and vegetation health are recorded in both study and control sites, it is more likely due to climatic conditions than groundwater drawdown at Orchard Hills Metro Station.

A Linear Mixed-Effects Model (LME) was used to examine the relationship between Canopy Cover, Survey Time, and Group (Study Group, Control Group) while considering the potential variability associated with transect location as a random effect. The response variable, Canopy Cover, was square root transformed to meet the assumption of normality for residuals. The analysis was conducted using R version 4.3.0 (R Core Team, 2024), utilising the *lme4* R package for fitting the LME model (Bates et al., 2015). To assess the significance of fixed effects, an analysis of variance (ANOVA) was conducted using the *car* R package (Fox and Weisberg, 2019). A Shapiro-Wilk test was conducted on the residuals to verify the assumption of normality. Post-hoc analysis involved a Tukey HSD test using the *emmeans* R package (Lenth et al., 2024).

Results

Canopy Cover

Statistical analysis indicated a significant difference in Canopy Cover between survey times (p = 0.016) and highly significant between the Control and Study Groups (p = < 0.001; Figure 1; Table 1). A Post-hoc analysis using a Tukey HSD test showed a significant reduction in Canopy Cover between surveys 1 and 2 ($t^{2,91}$ = 2.4, p = 0.04), a significant increase in Canopy Cover between surveys 2 and 3 ($t^{2,91}$ =-2.5, p = 0.04), and no significant difference in Canopy Cover between surveys 1 and 3 ($t^{2,91}$ = -0.01, p = 0.99).. The interaction between group and survey time did not reach statistical significance, suggesting that the observed differences in Canopy Cover did not significantly vary for both groups (Table 1).

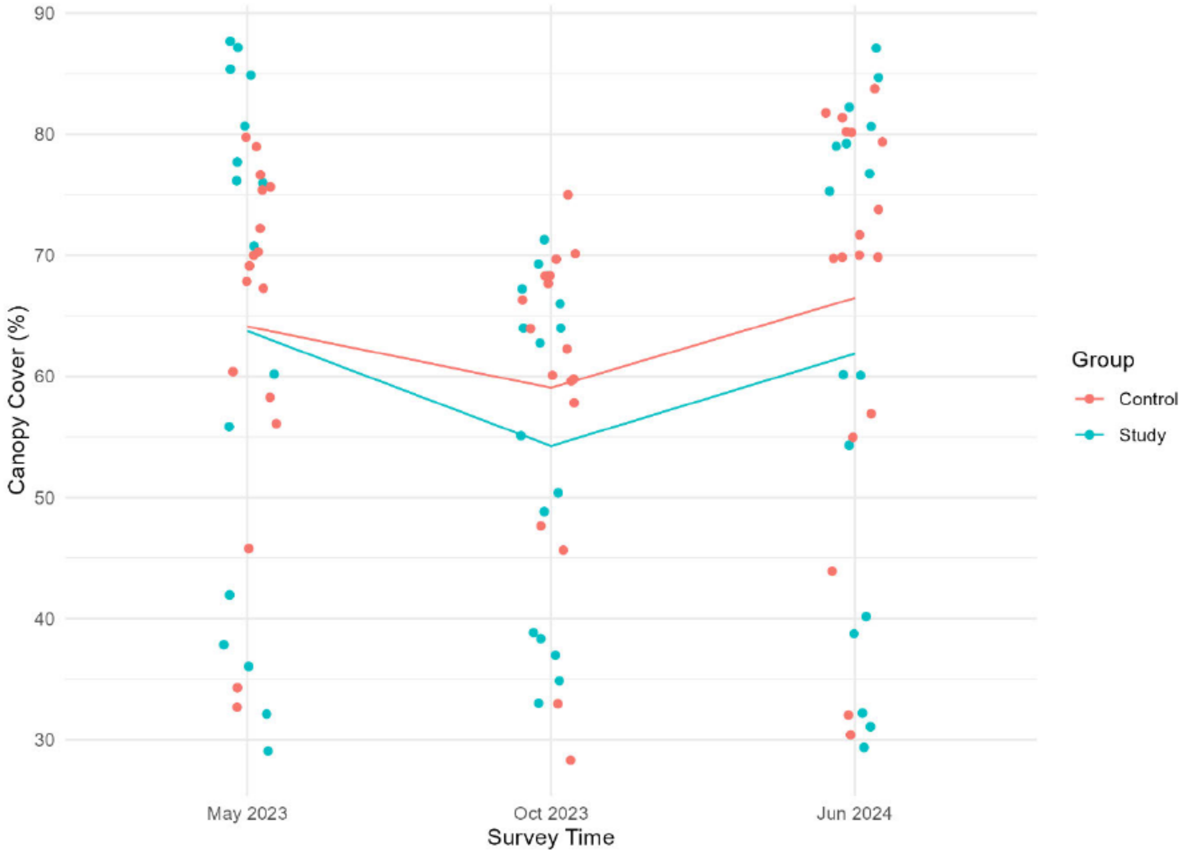

Figure 1. Scatter Plot of Canopy Cover for Control and Study Areas in May 2023, October 2023 and June 2024.

Table 1. ANOVA for LME with square root transformed Canopy Cover

Fixed Effects	F Statistic	Degrees of Freedom	P
Group	19.59	1	< 0.001 ***
Survey	3.93	2	0.0229 *
Group:Survey	0.30	2	0.741 n.s.

Following a decrease in mean canopy cover for Transect 1 (study) from 77% in survey 1 to 62% in survey 2, survey 3 saw an increase to 75% (Table 2). Transect 2 (control) followed a similar pattern, with a decrease in mean canopy cover between survey 1 (70%) and survey 2 (63%), followed by an increase to 74% in survey 3. Mean canopy cover for Transect 3 has remained relatively consistent in the study area across survey 1 (35%), survey 2 (36%) and survey 3 (34%). The control area also had little variation in mean canopy cover, with 53% in survey 1, 51% in survey 2 and 52% in survey 3. Three outlier points in the Transect 3 control area (3.5, 3.7, 3.8) for survey 2 were deemed inaccurate and incomparable to survey 1 due to the sun obscuring the images. When excluding these outlier points, mean canopy cover in the control area slightly decreased from 38% in survey 1 to 36% in survey 2, and remained at 36% in survey 3.

Table 2: Percent canopy cover at canopy monitoring photo points

Transect 1 (study area)			
Point	% Cover		
	Survey 1	Survey 2	Survey 3
1.0	76	64	75
1.1	81	68	77
1.2	85	67	81
1.3	88	71	85
1.4	87	69	87
1.5	85	66	82
1.6	71	55	60
1.7	60	50	60
1.8	76	63	79
1.9	78	64	79
1.10	56	49	54
T1 Mean % Cover	**77**	**62**	**75**

Transect 2 (control)			
Point	% Cover		
	Survey 1	Survey 2	Survey 3
2.0	56	48	57
2.1	60	58	70
2.2	70	66	81
2.3	68	62	70
2.4	77	68	82
2.5	75	68	79
2.6	67	60	70
2.7	69	64	74
2.8	72	60	72
2.9	76	70	84
2.10	80	75	80
T2 Mean % Cover	**70**	**63**	**74**

Transect 3 (study area & control)			
Point	% Cover		
	Survey 1	Survey 2	Survey 3
3.0 (study area)	36	37	32
3.1 (study area)	38	38	39
3.2 (study area)	42	39	40
3.3 (study area)	32	33	29
3.4 (study area)	29	35	31
T3 Mean % cover (study area)	**35**	**36**	**34**
3.5 (control)	70	60*	70
3.6 (control)	46	46	44
3.7 (control)	58	68*	55
3.8 (control)	7	70*	80
3.9 (control)	33	28	30
3.10 (control)	34	33	32
T3 Mean % cover (control)	**53**	**51**	**52**
T3 Mean % cover (control - excluding outliers 3.5, 3.7, 3.8)	**38**	**36**	**36**

* outlier canopy photo monitoring point due to distortion from direct sunlight.

Canopy at all transects was observed to be in good condition, despite some minor canopy dieback observed at Transect 1 during survey 2, none was observed during survey 3. Survey 2 recorded a reduction of shrubs at Transects 1 and 2 which contributed to a reduced calculated canopy cover, particularly at transect 1 (Table 2; Table 3). However, survey 3 recorded a slight increase in shrub cover, which contributed to an increase in the average canopy cover (Table 2; Table 3). Overall canopy cover, in survey 3, increased to a similar cover recorded in survey 1 for Transects 1 and 2 (Table 2; Plate 1).Canopy cover at Transect 3 was found to be relatively consistent across all three surveys. Shrub cover had very little impact on canopy cover percentage at Transect 3 as the positioning of the camera excluded shrubs from the frame.

Plate 1: Example canopy monitoring photograph from Transect point 1.4 during baseline survey 1 (left, 87%) survey 2 (middle, 69% cover) and survey 3 (right, 87% cover), showing a decrease in canopy and shrub cover during survey 2, and an increase during survey 3.

Shrub Condition

Shrubs were differentiated into good, moderate, and poor condition dependant on how healthy in colour and shape their leaves appeared. For instance, shrubs with wilting and browning leaves were classed as being in very poor condition.

Survey 2 recorded a decrease in leaf cover for most monitored shrubs on Transect 1, and survey 3 found most shrubs had improved slightly in leaf cover or remained the same. Leaf condition was good across all monitored shrubs with one exception on Transect 1 which is an improvement compared to surveys 1 and 2. No signs of disease were seen in survey 3, compared to some disease observed on one shrub in survey 2 and three shrubs in survey 1. Only one shrub was found to have buds in survey 3, slightly fewer than surveys 1 and 2.

Transect 2 found most of the monitored shrubs continued to have good to moderate leaf cover and condition, although two shrubs (2.3 and 2.8) were not located during Survey 3 and therefore could not be assessed. Presence of disease and flowering status on Transects 1 & 2 were generally consistent across surveys 1, 2 and 3 (Table 2; Plate 2). Monitored shrubs at Transect 2 (control) continue to generally be better in leaf cover and condition than shrubs at Transect 1 (study), likely due to its position in a wetter area with a creek line intersecting the transect (Table 3).

Transect 3 showed a large decrease in leaf cover and condition from survey 1 to survey 2, with all monitored shrubs having very few leaves or appearing completely dead due to a fire (Plate 3). During survey 3 some shrubs were observed with regrowth, while others remained completely dead. These changes were found to be consistent across both study and control areas of Transect 3. The fence at Transect 3 limited the accuracy of assessing shrub condition due to separation from the monitored shrubs, and the lack of remaining plant material resulted in no disease or presence of flowering parts found on any of the monitored shrubs.

Table 3: Shrub condition monitoring notes

Transect	Point	Species	Leaf cover			Leaf condition			Disease notes			Flower status		
			Survey 1	Survey 2	Survey 3	Survey 1	Survey 2	Survey 3	Survey 1	Survey 2	Survey 3	Survey 1	Survey 2	Survey 3
Transect 1 (study area)	1.0	*Bursaria spinosa*	Moderate	Poor	Poor	Good	Moderate	Good	None seen	None seen	None seen	Buds	Buds	Buds
	1.1	*Bursaria spinosa*	Good	Moderate	Poor	Moderate	Moderate	Good	Some disease	Some disease	None seen	Buds	Buds	None
	1.2	*Bursaria spinosa*	Moderate	Poor	Moderate	Moderate	Moderate	Good	None seen	None seen	None seen	None	None	None
	1.3	*Olea europea**	Moderate	Poor	Moderate	Good	Good	Good	None seen	None seen	None seen	None	None	None
	1.4	*Bursaria spinosa*	Good	Moderate	Moderate	Good	Good	Good	None seen	None seen	None seen	None	None	None
	1.5	*Olea europea**	Moderate	Moderate	Moderate	Moderate	Moderate	Good	Some disease	Some disease	None seen	None	None	None
	1.6	*Bursaria spinosa*	Good	Moderate	Good	Moderate	Moderate	Good	None seen	None seen	None seen	None	Buds	None
	1.7	*Bursaria spinosa*	Very poor	Very poor	Poor	Moderate	Moderate	Good	None seen	None seen	None seen	Buds	None	None
	1.8	*Bursaria spinosa*	Poor	Poor	Moderate	Good	Good	Good	None seen	None seen	None seen	None	None	None
	1.9	*Bursaria spinosa*	Poor	Very poor	Poor	Moderate	Very poor	Good	None seen	None seen	None seen	Buds	None	None
	1.10	*Solanum nigrum**	Good	Very poor	Very poor	Moderate	Poor	Very poor	Some disease	None seen	None seen	Buds/ Flowers/ Fruit	None	None
	Number "Good"/ "None seen" (/11)		4	0	1	4	3	10	8	9	11			
Transect 2 (control)	2.0	*Bursaria spinosa*	Moderate	Moderate	Good	Good	Good	Good	None seen	None seen	None seen	None	Buds	Buds
	2.1	*Bursaria spinosa*	Good	Good	Good	Good	Good	Good	None seen	None seen	None seen	Buds	Buds	Buds
	2.2	*Bursaria spinosa*	Good	Moderate	Moderate	Good	Good	Good	None seen	None seen	None seen	Buds	Buds	Buds
	2.3	*Ligustrum sinense**	Good	Good	Not located **	Good	Good	Not located **	None seen	None seen	Not located **	Fruit	Flowers	Not located **
	2.4	*Olea europea**	Moderate	Moderate	Moderate	Good	Good	Good	None seen	None seen	None seen	None	None	None

Transect	Point	Species	Leaf cover			Leaf condition			Disease notes			Flower status		
			Survey 1	Survey 2	Survey 3	Survey 1	Survey 2	Survey 3	Survey 1	Survey 2	Survey 3	Survey 1	Survey 2	Survey 3
	2.5	*Olea europea**	Poor	Poor	Poor	Moderate	Moderate	Moderate	None seen	None seen	None seen	None	None	None
	2.6	*Ligustrum sinense**	Good	Good	Good	Moderate	Moderate	Moderate	None seen	Some disease	None seen	Fruit	Flowers. fruit	Fruit
	2.7	*Olea europea**	Moderate	Poor	Moderate	Moderate	Moderate	Moderate	Some disease	Some disease	Some disease	None	None	None
	2.8	*Bursaria spinosa*	Moderate	Moderate	Not located **	Good	Good	Not located **	None seen	None seen	Not located **	None	None	Not located **
	2.9	*Olea europea**	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Some disease	Some disease	Some disease	Fruit	None	None
	2.10	*Bursaria spinosa*	Good	Good	Good	Good	Good	Moderate	None seen	None seen	None seen	Buds	Buds	Buds
	Number "Good"/ "None seen" (/11)		**5**	**4**	**4/9****	**7**	**7**	**4/9****	**9**	**8**	**8/9****			
	3.0 (study area)	*Bursaria spinosa*	Good	Very poor	Poor	Good	Moderate	Good	None seen	None seen	None seen	None	None	None
	3.1 (study area)	*Acacia elongata*	Good	Very poor-dead	Very poor-dead	Good	Very poor-none	Very poor-dead	None seen	None seen	None seen	Buds	None	None
	3.2 (study area)	*Bursaria spinosa*	Moderate	Very poor	Very poor-dead	Good	Moderate	Very poor-dead	None seen	None seen	None seen	None	None	None
Transect 3	**3.3** (study area)	None	-	-	-	-	-	-	-	-	-	-	-	-
	3.4 (study area)	*Melaleuca decora*	Good	Very poor	Poor	Good	Moderate	Good	None seen	None seen	None seen	None	None	None
	Study: Number "Good"/ "None seen" (/4)		**3**	**0**	**0**	**4**	**0**	**2**	**4**	**4**	**4**			
	3.5 (control)	*Bursaria spinosa*	Moderate	Very poor	Very poor	Good	Moderate	Good	None seen	None seen	None seen	None	None	None
	3.6 (control)	*Bursaria spinosa*	Moderate	Very poor	Very poor	Good	Poor	Good	None seen	None seen	None seen	None	None	None

Transect	Point	Species	Leaf cover			Leaf condition			Disease notes			Flower status		
			Survey 1	Survey 2	Survey 3	Survey 1	Survey 2	Survey 3	Survey 1	Survey 2	Survey 3	Survey 1	Survey 2	Survey 3
	3.7 (control)	None	-	-	-	-	-	-	-	-	-	-	-	-
	3.8 (control)	*Bursaria spinosa*	Very poor	Very poor-dead	Very poor-dead	Good	Very poor-none	Very poor-dead	None seen	None seen	None seen	None	None	None
	3.9 (control)	*Bursaria spinosa*	Moderate	Very poor-dead	Very poor	Good	Very poor-none	Good	None seen	None seen	None seen	None	None	None
	3.10 (control)	None	-	-	-	-	-	-	-	-	-	-	-	-
	Control: Number "Good"/ "None seen" (/4)		**0**	**0**	**0**	**4**	**0**	**3**	**4**	**4**	**4**			

* denotes an introduced species ** shrub/s not located during survey therefore not assessed

Plate 2: *Bursaria spinosa* (Transect 2 (control), point 2.2) with good leaf cover and leaf condition in survey 1 (left), moderate leaf cover and good leaf condition in survey 2 (middle) and moderate cover and good leaf condition in survey 3 (right). In all three surveys the plant had buds and no signs of disease.

Plate 3: *Melaleuca decora* (Transect 3 (study area), point 3.4) in good condition and leaf cover during baseline survey 1 (left), in very poor condition and leaf cover in survey 2 (middle) and in poor leaf cover and good condition in survey 3 (right).

Discussion

Fire, an increase in temperature and a decrease in rainfall between surveys 1 and 2 have likely contributed to a dieback in canopy and shrubs on all three transects. The initial baseline surveys were performed in May and June of 2023. BOM station number 67113 (Penrith Lakes AWS), recorded an average maximum monthly temperature respectively of 20.7℃ and 18.9℃. Survey 2 was performed in October 2023, recording an increased average maximum monthly temperature of 28.3℃ (BOM, 2024). Survey 3 was performed in June 2024, and May 2024 which recorded a decreased maximum monthly temperature of 20.5 ℃ (BOM, 2024).

BOM station number 67084 (Orchard Hills Treatment Works) recorded a monthly rainfall total for May and June of 2023 of 13.6 mm and 17.1 mm respectively, compared to 18.2 mm in October of 2023. Although slightly increasing between these two periods, monthly rainfall in 2022 was significantly higher. Average rainfall reduced from a combined monthly total from May to October of 2022 from 655.8 mm, to 126 mm within that same period in 2023. BOM station number 67113 (Penrith Lakes AWS) recorded an increased monthly rainfall total of 62.4mm in May 2024 (BOM, 2024).

The large reduction in rainfall and increase in temperature that occurred between surveys 1 and 2 likely resulted in a dieback of shrubs and canopy. This was followed by an increase in rainfall and decrease in temperature between surveys 2 and 3, resulting in an increase in canopy and shrub cover, and regrowth of burnt shrubs at Transect 3. However, variation in shrub and canopy cover is also expected due to the time of year the surveys were completed in.

Conclusion

The decrease in canopy cover in Transects 1 and 2 between surveys 1 and 2, followed by an increase in survey 3, is likely to be within natural variation of the climate and unlikely to be a result of potential groundwater drawdown. Canopy cover at Transect 3 has remained relatively consistent across all three surveys, although the monitored shrubs were severely damaged by heat and fire between surveys 1 and 2, which is also unrelated to any potential groundwater drawdown.

Future monitoring visits will be required to detect whether there are significant changes in canopy cover and/or shrub condition indicative of impacts to the GDE study area. Monitoring visits will continue to occur every six months, until the end of 2028.

Should you require any additional information or if I can be of assistance in any way, please contact me on [redacted]

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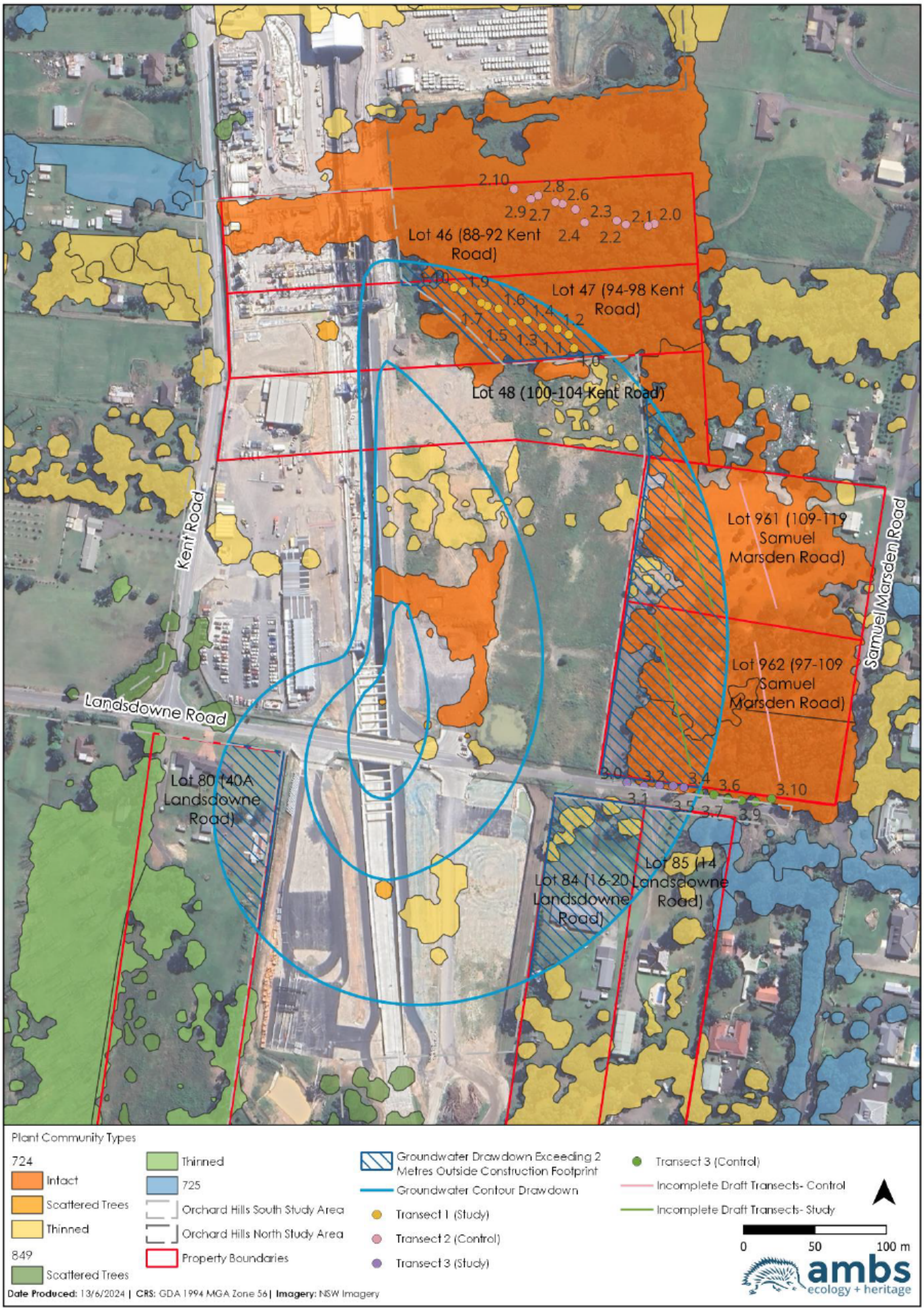

Figure 1: Potential Groundwater Drawdown Impact Area and Monitoring Points at Orchard Hills Metro Station

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Annexure I Claremont Creek – AUSRIVAS & Surface Water Quality Survey

AQUATIC
ECOLOGICAL
INVESTIGATIONS

Claremont Creek

AUSRIVAS & Surface Water Quality Survey

Draft Report prepared for
AMBS Ecology & Heritage

8 July 2024

Document Information

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1.0 INTRODUCTION

1.1 Background

The Sydney Metro Western Sydney Airport (SMWSA) is a new rail line to the Western Sydney Airport that is currently under construction at from St Mary's to the new city of Bradfield and the new Western Sydney Airport at Badgerys Creek. The contract to build the WSA Metro Station Boxes and Tunnelling Works (WSA Metro SBT) (the Project) was awarded to the CBP Contractors and Ghella Joint Venture (CPBG).

Groundwater drawdown can potentially reduce baseflow and pool water levels which can have potential impacts to aquatic habitat and biota (Buck et al., 2019; Lake, 2000).

Aquatic Ecological Investigations (AEI) has been engaged by AMBS Ecology & Heritage Pty Ltd (AMBS) on behalf of CPBG to undertake a survey of aquatic ecology at selected sites within Claremont Creek.

or Wianamatta) South Creek flows generally north before reaching its confluence with the Hawkesbury River, near Windsor.

AEI have been advised that a survey is required at selected sites within Claremont Creek to assess the current ecosystem value and any potential ecological sensitivity to surface water flow changes that could potentially be generated from groundwater levels drawdown. The data is required to enable CPBG to understand potential changes to stream health if groundwater drawdown is impacted surface water flow and pool retention.

1.2 Scope of Works

The scope of works included:

- a field survey of aquatic habitat, *in-situ* water quality and aquatic macroinvertebrates at selected sites within and adjacent to the Study Area;
- a review of previous monitoring data and existing information on aquatic habitat and biota within and adjacent to Study Area;
- provision of recommendations on further surveys if stream health within the Study Area has deteriorated.

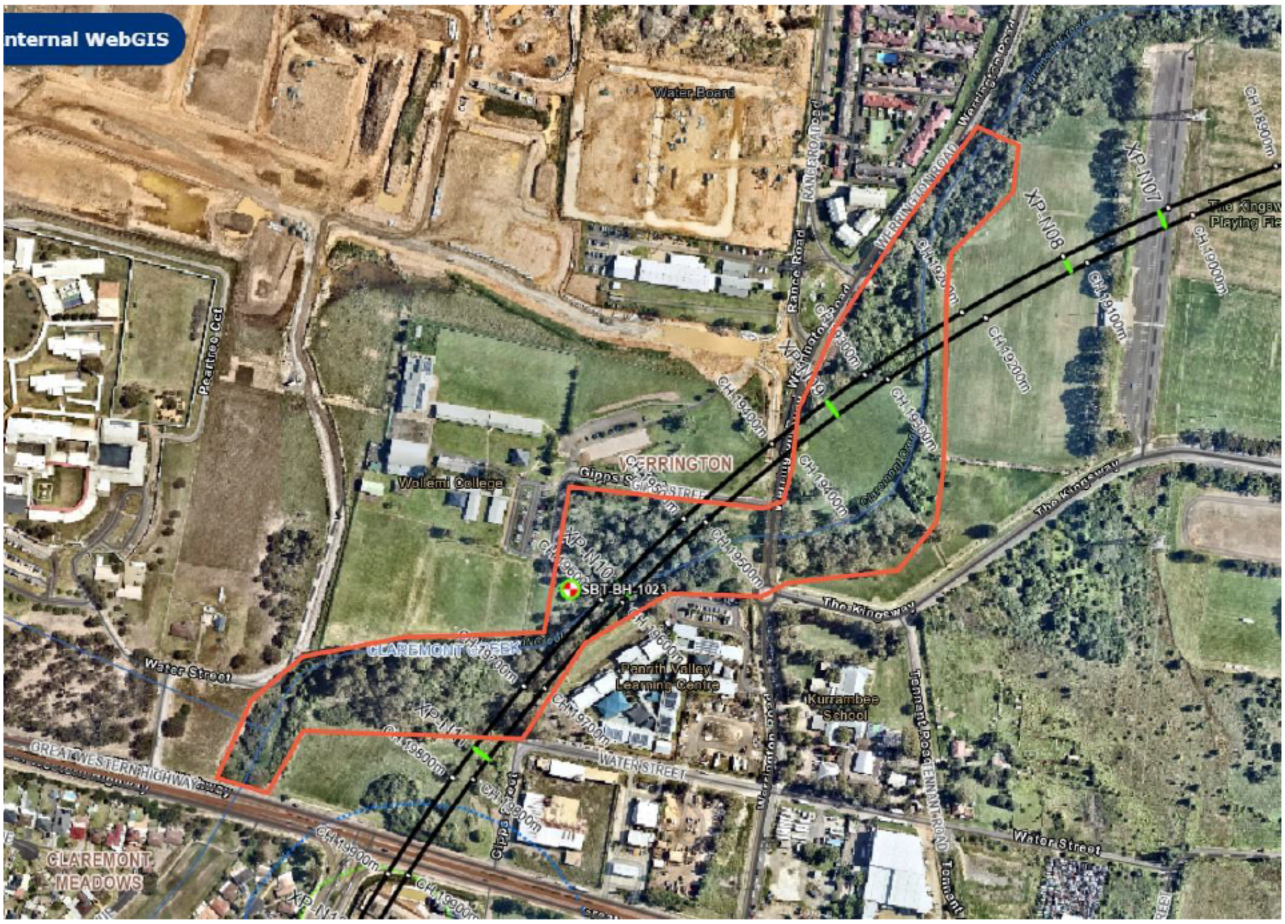

Figure 1. The Study Area.

2.0 METHODS

2.1 Survey Overview

A total of nine sites were selected to be surveyed for aquatic habitat, surface water quality and macroinvertebrates (Table 1, Figure 2). The aquatic habitat assessment was done using the AUSRIVAS sampling protocol (Turak et al., 2004). Each site (approximately 100 m in length) was photographed and the locations recorded with a hand-held satellite-based Global Positioning System (GPS).

Collections of macroinvertebrates were completed in accordance with Section 37 of the *NSW Fisheries Management Act 1994* using Scientific Collection Permit Number P03/0032(B) and NSW Agriculture, Animal Research Authority Care and Ethics Certificate of Approval Number 03/2445.

Table 1. Sites sampled for surface water habitats and biota (u/s: upstream, d/s: downstream).

Creek	Site Code	Easting	Northing	Description
Claremont Creek	**CC-1**	291619	6261006	Upstream of potential impact area
	CC-2	291943	6261444	Upstream of potential impact area
	CC-3	292207	6261540	Upstream or edge of potential impact area
	CC-4	292512	6261812	Within potential impact area
	CC-5	292555	6262082	Downstream or edge of potential impact area
South Creek	**SC u/s**	293219	6261551	Upstream of the potential impact area.
	SC d/s	292792	6263411	Downstream of the potential impact area.
Werrington Creek	**WC1**	291006	6263023	Control site, situated ~ 900 m u/s of confluence with South Creek.
	WC2	291952	6263170	Control site, situated ~ 400 m u/s of confluence with South Creek.

Figure 2. Survey sites situated within Claremont Creek (CC1-CC5), South Creek (SC1&SC2) and Werrington Creek (WC1&WC2). Image provided by Google Earth.

2.2 Field Methods

2.2.1 Aquatic Habitat Assessment

The condition of the aquatic habitat was assessed at each site using a modified version of the Riparian Channel and Environmental (RCE) inventory method (Chessman et al., 1997). This method involves evaluation and scoring of the characteristics of the adjacent land, the condition of riverbanks, channels and beds of the watercourse, and degree of disturbance evident at each site.

Information was collected on the following features:

- characteristics of each waterway (e.g. flow and stream width);
- occurrence of key aquatic habitat (e.g. gravel beds, pools, macrophytes, riffles and woody debris);
- water clarity;
- presence of in-stream and emergent aquatic macrophytes at each site;
- barriers to fish passage;
- presence of algae, exotic plants, bank degradation, flocculent, odour, detergents, oil, rock piles or sedimentation, pipes, rubbish and point sources; and
- surrounding land uses.

Based on the original classification established by Peterson (1992), site condition was rated:

- Poor for RCE scores of 0-24%;
- Fair for RCE scores of 25-43%;
- Good for RCE scores of 44-62%;
- Very good for RCE scores of 63-81%; and
- Excellent for RCE scores of 82-100%.

Other habitat features were assessed in accordance with the AUSRIVAS proforma and NSW *Policy and Guidelines for Fish Habitat Conservation and Management (Update 2013)* (DPI, 2013).

2.2.2 Surface Water Quality

Where sufficient water was present, *in situ* water quality was measured using a Yeo-Kal 611 probe. Physico-chemical properties measured included electrical conductivity (µS/cm), dissolved oxygen (% saturation and mg/L), pH (pH units), temperature (°C) and turbidity (NTU). Three replicate measures of each variable were collected from just below the water surface at each site. Alkalinity was also determined in the field, using a CHEMetrics' total alkalinity field kit.

2.2.3 AUSRIVAS Macroinvertebrates

In freshwater habitats, aquatic macroinvertebrates were sampled in accordance with the Australian River Assessment System (AUSRIVAS) protocols (Turak et al., 2004). AUSRIVAS models predict the aquatic macroinvertebrate fauna expected to occur at a site in the absence of environmental stress, such as pollution or habitat degradation, to which the fauna collected at a site can be compared (Turak et al., 2004).

Edge habitats were sampled for aquatic macroinvertebrates using a 250 µm mesh dip net. At each site (approximately 100 m long), samples were collected over a total length of 10 m, usually in 1-2 m sections, ensuring all significant edge sub-habitats within a site (i.e. macrophytes, over-hanging bank and vegetation, leaf-litter, logs) were included in the sample (Turak et al., 2004).

The contents of each net sample were placed into a white sorting tray and animals collected for a minimum period of 30 minutes. Thereafter, removals were done in 10- minute periods, up to a total of one hour (Turak et al., 2004). If no new taxa were found within a 10-minute period, removals ceased (Turak et al., 2004).

The animals collected were placed inside a labelled container, preserved with 70% alcohol and taken to the laboratory for identification. Environmental variables required for running the AUSRIVAS predictive model, including model stream width, percentage boulder or cobble cover, latitude and longitude were recorded at each site.

In the laboratory, taxa were identified to family level except for Acarina (to order), Chironomidae (to sub-family), Nematoda (to phylum), Nemertea (to phylum), Oligochaeta (to class), Ostracoda (to subclass) and Polychaeta (to class) using a stereo microscope. Families of Anisoptera (dragonfly larvae) that include listed species were identified to species.

All samples were retained in appropriate containers and preservative to allow further examination later if required. After checks on identifications, numbers of each type of animal were entered into spreadsheet format and data checked against laboratory data sheets.

2.3 Laboratory Methods

In the laboratory, AUSRIVAS samples were sorted under a binocular microscope (at 40X magnification) and identified to family level with the exception of Acarina (to order), Chironomidae (to sub-family), Nematoda (to phylum), Nemertea (to phylum), Oligochaeta (to class), Ostracoda (to subclass) and Polychaeta (to class). Some families of Anisoptera (dragonfly larvae) would be identified to species, because they could potentially include threatened aquatic species listed under the *Fisheries Management Act, 1994* (FM Act).

Up to 25 animals of each family were counted, in accordance with the AUSRIVAS protocol (Turak et al., 2004) and the SIGNAL2 (Stream Invertebrate Grade Number Average Level) biotic index developed by Chessman (2003).

2.4 Data Analysis

The water quality measurements taken during the site inspection were used to assess water quality within the study area in terms of health of aquatic ecosystems by comparison with guideline values recommended by ANZECC and ARMCANZ (2000).

The macroinvertebrate data were analysed using the appropriate AUSRIVAS predictive models developed for New South Wales. The ecological health of the waterways was assessed by comparing the macroinvertebrates collected at a site (i.e. Observed) to those predicted to occur (Expected) if the site is in an undisturbed or ‘reference’ condition.

The principal outputs of the AUSRIVAS model include:

- Observed to Expected ratio (OE50): the ratio of the number of macroinvertebrate families collected at a site which had a predicted probability of occurrence of greater than 50 % (i.e. Observed) to the sum of the probabilities of all of the families predicted with greater than a 50 % chance of occurrence (i.e. Expected) (Ransom et al., 2004);
- BAND: for each model, the OE50 taxa ratios are divided into bands representing different levels of impairment. Band X represents a more diverse assemblage of macroinvertebrates than control sites; Band A is considered equivalent to reference condition; Band B represents sites below reference condition (i.e. significantly impaired); Band C represents sites well below reference condition (i.e. severely impaired); and Band D represents impoverished sites (i.e. extremely impaired) (Ransom et al., 2004).

The Stream Invertebrate Grade Number Average Level (SIGNAL2) biotic index developed by Chessman (2003) was also calculated, to give an indication of water quality at the sites sampled. The SIGNAL2 score for a macroinvertebrate sample is calculated by averaging the pollution sensitivity grade numbers of the families present, which may range from 10 (most sensitive) to 1 (most tolerant). SIGNAL2 values are as follows:

- SIGNAL >6 = Healthy habitat
- SIGNAL 5-6 = Mild pollution
- SIGNAL 4-5 = Moderate pollution, and
- SIGNAL <4 = Severe pollution.

2.5 Quality Assurance/Quality Control (QA/QC)

Data collected in the field was checked for accuracy and completeness before leaving each site. In the office, field data and other records were incorporated into appropriate excel data sheets and checked. Spreadsheets were locked prior to analysis to prevent accidental over-writes or corruption.

In the laboratory, macroinvertebrate samples were identified by an appropriately qualified staff member. Data for each sample were entered into an excel spreadsheet and then checked.

2.6 Limitations

Sampling was unable to commence until 5 June 2024 due to rainfall and high flow related delays. Prolonged periods of high flow conditions can reduce the likelihood of identifying a range of potentially occurring species that may use habitats in the Study Area. Water quality measurements collected during the biological sampling only provide a snapshot of quality at the time of sampling under the prevailing flow conditions. However, the results from previous stream health surveys undertaken for the Project in different seasons and across several years have been incorporated into this report to help address this limitation (GHD, 2016; AEI, 2022).

3.0 RESULTS

3.1 Survey Dates and Rainfall

The selected sites were sampled on 5 June 2024 by Dr Sharon Cummins (Senior Scientist – Applied Aquatic Ecology) and Mr William Roberts (Senior Environmental Technician). Within the two months prior to the field survey, a total of 273 mm of rainfall was recorded at the nearest AWS (Station ID: 67081). A total of 40.4 mm of rainfall was recorded in the week prior to the survey.

Within the two months prior the stream health survey, mean water levels measured at the nearest gauge, in South Creek at the Great Western Highway (Station ID 212048), ranged from 0.255 m (28 April 2024) to 5.077 m (7 April 2024). At the time of the current survey, mean water level was 0.433 m (5 June 2024).

3.2 Aquatic Habitat Characteristics

The sections of Claremont Creek, South Creek, and Werrington Creek within the Study Area are mapped as Key Fish Habitat by the New South Wales (NSW) Department of Primary Industries (DPI) (NSW DPI, 2024).

Information collected by the current survey has been used to describe the aquatic ecology values at sites that occur within the Study Area, on Claremont Creek, South Creek and Werrington Creek (Figure 1).

Claremont Creek

At Site CC1, situated upstream of the Great Western Highway, the stream channel has been highly modified by development and flood control activities. Riparian vegetation has mostly been cleared along this section the stream channel, and replaced by exotic grasses with occasional *Typha* sp., *Cyperus eragrostis* and *Persicaria decipiens*. Surface water habitat was present in occasional temporary, shallow (up to 20 cm deep) depressions. Conductivity of the water within these depressions ranged from 791 to 9,076 µS/cm. This site received an RCE score of 14 (27%). Aquatic habitat was mostly absent and significant barriers to fish movement were present.

Plate 1: Claremont Creek (CC1) (5 June 2024)
View upstream

Plate 2: Claremont Creek (CC1) (5 June 2024)
View downstream

Downstream of the Great Western Highway to the confluence with South Creek, Claremont Creek consisted of pools up to 6 m wide and 1.2 m deep. Unlike the findings of a recent survey (AEI, 2022), pools were connected by flow along the creek channel, including upstream and downstream of the crossing at Site CC4 (Plates), indicating that flow along this section of Claremont Creek is intermittent.

The active channel bed is composed primarily of silts and clay (as are the banks of the main channel) overlying a mostly gravel bed. A range of habitats were available for fish, including large woody debris, rocks and submerged aquatic macrophytes, including Water Ribbons (*Vallisneria* sp.) and Blunt pondweed (*Potamogeton ochreatus*). Emergent macrophytes included Phragmites and River Club-Rush (*Schoenoplectus validus),* both of which commonly grow in fresh to brackish water. Marsh Clubrush (*Bolboschoenus fluviatilis*), Swamp Club-Rush (*Isolepis inundata*), Typha, Umbrella Sedge (*Cyperus eragrostis*) and Slender knotweed (*Persicaria decipiens*) were also common. Water visibility was good to fair (Plates 3-10).

Despite evidence of recent scouring by elevated flows, the stream banks appeared relatively stable, due to the presence of mature trees (predominantly Casuarina and Eucalyptus). Exotic weeds, including Privet (*Ligustrum* sp.), Ballon vine (*Cardiospermum grandiflorum*), Trad (*Tradescantia albiflora*) and grasses were common (Plates 3-10). The overall condition of aquatic habitats at site's CC2 to CC5 was classified as good, with an RCE score of 25 (48%). The downstream reaches of Claremont Creek are classified as Class 2, Type 2 (moderate) fish habitat according to the DPI (2013) classification.

Plate 3: Claremont Creek (CC2) (5 June 2024)

View upstream

Plate 4: Claremont Creek (CC2) (5 June 2024)

View downstream

Plate 5: Claremont Creek (CC3) (5 June 2024)

View upstream

Plate 6: Claremont Creek (CC3) (5 June 2024)

View downstream

Plate 7: Claremont Creek (CC4) (5 June 2024)

View downstream

Plate 8: Claremont Creek (CC4) (5 June 2024)

View across-stream

Plate 9: Claremont Creek (CC5) (5 June 2024)
View upstream

Plate 10: Claremont Creek (CC5) (5 June 2024)
View downstream

South Creek

Site SC1 is situated on South Creek, approximately 740 m upstream from the confluence with Claremont Creek (Figure 2). At the time of the survey, there were signs of recent flooding, including severe scouring of the stream channel and rubbish caught in tree branches (Plates 11-14). Water clarity was considered poor.

This section of the creek is generally characterised by a large pool (up to approximately 14 m wide and 1.6 m deep) upstream of a weir. Immediately downstream of the weir, the stream channel was approximately 8 m wide. The active channel bed is composed primarily of silts and clay (as are the banks of the main channel) overlying a mostly gravel bed. A range of habitats were available for fish, including large woody debris, rocks and the submerged aquatic macrophyte, *Vallisneria* sp. Flow was rapid and water visibility poor (Plates 11&12).

The tree canopy was comprised by mostly Casuarina and Eucalyptus species and some exotic trees. (*Lomandra longifolia*), Slender knotweed, and the exotic species, Trad and Alligator weed ( ), and grasses were common, particularly in areas where there were breaks (at intervals of between 5 and 30 m) in the riparian strip. The overall condition of aquatic habitats at Site SC1 was classified as fair, with an RCE score of 35 (67%).

Site SC2 is situated approximately 2.2 km downstream of Site SC1, approximately 1.2 km downstream of the confluence with Claremont Creek (Figure 1).

There were signs of recent flooding, including severe scouring of the stream channel (Plates 13&14). The pool sampled upstream of the bridge was up to 12 m wide and 1.4 m deep. Water clarity was considered poor (Plates 13&14).

The active channel zone at both sites was composed of poorly sorted gravel overlain by fine-grained sediments (13&14). Large woody debris contributed habitat to the stream channel. The tree canopy was comprised by mostly Casuarina and Eucalyptus species and some exotic trees. *Lomandra longifolia* ( ), and grasses were common The overall condition of aquatic habitats at Site SC2 was classified as fair, with an RCE score of 35 (67%). The downstream reaches of South Creek are classified as Class 2, Type 2 (moderate) fish habitat according to the DPI (2013) classification.

Plate 11: South Creek (SC1) (5 June 2024)

View upstream

Plate 12: South Creek (SC1) (5 June 2024)

View downstream

Plate 13: South Creek (SC2) (5 June 2024)

View upstream

Plate 14: South Creek (SC2) (5 June 2024)

View downstream

Werrington Creek

Site WC1 is situated on Werrington Creek, approximately 1.6 km upstream from the confluence with South Creek (Figure 2). At the time of the survey, there were signs of recent flooding, including severe scouring of the stream channel and rubbish caught in tree branches (Plates 15-18). There was a strong smell of sewage at Site WC1. The tree canopy at both sites was comprised by mostly Casuarina and Eucalyptus trees and some exotic trees.

, Trad and exotic grasses were common. The active channel zone (0.4 to 1.5 m wide) was composed of poorly sorted gravel overlain by fine-grained sediments. The native submerged macrophyte species, *Stuckenia pectinata* (Sago pondweed) and the introduced species, *Egeria densa* (Dense waterweed), were abundant at Site WC1 (Plate 16). Water clarity was considered poor at both sites. The overall condition of aquatic habitats at Site WC1 & WC2 was classified as fair, with an RCE score of 25 (48%).

Plate 15: Werrington Creek (WC1) (5 June 2024)
View upstream

Plate 16: Werrington Creek (WC1) (5 June 2024)
View downstream

Plate 17: Werrington Creek (WC2) (5 June 2024)
View upstream

Plate 18: Werrington Creek (WC2) (5 June 2024)
View downstream

3.3 Surface Water Quality

Mean physico-chemical water quality measurements from 5 June 2024 are summarised in Table 2. Values highlighted in bold type indicate where results were outside the appropriate default trigger values (DTVs) recommended by ANZECC/ARMCANZ (2000).

The main findings for the water quality survey are summarised as follows:

- pH levels (range = 7.4 – 7.8) were within the DTVs recommended by the ANZECC/ARMCANZ (2000) guidelines at all of the sites sampled
- Mean conductivity levels (range = 657 to 4,320 µS/cm) exceeded the upper DTV at Site CC1.
- Dissolved oxygen levels (range = 63 to 109.3 % saturation) were below the lower DTV at all sites except site 2 situated on South Creek (Site SC2)
- Turbidity levels (range = 40 to 100 NTU) exceeded the upper DTV at both sites sampled within South Creek (i.e., Site SC-1 and SC-2) (Table 2).

Table 2. Mean (± SE) values of water quality variables recorded at each site (5 June 2024). Values highlighted in bold type indicate where results were outside the recommended DTV values.

Site	DTV*	CC1	CC2	CC3	CC4	CC5
Temperature °C	-	16.0 (0.8)	12.9 (0.0)	12.7 (0.0)	12.6 (0.0)	12.4 (0.0)
pH	**6.5-8.0**	7.6 (0.4)	7.8 (0.0)	7.6 (0.0)	7.6 (0.0)	7.5 (0.0)
Conductivity (µS/cm)	**125-2200**	**4,320** (2469)	1,963 (0.3)	1,921 (0.9)	1,822 (0.0)	1,860 (0.3)
Dissolved Oxygen (%)	**85-110**	**63.0** (27.8)	**80.5** (0.0)	**71.4** (0.1)	**74.0** (0.0)	**70.9** (0.0)
Turbidity (NTU)	**6-50**	27.8 (14.2)	22.6 (0.2)	24.0 (0.2)	22.5 (0.0)	24.4 (0.1)
Alkalinity (mg/L $CaCO_3$)	-	40	40	50	100	70
Site	**DTV***	**SC1**	**SC2**	**WC1**	**WC2**	
Temperature °C	-	12.1 (0.0)	12.2 (0.0)	13.2 (0.0)	12.4 (0.0)	
pH	**6.5-8.0**	7.5 (0.0)	7.5 (0.0)	7.4 (0.0)	7.4 (0.0)	
Conductivity (µS/cm)	**125-2200**	966 (0.3)	961 (0.0)	657 (0.0)	872 (0.0)	
Dissolved Oxygen (%)	**85-110**	**71.0** (0.1)	109.3 (0.0)	**67.2** (0.1)	**69.1** (0.1)	
Turbidity (NTU)	**6-50**	**129.8** (0.2)	**136.7** (1.1)	31.0 (0.2)	24.4 (0.1)	
Alkalinity (mg/L $CaCO_3$)	-	100	70	50	70	

* DTVs are based on the ANZECC/ARMCANZ (2000) guidelines for the protection of slightly disturbed aquatic ecosystems in lowland rivers (i.e. systems at < 150 m altitude) in south-east Australia. Bold values indicate results that were outsides the DTVs.

3.4 Aquatic Macroinvertebrates

A total of 28 taxon were identified from edge habitat samples collected at the nine sites sampled on 5 June 2024 (Table 3). The number of taxa ranged from 1, at Site SC2, and 13 at Site CC1 (Table 3). Corixidae (water boatmen) were the most common taxa collected, occurring at eight of the nine sites sampled (Table 3). Tubificidae (segmented worms), Physidae, Bithyniidae and Hydrobiidae (freshwater snails) were collected at five of the sites sampled (Table 3). Freshwater snails (Hydrobiidae, Physidae and Bithyniidae) and true fly larvae (Chironomidae and Tanypodinae) were the most abundant taxa collected (Table 3). The alien fish, *Gambusia holbrooki*, was present in samples collected at the Site CC3, SC1, SC2 and WC1 (Table 3). Two freshwater eels (*Anguilla* sp.) were observed at each of Sites CC2 and CC3.

No individuals of threatened dragonfly species, including the Adams emerald dragonfly (*Archaeophya adamsi*) (Family Corduliidae) (NSW Fisheries, 2002) or Sydney hawk dragonfly (*Austrocordulia leonardi*) (Family Austrocorduliidae) (NSW Fisheries, 2007), or fish, including Macquarie Perch (*Macquaria australasica*) or Australian Grayling (*Prototroctes maraena*) were observed or collected within the Study Area.

AUSRIVAS Scores

The OE50 Taxa Scores ranged from 0.00 (WC1) to 0.54 (CC1) (Table 4). Of the nine sites sampled on 5 June 2024, one was grouped within Band B (CC1), three within Band C (CC3, SC1 and WC2), and five were grouped in Band D (CC2, CC4, CC5, SC2 and WC1) (Table 4). Thus, fewer families of macroinvertebrates than expected were collected from the sites sampled compared to reference sites selected by the AUSRIVAS model (Ransom et al., 2004). Taxon with > 0.85 probability of occurrence but not collected included the Acarina (Water mites) and Veliidae (Small water striders) families at all sites and Leptoceridae (caddis flies) at all sites except Site CC3 (Table 3). Leptophlebiidae (mayflies) family, were expected with > 0.79 probability but not collected at all sites (Table 3).

The SIGNAL2 scores ranged from 2.00 (Site SC2) to 3.09 (CC4) (Table 4). SIGNAL 2 values less than 4 (i.e., at all sites) generally indicate that the macroinvertebrate assemblage is dominated by pollution tolerant taxa (Chessman, 2003).

Table 3. Macroinvertebrate taxa collected using the AUSRIVAS protocol (5 June 2024).

Family	CC1	CC2	CC3	CC4	CC5	SC1	SC2	WC1	WC2
Dugesidae	0	0	0	0	0	0	0	1	0
Hirudinea	1	0	0	0	0	0	0	0	0
Lumbriculidae	0	0	2	0	0	0	0	1	0
Tubificidae	0	0	1	2	4	0	0	2	3
Physidae	19	19	12	2	1	0	0	0	0
Glyptophysa	6	7	1	0	1	0	0	0	0
Hydrobiidae	0	20	20	15	11	0	0	0	1
Bithyniidae	9	0	4	0	4	0	0	10	3
Lymnaeidae	4	0	0	0	2	0	0	0	0
Oniscidae	0	0	0	1	0	0	0	0	0
Atyidae	1	0	3	0	0	1	0	0	0
Isotomidae	0	1	0	0	0	0	0	0	0
Sisyridae	0	0	0	0	0	0	0	1	0
Sphaeriidae	0	0	0	0	0	0	0	3	0
Baetidae	0	0	0	0	0	0	0	0	1
Coenagrionidae	0	0	0	0	0	1	0	2	0
Megapodagrionidae	0	0	0	2	0	0	0	0	0
Libellulidae	1	1	0	0	0	0	0	2	0
Corixidae	2	1	1	1	0	1	2	1	1
Gerridae	0	0	0	5	0	0	0	0	0
Notonectidae	1	0	0	0	0	0	0	0	0
Dytiscidae	2	0	0	0	0	0	0	0	0
Ceratopogonidae	2	0	0	0	0	0	0	0	0
Chironominae	24	2	3	0	0	0	0	0	2
Tanypodinae	19	0	0	0	1	0	0	0	1
Simuliidae	0	0	0	0	0	0	0	0	2
Stratiomyidae	0	0	0	0	0	0	0	0	1
Leptoceridae	0	0	1	0	0	0	0	0	0
Number of Taxa	**13**	**7**	**10**	**7**	**7**	**3**	**1**	**9**	**9**
Gambusia			13			14	7	1	

Table 4. Number of taxa, SIGNAL 2 and AUSRIVAS scores.

Site	No. Taxa	SIGNAL2	OE50	Band
CC1	13	2.43	0.54	B
CC2	7	2.44	0.1	D
CC3	10	2.60	0.29	C
CC	-	-	-	-
CC4	7	3.09	0.1	D
CC5	7	2.50	0.1	D
SC1	3	2.33	0.15	C
SC2	1	2.00	0.07	D
WC1	9	2.73	0	D
WC2	9	2.82	0.21	C

4.0 DISCUSSION

Downstream of the Great Western Highway to the confluence with South Creek, Claremont Creek consisted of pools up to approximately 6 m wide and 1.2 m deep. The active channel bed was composed primarily of silts and clay (as are the banks of the main channel) overlying a mostly gravel bed. Unlike the findings of a recent aquatic ecology survey done during August 2022 (AEI, 2022), the pools were connected by flow. Such a disparity between flows suggests that waterflow is ephemeral with upstream and downstream habitats connected intermittently during periods of high rainfall.

Importantly for this investigation, pools overlying areas experiencing water drawdown were full and there was flow along the creek channel. If water movement between the stream and underlying aquifer have been altered, recent rainfall within the catchment appears to have mitigated any changes to availability of aquatic habitat within the overlying creek channel. The overall condition of aquatic habitats at site's CC2 to CC5 was classified as good, with an RCE score of 25 (48%). The presence of eels (*Anguilla* sp.) indicates that Claremont Creek continues to provide habitat for native species of fish.

Aquatic macroinvertebrate fauna within Claremont Creek continues to be dominated by pollution-tolerant taxa (see AEI, 2022). Low macroinvertebrate indices were not unexpected given historical and continued exposure to multiple stressors (e.g., elevated levels of salinity, nitrogen and excessive algal and aquatic plant growth) that can adversely affect the condition of aquatic habitat. Small numbers of some pollution sensitive taxa were present in the creeks sampled, including mayfly and caddis fly families, but groups within these families (particularly Baetidae) as well as Chironomidae and several freshwater snails and worms that were present, are amongst the most salt-sensitive freshwater macroinvertebrates (Kefford et al., 2003; Rutherford and Kefford, 2005). Sites with high salinity (i.e. CC1 791 to 9,076 µS/cm) could represent localised groundwater seepage points. High salinity commonly recorded within the area is thought to be related to the increased water table recharges due to reduced vegetation water use by land clearing, over irrigation of golf courses, sport fields, parks, gardens, crops and improved pastures, and leakage from farm dams, water supply and stormwater services (DLWC, 1998).

The introduced Mosquito fish (*Gambusia holbrooki*) has also commonly been collected (AEI, 2022), including at the time of the current survey. Predation by Mosquito fish is listed as a Key Threatening Process

because of known effects on frogs, freshwater fishes and other organisms such as aquatic macroinvertebrates.

Importantly,

they were comparable (in direction and magnitude) with those that occurred at the sites sampled in South Creek (GHD, 2016; AEI, 2022). Moreover, macroinvertebrate indices obtained at external control sites sampled within Werrington Creek were similar to those obtained at the Claremont Creek and South Creek sites. No individuals of threatened species, including the Adams emerald dragonfly, Sydney hawk dragonfly, Macquarie Perch or Australian Grayling were observed or collected in net samples within the Study Area.

5.0 CONCLUSIONS & RECOMMENDATIONS

At the time of the current survey, there was no evidence of reductions in the availability and connectivity of aquatic habitat within Claremont Creek related to localised decreases in water table levels. If the observed water draw down is influencing water availability within the Claremont Creek catchment, such impacts have been mitigated by recent rainfall patterns within the catchment. The detection of continued groundwater drawdown should trigger further investigations into the potential impacts on stream flow and subsequent impacts on aquatic ecology.

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