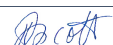



Construction Monitoring Report September 2021 – February 2022

Sydney Metro City & Southwest – Line-wide Works

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1. Introduction

1.1 Project Summary

The Sydney Metro City & Southwest (SMCSW) is the second portion of the new standalone rail network known as the Sydney Metro, which is Australia's largest public transport infrastructure project and a priority rail project for the NSW Government. The project will extend Sydney Metro Northwest to the CBD and beyond to Bankstown. The project is being delivered through a suite of contracts for the tunnels, stations, Line-wide infrastructure and systems. Line-wide is a key component of the SMCSW, with works taking place over the full length of the project as shown in Figure 1 below:

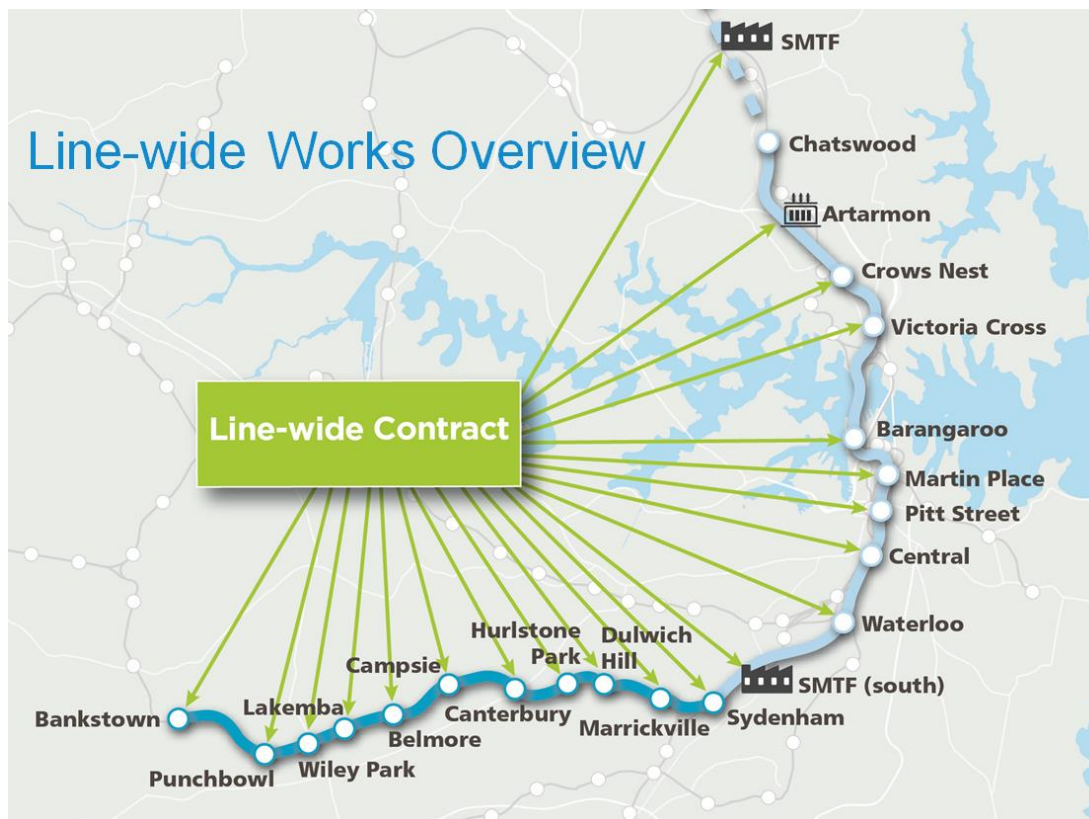


Figure 1: Line-wide Locations

1.2 Planning Approval Requirements

The Sydney Metro Authority received planning approval to construct the project from the Department of Planning, Industry and Environment. The Conditions of Approval CSSI 7400 cover the works from Chatswood to Sydenham and the Conditions of Approval CSSI 8256 cover the works from Marrickville to Bankstown.

A Construction Environmental Management Plan and sub-plans were developed for the project to address all environmental aspects, including construction monitoring. Approval of the plans enabled commencement of construction on 04 March 2020. The plans for the Line-wide works were developed to address the requirements of both planning approvals in each plan or sub-plan. Construction monitoring requirements are detailed in the Soil, Water and Groundwater Management Sub-Plan C2B and the Construction Noise and Vibration Management Plan – C2B. The plans can be accessed at the CPB Sydney Metro City & Southwest Line-wide Works Project website:

<https://www.cpbcon.com.au/en/our-projects/2018/sydney-metro-line-wide-works>

The objectives for this report are to provide construction monitoring results for the fourth 6 months of works on the Line-wide Project, from the start of September 2021 to the end of February 2022. This

report is provided for information to the Department of Planning, Industry and Environment. It is intended to address the requirements of Conditions C16 of CSSI 7400 and C14 of CSSI 8256.

2. Water Quality Monitoring

The Soil, Water and Groundwater Management Sub-Plan C2B requires that water quality monitoring will be undertaken for controlled discharges offsite to watercourses and stormwater drainage to ensure compliance with discharge criteria. The discharge criteria are shown in Table 1 below:

Table 1: Discharge Criteria

Parameter	Measurement and Assessment			Discharge Criteria
	Percentile Concentration Limit	Sample Method & Frequency	Units	
pH	100	Probe/ grab sample Prior to discharge	pH	6.5-8.5
Total Suspended Solids	100	Probe/ grab sample Prior to discharge	mg/L	<50
Oil and Grease	100	Visual Prior to discharge	mg/L	<10 and no visible trace

2.1 Permit to Dewater

Systems Connect have an internal Permit to Dewater system, which ensures compliance with discharge criteria at all times. Monitoring is done prior to each dewatering event. The Systems Connect Permit to Dewater and Water Quality Monitoring Register is provided in Appendix A. This demonstrates that discharge criteria were met for all discharges.

2.2 Water Treatment Plant

On 1 August 2020, Systems Connect took possession of a portion of the Chatswood Dive site from the Tunneling and Station Excavation Contractor. The portion contains the Chatswood Water Treatment Plant, which is now operated by Systems Connect. It collects surface water from the Chatswood Dive site, station box water from Crows Nest station, and tunnel water from between Victoria Cross Station and the Chatswood Dive.

From November 2021, the Water Treatment Plant at Marrickville became operational. This WTP takes water from the tunnels between Central and the Marrickville Dive.

A WTP Checklist is completed by the WTP operator daily (working days), where a range of WTP observations, parameters and chemical levels are noted. This includes water discharge parameters required for regulatory compliance. The compliance results from the checklists completed during the reporting period are described in Table 2 below:

Table 2: WTP Compliance Results

WTP	Date	pH	Turbidity (NTU)	Oil and Grease
Chatswood	01/09/2021 to 28/02/2022	6.8 - 8.4	0.1 - 12.3	None visible
Marrickville	01/09/2021 to 28/02/2022	7.1 - 8.1	0.7 - 8.7	None visible

At each water treatment plant under Systems Connect control, the discharge parameters pH, TSS and NTU are to be sampled monthly. Results demonstrating compliance are provided in Appendix B.

2.3 Receiving Water Monitoring

The Soil, Water and Groundwater Management Sub-Plan C2B requires that monitoring of receiving waters will occur three-monthly, while WTPs are active and in SC control. Monitoring parameters are provided in Table 3 below:

Table 3: Surface Water Quality Parameters

Parameter	Sample Method	Analytical method	ANZECC ^{1, 2} Criteria (freshwater) ⁷	ANZECC ^{1, 3} Criteria (marine water) ⁸	EPL 21423	Trigger Values	Action
Temperature (°C)	Probe	Field Analysis	>80%ile ⁴ <20%ile ⁴			Results are > than the baseline 80th percentile	Environment Coordinators to re-test to confirm results. Environment Coordinator is to undertake an inspection of the Works and propose actions where required Note: There is a delay in receiving the results from grab samples. Environment Coordinator to obtain further grab samples for testing to confirm results. Environment Coordinator to undertake an inspection once results received and establish what activities had been undertaken prior to the tests being undertaken and propose actions where required.
Dissolved Oxygen (%Sat)	Probe	Field Analysis	Lower Limit: 85 Upper Limit: 110	Lower Limit: 90 Upper Limit: 110			
Turbidity (NTU)	Probe	Field Analysis	6-50	0.5-10			
Oil and Grease	Visual analysis, then grab sample if required	Visual Assessment Lab Analysis	-	-	No visible sign of oil and grease	Visible oil and grease	
Conductivity (µS/cm) ⁶	Grab Sample and Probe	Field Analysis Lab Analysis	125 – 2200	-		Results are > than the baseline 80th percentile	
Total Suspended Solids (TSS: mg/L)	Grab Sample	Lab Analysis	-	-	50mg/L		
Iron (mg/L)			0.3 ⁵	-			
Manganese(mg/L)			1.7	0.8			
pH	Grab Sample and Probe	Field Analysis Lab Analysis	Lower Limit: 6.5 Upper Limit: 8.0	Lower Limit: 8.0 Upper Limit: 8.4	6.5 -8.5		

Notes:

¹ 95% protection level – most commonly applied to ecosystems that could be classified as slightly to moderately disturbed.

² ANZECC (2000) guidelines for the protection of freshwater aquatic ecosystems

³ ANZECC (2000) guidelines for the protection of marine aquatic ecosystems

⁴ Default trigger value for each ecosystem-type

⁵ There is insufficient data at this stage to derive a reliable value for iron. The current Canadian guideline has been used.

⁶ Conductivity will not be tested at monitoring points at estuarine/marine catchments.

- No data available

⁷ Applicable to monitoring locations SW-SC-01, SW-FR-02, SW-EC-01

⁸ Applicable to monitoring locations SW-SC-01, SW-FR-02, SW-MP-01, SW-BP-01, SW-B-01, SW-FC-01, SW-AC-01

Only the receiving waters downstream of the Chatswood WTP and Marrickville WTP are applicable for monitoring during this period. All other WTPs are being operated by other Sydney Metro contractors. The two monitoring sites downstream of the Chatswood WTP are both in the Scotts Creek/Middle Harbour Catchment. The sampling point downstream of the Marrickville WTP is in the Alexandra Canal. Sampling points are described in Table 4 below:

Table 4: Sampling Point Information

Site ID	Site interaction	Relative location	Catchment	Sampling address	Easting	Northing	Type
SW-SC-01	Receiving waters from Chatswood WTP discharges.	Downstream	Scotts Creek / Middle Harbour	Muston Park, access via Eden Street, Chatswood	330586	6245923	Freshwater
SW-SC-02	Monitoring location active while the Chatswood WTP is active and in SC control.			Access via North Arm Track, North Arm Road, Chatswood	332788	6246304	Estuarine / Marine
SW-AC-01	Receiving waters from Marrickville WTP discharges. Monitoring location active while the Marrickville WTP is active and in SC control.	Downstream	Alexandra Canal	Access via bicycle track from the end of Coward Street, Mascot	331342	6244783	Estuarine

The results of the receiving water monitoring are provided in Appendix C.

3. Noise and Vibration

The Construction Noise and Vibration Management Plan – C2B includes the Construction Noise and Vibration Monitoring Program. This program requires that the results of construction noise and vibration monitoring will be reported every six months. The results for this monitoring period are included in this report.

3.1 Noise Monitoring

Section 8.1.4 of the CNVMP states that: “Attended monitoring of construction noise levels will be undertaken as follows:

- At the first opportunity following the commencement of construction activity to confirm the effectiveness of actions and measures determined in CNVIS process
- Repeated as described in the CNVIS, as part of the audit cycle to ensure that noise and vibration levels in the adjacent community remain consistent with the predicted levels in the CNVIS
- Where appropriate in response to a noise related complaint(s) (determined on a case-by-case basis)
- During sensitive periods (i.e. night works)
- As directed by an authorised officer of the EPA.

Monitoring would be undertaken at the potentially most exposed receivers in proximity to construction activities. Noise monitoring locations should be consistent with the distances/ locations identified in the CNVIS and will consider factors including:

- The location of previous monitoring sites
- The proximity of the receiver to a worksite
- The sensitivity of the receiver to noise
- Background noise levels
- The expected duration of the impact.”

Summary results of attended noise monitoring conducted by Systems Connect in the reporting period are provided in Appendix D (Systems Connect Noise Monitoring Register), demonstrating compliance with project requirements, including the above extract from the management plan.

Noise monitoring equipment details, including make, model, serial number, last calibration date and NATA testing facility, are provided in Appendix E.

Further details are collected for each field reading, including time, duration, meteorological conditions and extraneous noise sources during reading. Samples of Noise Monitoring Record Sheets are provided in Appendix F. Others are available on request.

3.2 Vibration Monitoring

The Construction Noise and Vibration Management Plan – C2B explains that: “the requirement for real time vibration monitoring will be determined on a site by site basis and identified in the CNVIS for LW worksites between Chatswood and Sydenham. Real time vibration monitoring will be deployed to manage vibration impacts from ‘high risk’ sites, where the CNVIS vibration predictions identify there is a high risk of annoyance (or potential building damage) from construction vibration.”

During the reporting period, there were numerous locations and work campaigns where vibration monitoring was done. Summary results demonstrating compliance with vibration criteria are included in Appendix G (Systems Connect Vibration Monitoring Register).

Samples of Vibration Monitoring Reports are provided in Appendix H. Others are available on request.

Appendix A: Systems Connect Permit to Dewater and Water Quality Monitoring Register

Systems Connect LWW Permit to Dewater and Water Quality Monitoring Register

Permit to Dewater	Date	Location	Detailed Monitoring Location	Single or Continuous	Reason	Discharge Point	Water Quality Analyser	pH	Turbidity NTU	Oil & Grease
Permit to Dewater LWW-127	3/09/2021	Chatswood Dive	Chatswood WTP	Continuous	For discharge approval	Stormwater pit - CD-2	WTP	NA	NA	NA
Permit to Dewater LWW-128	2/09/2021	SMTF	Sediment basin SB1	Single	For discharge approval	Schofields Rd drainage swale	Horiba U-52	7.71	54.2	None visible
Permit to Dewater LWW-129	6/09/2021	Campsie TSS	Campsie TSS 10,000L holding tank	Single	For discharge approval	Trackside drainage swale	Horiba U-52	6.98	12.5	None visible
Permit to Dewater LWW-130	10/09/2021	SMTF-South	Concrete Sump	Single	For discharge approval	Stormwater pit into culvert	Horiba U-52	8.4	46	None visible
Permit to Dewater LWW-131	15/09/2021	SMTF-South	Concrete Sump within building footprint	Single	For discharge approval	Stormwater pit into culvert	Horiba U-52	8.07	66.6	None visible
Permit to Dewater LWW-132	15/09/2021	SMTF-South	Trench adjacent Sth Dive	Single	For discharge approval	Stormwater pit into culvert	Horiba U-52	8.2	42.7	None visible
Permit to Dewater LWW-133	1/10/2021	Chatswood Dive	Chatswood WTP	Continuous	For discharge approval	Stormwater pit - CD-2	WTP	NA	NA	NA
Permit to Dewater LWW-134	8/10/2021	Campsie TSS	Campsie TSS 10,000L holding tank	Single	For discharge approval	Trackside drainage swale	Horiba U-52	8.12	43.3	None visible
Permit to Dewater LWW-135	25/10/2021	Marrickville WTP	Marrickville WTP - Point 2	Single	For discharge approval - Batch Commissioning Phase 1	Stormwater pit into culvert	ALS Lab	8.24	7mg/L (TSS)	None visible
Permit to Dewater LWW-136	27/10/2021	Marrickville WTP	Marrickville WTP - Point 2	Continuous	For discharge approval - Batch Commissioning Phase 2	Stormwater pit into culvert	ALS Lab	7.92	6mg/L (TSS)	None visible
Permit to Dewater LWW-137	21/10/2021	Chatswood Dive	Chatswood WTP	Continuous	For discharge approval	Stormwater pit - CD-2	WTP	NA	NA	NA
Permit to Dewater LWW-138	3/11/2021	Marrickville WTP	Marrickville WTP - Point 2	Continuous	For discharge approval - Batch Commissioning Phase 2	Stormwater pit into culvert	ALS Lab	8.21	<5 mg/L (TSS)	None visible
Permit to Dewater LWW-139	18/11/2021	Campsie TSS	Campsie TSS concrete structure	Single	For discharge approval	Trackside drainage swale	Horiba U-52	8.48	5	None visible
Permit to Dewater LWW-140	10/11/2021	Marrickville WTP	Marrickville WTP - Point 2	Continuous	For discharge approval	Stormwater pit into culvert	WTP	NA	NA	NA
Permit to Dewater LWW-141	22/11/2021	Canterbury TSS	Canterbury TSS open excavation on work site	Single	For discharge approval	Geofab-lined stormwater drain on Hutton Street side of the work site	Horiba U-52	6.65	46	None visible
Permit to Dewater LWW-142	24/11/2021	Chatswood Dive	Chatswood WTP	Continuous	For discharge approval	Stormwater pit - CD-2	WTP	NA	NA	NA
Permit to Dewater LWW-143	10/12/2021	Marrickville WTP	Marrickville WTP - Point 2	Continuous	For discharge approval	Stormwater pit into culvert	WTP	NA	NA	NA
Permit to Dewater LWW-144	15/12/2021	Chatswood Dive	Chatswood WTP	Continuous	For discharge approval	Stormwater pit - CD-2	WTP	NA	NA	NA
Permit to Dewater LWW-145	30/12/2021	Campsie BPS	Cooks Ave Joint Bay	Single	For discharge approval	Roadside stormwater gutter	Horiba U-52	7.9	13.6	None Visible
Permit to Dewater LWW-145	30/12/2021	Campsie BPS	Gould Street Joint Bay	Single	For discharge approval	Roadside stormwater gutter	Horiba U-52	6.79	27.5	None Visible
Permit to Dewater LWW-146	6/01/2022	Campsie BPS	Cooks Ave Joint Bay	Single	For discharge approval	Roadside stormwater gutter	Horiba U-52	7.12	9.3	None Visible
Permit to Dewater LWW-147	10/01/2022	Campsie BPS	Anzac Street Joint Bay	Single	For discharge approval	Roadside stormwater gutter	Horiba U-52	8.09	20.5	None Visible
Permit to Dewater LWW-148	11/01/2022	Campsie BPS	Cooks Ave Joint Bay	Single	For discharge approval	Roadside stormwater gutter	Horiba U-52	6.55	5.2	None Visible
Permit to Dewater LWW-148	11/01/2022	Campsie BPS	Gould Street Joint Bay	Single	For discharge approval	Roadside stormwater gutter	Horiba U-52	7.5	13.1	None Visible
Permit to Dewater LWW-149	10/01/2022	Marrickville WTP	Marrickville WTP - Point 2	Continuous	For discharge approval	Stormwater pit into culvert	WTP	NA	NA	NA
Permit to Dewater LWW-150	19/01/2022	Campsie BPS	Anzac Street Joint Bay	Single	For discharge approval	Roadside stormwater gutter	Horiba U-52	7.09	18.3	None Visible
Permit to Dewater LWW-150	19/01/2022	Campsie BPS	Cooks Ave Joint Bay	Single	For discharge approval	Roadside stormwater gutter	Horiba U-52	7.33	7.9	None Visible
Permit to Dewater LWW-151	24/01/2022	Campsie BPS	Cooks Ave Joint Bay	Single	For discharge approval	Roadside stormwater gutter	Horiba U-52	7.23	24.8	None Visible
Permit to Dewater LWW-152	31/01/2022	Campsie BPS	Gould Street Comms Pit	Single	For discharge approval	Roadside stormwater gutter	Horiba U-52	7.71	8.5	None Visible
Permit to Dewater LWW-152	31/01/2022	Campsie BPS	Gould Street Comms Pit	Single	For discharge approval	Roadside stormwater gutter	Horiba U-52	7.91	17	None Visible
Permit to Dewater LWW-153	2/02/2022	Campsie BPS	Anzac Street Joint Bay	Single	For discharge approval	Roadside stormwater gutter	Horiba U-52	8.3	22	None Visible
Permit to Dewater LWW-154	2/02/2022	Chatswood Dive	Chatswood WTP	Continuous	For discharge approval	Stormwater pit - CD-2	WTP	NA	NA	NA
Permit to Dewater LWW-155	10/02/2022	Marrickville WTP	Marrickville WTP - Point 2	Continuous	For discharge approval	Stormwater pit into culvert	WTP	NA	NA	NA
Permit to Dewater LWW-156	11/02/2022	Campsie BPS	Cooks Ave Joint Bay	Single	For discharge approval	Roadside stormwater gutter	Horiba U-52	7.8	12.5	None visible
Permit to Dewater LWW-156	11/02/2022	Campsie BPS	Anzac Street Joint Bay	Single	For discharge approval	Roadside stormwater gutter	Horiba U-52	7.05	9.8	None visible
Permit to Dewater LWW-159	23/02/2022	Southern Dive	N/A	Continuous	For discharge approval	Stormwater Drain adjacent Gate E2	NA	NA	NA	None Visible

Appendix B: Monthly WTP Sampling

Monthly Water Quality Monitoring - Chatswood WTP

CHW2 Discharge point

Date	Time	Sample ID	pH	Total Suspended Solids (mg/L)	Turbidity (NTU)
24/09/2021	11:00	CHW2	7.35	12	4.2
21/10/2021	10:00	CHW2	7.19	27	11.8
26/11/2021	11:15	CHW2	7.71	12	8.6
15/12/2021	10:40	CHW2	7.27	10	2.2
25/01/2022	11:57	CHW2	7.43	8	1.9
18/02/2022	11:30	CHW2	7.43	6	2

Monthly Water Quality Monitoring - Marrickville WTP

MKV-O Discharge point

Date	Time	Sample ID	pH	Total Suspended Solids (mg/L)	Turbidity (NTU)
24/11/2021	8:00:00 AM	MKV-O	8.14	<5	0.6
20/12/2021	9:10:00 AM	MKV-O	8.16	5	0.5
20/01/2022	8:30:00 AM	MKV-O	8.07	<5	0.4
21/02/2022	9:15:00 AM	MKV-O	8.14	9	4.9

Appendix C: Receiving Water Monitoring Results

Quarterly Surface Water Quality Monitoring - Chatswood

			Field Results						Lab Results				
Date	Time	Sample ID	Temperature (C)	Dissolved Oxygen (%)	Turbidity (NTU)	Conductivity (µS/cm)	pH	Oil & Grease (Y/N)	Total Suspended Solids (mg/L)	Iron (Fe)	Manganese (Mn)	pH	Oil & Grease (mg/L)
21/10/2021	11:00:00 AM	SW-SC-01	15.71	265	4.2	1300	8	N	7	<0.05	0.004	7.52	Not tested
21/10/2021	11:20:00 AM	SW-SC-02	18.31	157.3	4.5	42700	7.74	N	8	<0.10	0.012	7.73	Not tested
15/12/2021	12:30:00 PM	SW-SC-01	21.69	85.5	1.4	1090	7.34	N	6	<0.05	0.002	7.31	Not tested
15/12/2021	12:50:00 PM	SW-SC-02	21.77	85.2	0	5260	7.38	N	5	0.08	0.013	7.43	Not tested

Quarterly Surface Water Quality Monitoring - Marrickville

			Field Results						Lab Results				
Date	Time	Sample ID	Temperature (C)	Dissolved Oxygen (%)	Turbidity (NTU)	Conductivity (µS/cm)	pH	Oil & Grease (Y/N)	Total Suspended Solids (mg/L)	Iron (Fe)	Manganese (Mn)	pH	Oil & Grease (Y/N)
20/01/2022	8:01:00 AM	SW-AC-01	28.71	68.4	20.2	33100	7.62	N	27	0.07	0.024	7.09	Not tested

Appendix D: Systems Connect Noise Monitoring Register

Systems Connect LWW Noise Monitoring Register

Date	Location	Detailed Monitoring Location	NCA	Predicted Noise Level	Measured L _{Aeq}	Comments
2/09/2021	Blues Point Temporary Site	14-28 Blues Point Road, McMahon's Point (Blues Point Tower)	BP_01	61	55	LW works compliant
2/09/2021	Blues Point Temporary Site	Intersection of Blues Point Road and Henry Lawson Avenue (representing 1 Warung Street), McMahon's Point	BP_02	53	53	LW works compliant
2/09/2021	Blues Point Temporary Site	2-4 East Crescent Street, McMahon's Point	BP_02	41	47	LW works compliant, wind noise dominant
2/09/2021	Blues Point Temporary Site	1A Henry Lawson Avenue	BP_02	52	48	LW works compliant
2/09/2021	Blues Point Temporary Site	14-28 Blues Point Road, McMahon's Point (Blues Point Tower)	BP_01	<35	49	No LW activities - background noise measured
2/09/2021	Blues Point Temporary Site	Intersection of Blues Point Road and Henry Lawson Avenue (representing 1 Warung Street), McMahon's Point	BP_02	36	44	No LW activities - background noise measured
2/09/2021	Blues Point Temporary Site	1A Henry Lawson Avenue	BP_02	42	47	No LW activities - background noise measured
9/09/2021	Blues Point Temporary Site	14-28 Blues Point Road, McMahon's Point (Blues Point Tower)	BP_01	61	55	LW works compliant
9/09/2021	Blues Point Temporary Site	Intersection of Blues Point Road and Henry Lawson Avenue (representing 1 Warung Street), McMahon's Point	BP_02	53	49	LW works compliant
9/09/2021	Blues Point Temporary Site	2-4 East Crescent Street, McMahon's Point	BP_02	41	44	LW works compliant, background noise dominant
9/09/2021	Blues Point Temporary Site	1A Henry Lawson Avenue	BP_02	52	50	LW works compliant
9/09/2021	Blues Point Temporary Site	1A Henry Lawson Avenue	BP_02	42	47	No LW activities - background noise measured
9/09/2021	Blues Point Temporary Site	Intersection of Blues Point Road and Henry Lawson Avenue (representing 1 Warung Street), McMahon's Point	BP_02	36	42	No LW activities - background noise measured
9/09/2021	Blues Point Temporary Site	14-28 Blues Point Road, McMahon's Point (Blues Point Tower)	BP_01	<35	45	No LW activities - background noise measured
10/09/2021	Canterbury TSS	6 Hutton Street, Hurlstone Park	S2B_03		75	Daytime noise monitoring in response to a complaint. Noise mats installed after monitoring.
10/09/2021	Canterbury TSS	30 Hurlstone Avenue, Hurlstone Park	S2B_03		72	Daytime noise monitoring in response to a complaint. Noise mats installed after monitoring.
10/09/2021	Canterbury TSS	1 Canberra Street, Hurlstone Park	S2B_04		70	Daytime noise monitoring in response to a complaint. Noise mats installed after monitoring.
11/09/2021	Crows Nest Station	400 Pacific Highway, Crows Nest	NC_04		71.4	LW works compliant, daytime reading, traffic noise dominant
11/09/2021	Crows Nest Station	368 Pacific Highway, Crows Nest	NC_04		77	LW works compliant, daytime reading, traffic noise dominant
11/09/2021	Crows Nest Station	348 Pacific Highway, Crows Nest	NC_04		80	LW works compliant, daytime reading, traffic noise dominant
11/09/2021	Crows Nest Station	473 Pacific Highway, Crows Nest	NC_03		75.3	LW works compliant, daytime reading, traffic noise dominant
13/09/2021	Canterbury TSS	6 Hutton Street, Hurlstone Park	S2B_03		77	Daytime reading. LW works compliant
13/09/2021	Canterbury TSS	30 Hurlstone Avenue, Hurlstone Park	S2B_03		74	Daytime reading. LW works compliant
13/09/2021	Canterbury TSS	6 Hutton Street, Hurlstone Park	S2B_03		76	Daytime reading. LW works compliant
20/09/2021	Pitt St. Station	24-48 Park St, Sydney NSW 2000	R5	78	69	LW works compliant
20/09/2021	Pitt St. Station	169 Castlereagh St, Sydney NSW 2000	R4	78	64	LW works compliant
20/09/2021	Pitt St. Station	24-48 Park St, Sydney NSW 2000	R5	71	67	LW works compliant
22/09/2021	Canterbury TSS	6 Hutton Street, Hurlstone Park	S2B_03		72	Daytime reading. LW works compliant
5/10/2021	Campsie TSS	2 Thorncraft Parade	S2B_06	90	62.1	LW works compliant
5/10/2021	Campsie TSS	9 Thorncraft Parade	S2B_07	65	65.8	LW works compliant. Traffic and wind contribution.
5/10/2021	Campsie TSS	5 Thorncraft Parade	S2B_07	65	64.8	LW works compliant
6/10/2021	Campsie TSS	57 Anglo Road, Campsie	S2B_06	90	71	LW works compliant
6/10/2021	Crows Nest Station	400 Pacific Highway, Crows Nest	NC_04	66	70.3	LW works compliant, traffic noise dominant
6/10/2021	Crows Nest Station	368 Pacific Highway, Crows Nest	NC_04	63	74.6	LW works compliant, traffic noise dominant
6/10/2021	Crows Nest Station	348 Pacific Highway, Crows Nest	NC_04	58	72.5	LW works compliant, traffic noise dominant
7/10/2021	Crows Nest Station	368 Pacific Highway, Crows Nest	NC_04	63	74.7	LW works compliant, traffic noise dominant
7/10/2021	Crows Nest Station	348 Pacific Highway, Crows Nest	NC_04	58	71.9	LW works compliant, traffic noise dominant
7/10/2021	Crows Nest Station	473 Pacific Highway, Crows Nest	NC_03	62	71.4	LW works compliant, traffic noise dominant
8/10/2021	BPS Artarmon	19 Barton Road, Artarmon	AS_01	67	63.5	LW works compliant, traffic noise dominant
8/10/2021	BPS Artarmon	19 Barton Road, Artarmon	AS_01	67	60.1	LW works compliant, traffic noise dominant
8/10/2021	BPS Artarmon	19 Barton Road, Artarmon	AS_01	67	63.3	LW works compliant, traffic noise dominant
12/10/2021	Northern Connection	13 Drake Street, Artarmon	CDS_05	68	61	LW works compliant
12/10/2021	Northern Connection	14 Raleigh Street, Artarmon	CDS_05	66	48	LW works compliant
12/10/2021	Northern Connection	340 A Mowbray Road, Artarmon	CDS_06	55	52	LW works compliant
15/10/2021	Campsie TSS	64 Anglo Road, Campsie	S2B_06	75	74.5	LW works compliant
15/10/2021	Campsie TSS	33 Loch Street, Campsie	S2B_06	65	69.4	LW works compliant, traffic noise dominant
15/10/2021	Campsie TSS	39 Loch Street, Campsie	S2B_06	70	66.5	LW works compliant
16/10/2021	Campsie TSS	48 Lilian Street, Campsie	S2B_06	75	66	LW works compliant
16/10/2021	Campsie TSS	50 Lilian Street, Campsie	S2B_06	73	63	LW works compliant
16/10/2021	Dulwich Hill TSS	18 Randall Street, Marrickville	S2B_02	69	56	LW works compliant
16/10/2021	Dulwich Hill TSS	41 Challis Avenue, Dulwich Hill	S2B_02	80	61	LW works compliant

Systems Connect LWW Noise Monitoring Register

Date	Location	Detailed Monitoring Location	NCA	Predicted Noise Level	Measured L _{Aeq}	Comments
16/10/2021	Canterbury TSS	6/24 Hutton Street, Hurlstone Park	S2B_04	71	53	LW works compliant
16/10/2021	Canterbury TSS	8 Hutton Street, Hurlstone Park	S2B_03	74	64	LW works compliant
16/10/2021	Canterbury TSS	27 Hurlstone Avenue, Hurlstone Park	S2B_03	72	64	LW works compliant
16/10/2021	Canterbury TSS	1 Canberra Street, Hurlstone Park	S2B_04	73	67	LW works compliant
17/10/2021	Southwest Corridor HV Cabling	21 South Parade, Campsie	S2B_05	56	54	LW works compliant
17/10/2021	Southwest Corridor HV Cabling	32 South Parade, Campsie	S2B_05	51	55	Additional mitigation to be implemented following monitoring outcome (noise blankets to be used).
22/10/2021	Campsie TSS	49-51 Anglo Street, Campsie, on Lillian Street	S2B_06		57	Daytime reading. LW works compliant
27/10/2021	Barangaroo	1 - 5 Towns Place Millers Point	BN_02	80	74.5	LW works compliant
27/10/2021	Barangaroo	56 - 56A High street, Millers Point	BN_03	55	50.1	LW works compliant
27/10/2021	Barangaroo	56 - 56A High street, Millers Point	BN_02	55	52.8	LW works compliant
27/10/2021	Barangaroo	1 - 5 Towns Place Millers Point	BN_03	69	69.8	Adjustments made to LW work methodology following noise monitoring.
6/11/2021	Northern Connection	13 Drake Street, Artarmon	CDS_05	67	56	LW works compliant
6/11/2021	Northern Connection	12 Drake Street, Artarmon	CDS_05	70	55	LW works compliant
6/11/2021	Northern Connection	14 Hawkins Street, Artarmon	CDS_05	71	55	LW works compliant
6/11/2021	Northern Connection	11 Hawkins Street, Artarmon	CDS_05	69	59	LW works compliant
6/11/2021	Northern Connection	12 Hopetoun Avenue, Artarmon	CDS_04	76	73	LW works compliant
12/11/2021	Waterloo Station	130 Wellington Street, Waterloo	RES-5	60	58	LW works compliant
12/11/2021	Waterloo Station	213 Cope Street, Waterloo	RES-1	60	58	LW works compliant
12/11/2021	Waterloo Station	72 Botany Road, Alexandria	RES-3	60	67	LW works compliant, traffic noise dominant
12/11/2021	Waterloo Station	130 Wellington Street, Waterloo	RES-5	60	59	LW works compliant
12/11/2021	Waterloo Station	213 Cope Street, Waterloo	RES-1	60	60	LW works compliant
12/11/2021	Waterloo Station	72 Botany Road, Alexandria	RES-3	60	68	LW works compliant, traffic noise dominant
15/11/2021	Southern Dive	76 Unwins Bridge Road, Marrickville	MDS_04	59	67	LW works compliant, traffic noise dominant
15/11/2021	Southern Dive	76 Unwins Bridge Road, Marrickville	MDS_04	59	70	LW works compliant, traffic noise dominant
15/11/2021	Southern Dive	76 Unwins Bridge Road, Marrickville	MDS_04	59	65	LW works compliant, traffic noise dominant
16/11/2021	Barangaroo Station	6 Argyle Place, Millers Point	BN_02	55	58.3	LW works compliant, traffic noise dominant
16/11/2021	Barangaroo Station	2 High Street, Millers Point	BN_03	50	48.3	LW works compliant
1/12/2021	Central Station	30 Chalmers Street, Surry Hills	CS_G	50	62	LW works compliant, light rail/train noise dominant
1/12/2021	Central Station	31 Chalmers Street, Surry Hills	CS_E	50	62	LW works compliant, light rail/train noise dominant
18/12/2021	Northern Connection	13 Drake Street, Artarmon	CDS_05	66	60	LW works compliant
18/12/2021	Northern Connection	12 Drake Street, Artarmon	CDS_05	74	62	LW works compliant
18/12/2021	Northern Connection	9 Hawkins Stree, Artarmon	CDS_05	69	51	LW works compliant
18/12/2021	Northern Connection	14 Hawkins Street, Artarmon	CDS_05	77	53	LW works compliant
18/12/2021	Northern Connection	14 Raleigh Street, Artarmon	CDS_05	62	67	LW works compliant, traffic noise dominant
18/12/2021	Lakemba TSS	14 The Boulevard, Lakemba	S2B_08	69	63	LW works compliant
18/12/2021	Lakemba TSS	15 Railway Parade, Lakemba	S2B_08	69	60	LW works compliant
18/12/2021	Lakemba TSS	14 Railway Parade, Lakemba	S2B_08	68	62	LW works compliant
31/12/2021	BPS Campsie	17 Gould Street	S2B_05	66	52.4	LW works compliant
31/12/2021	BPS Campsie	14 Gould Street	S2B_05	70	52.7	LW works compliant
31/12/2021	Dulwich Hill TSS	20 Randall Street, Marrickville	S2B_02	62	53.8	LW works compliant
31/12/2021	Dulwich Hill TSS	27 Albermarlie Street, Marrickville	S2B_02	53	45.4	LW works compliant
31/12/2021	Dulwich Hill TSS	41 Challis Avenue, Dulwich Hill	S2B_02	63	51.3	LW works compliant
3/02/2022	Barangaroo Laydown	70-70A High Street, Millers Point	BN_03	50	56.6	LW works compliant, traffic noise dominant
3/02/2022	Barangaroo Laydown	70-70A High Street, Millers Point	BN_03	50	52.5	LW works compliant, traffic noise dominant
3/02/2022	Barangaroo Laydown	70-70A High Street, Millers Point	BN_03	50	55.6	LW works compliant, traffic noise dominant
5/02/2022	Campsie TSS	52 Lillian Street, Campsie	S2B_06	69	67	LW works compliant
5/02/2022	Campsie TSS	54 Lillian Street, Campsie	S2B_06	71	69	LW works compliant
5/02/2022	Campsie TSS	49-51 Anglo Road, Campsie	S2B_06	70	64	LW works compliant
5/02/2022	Campsie TSS	50 Lillian Street, Campsie	S2B_06	69	61	LW works compliant
5/02/2022	Campsie TSS	54 Campsie Street, Campsie	S2B_06	56	56	LW works compliant
5/02/2022	Southwest Corridor HV Cabling	43 Marrickville Road, Marrickville	MDS_01	36	66	LW works compliant, traffic noise dominant

Systems Connect LWV Noise Monitoring Register

Date	Location	Detailed Monitoring Location	NCA	Predicted Noise Level	Measured L_{Aeq}	Comments
5/02/2022	Southwest Corridor HV Cabling	133 Meeks Road, Marrickville	MDS_01	53	55	LW works compliant, traffic noise dominant
5/02/2022	Southwest Corridor HV Cabling	129 Meeks Road, Marrickville	MDS_01	50	52	LW works compliant, traffic noise dominant
14/02/2022	Crows Nest Station	402 Pacific Highway	NCA A	54	72.6	LW works compliant, traffic noise dominant
14/02/2022	Crows Nest Station	545 Pacific Highway	NCA B	63	64	LW works compliant, traffic noise dominant
14/02/2022	Crows Nest Station	35 Hume Street	NCA D	60	59.4	Traffic noise dominant
14/02/2022	Crows Nest Station	402 Pacific Highway	NCA A	51	68.4	LW works compliant, traffic noise dominant
14/02/2022	Crows Nest Station	545 Pacific Highway	NCA B	60	58.7	LW works compliant
14/02/2022	Crows Nest Station	35 Hume Street	NCA D	50	52.9	LW works compliant, traffic noise dominant
26/02/2022	Artarmon TSS	19 Barton Road, Artarmon	AS_01	55	64	LW works compliant, traffic noise dominant
26/02/2022	Artarmon TSS	19 Barton Road, Artarmon	AS_01	55	62	LW works compliant, traffic noise dominant

Appendix E: Noise Monitoring Equipment Details

RION Tracking and Calibration Records

Bag No.	Make	Model	Device Serial Number	Portable Calibrator Serial Number	Previous Calibration Date	External Calibration Date 2021	Place of Calibration 2020
1	RION	NL-42	00509242		15/07/2020	7/09/2021	Acoustic Research Lab
		NC-75 - Portable Calibrator		34202225	13/07/2020	7/09/2021	Acoustic Research Lab
2	RION	NL-42	01000278		Purchased 18/03/2021	18/03/2021	Acoustic Research Lab
		NC-75 - Portable Calibrator		34212953	Purchased 18/03/2021	18/03/2021	Acoustic Research Lab
3	RION	NL-42	00269685		24/07/2020	9/07/2021	Acoustic Research Lab
		NC-75 - Portable Calibrator		00970021	24/07/2020	8/07/2021	Acoustic Research Lab
4	RION	NL-42	00469907		24/07/2020	27/07/2021	Acoustic Research Lab
		NC-75 - Portable Calibrator		34502426	15/07/2020	27/07/2021	Acoustic Research Lab
5	RION	NL-21	00877037		11/09/2020	11/09/2021	Acu-Vib Electronics
	Pulsar	100B - Portable Calibrator		42184	11/09/2020	11/09/2021	Acu-Vib Electronics

Appendix F: Noise Monitoring Record Sheet Samples

Noise Monitoring Record Sheet

DATE:	02-September-2021	MAIN ACTIVITY	Blues Point HV and Materials Delivery
CONDUCTED BY:	Raihan Zhafranata	LOCATION OF WORKS:	Within the Blues Point Site
METEROLOGICAL CONDITIONS:	Clear sky; air temperature 18.9°C, wind speed 1-3 m/s, very windy; relative humidity 68%		
DAY, EVENING OR NIGHT PERIOD?	Evening and Night period		
MAKE / MODEL:	XL2	SERIAL NUMBER:	A2A-02386-D2
TIME WEIGHTING:	FAST / SLOW	FREQUENCY WEIGHTING:	A / C / FLAT
FIELD CALIBRATION:	94	POST CALIBRATION CHECK:	94.1
COMMUNITY NOTIFICATIONS GONE OUT FOR THE WORKS?		YES / NO	
LIGHT SPILL into residences?	No (potential light spill into residences at Blues Point Tower)		
Are noise mitigation measures installed?	Yes (acoustic shed)		

MONITORING LOCATION 1				
LOCATION:	14-28 Blues Point Road, McMahon's Point (Blues Point Tower)			
ACTIVITIES:	Truck deliveries, forklift movement, crane and alimak activities			
PLANT:	Trucks, 8T forklift, 130T crane and Alimak			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
20:28	20:55	49	54	BP_01
L_{aeq}	L_{max}	L_{min}	L_{A10}	L_{A90}
55	78	45	57	50
PREDICTED NOISE LEVEL (dBA):		61		
LAeq ABOVE PREDICTED NOISE LEVEL:		-6.5		
Measured Construction Contribution (dBA)		54.5		
Measured Construction Contribution Above Predicted Noise Level		-6.5		
MONITORING COMMENTS	20:28 Truck coming down Blues Point Road to enter the BP site 20:28 Bus pass by 20:29 Truck idling on site 20:31 Truck door slam 20:37 Forklift unloading 20:38 Forklift dropping an object 20:39 Forklift reversing 20:40 Forklift reversing 20:41 Forklift reversing 20:42 Forklift reversing 20:42 Bus Pass by 20:43 Forklift moving around the site 20:44 Forklift reversing 20:45 Motorcycle pass by 20:50 Truck reversing 20:50 Truck reversing 20:51 Truck leaving the site 20:54 Alimak 20:55 Alimak			

MONITORING LOCATION 2				
LOCATION:	Intersection of Blues Point Road and Henry Lawson Avenue (representing 1 Warung Street), McMahon's Point			
ACTIVITIES:	Truck deliveries, forklift movement and alimak activities			
PLANT:	Trucks, 8T forklift and Alimak			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
21:03	21:18	49	54	BP_02
L _{aeq} (dBA)	L _{max} (dBA)	L _{min} (dBA)	L _{A10} (dBA)	L _{A90} (dBA)
53	73	41	55	44
PREDICTED NOISE LEVEL (dBA):		53		
L _{aeq} ABOVE PREDICTED NOISE LEVEL:		0.0		
Measured Construction Contribution (dBA)		53.0		
Measured Construction Contribution Above Predicted Noise Level			0.0	
MONITORING COMMENTS	21:03 Alimak 21:03 Forklift reversing 21:05 Car pass by 21:06 Truck entering the BP site 21:06 Truck idling on site 21:08 Workers talking 21:08 Car pass by 21:11 Car pass by 21:12 Car pass by 21:13 Motorcycle pass by 21:13 Forklift reversing 21:14 Forklift reversing 21:14 Bus pass by 21:15 Car pass by 21:15 Forklift reversing 21:16 Forklift reversing 21:17 Forklift engine revving 21:17 Motorcycle pass by 20:18 Bus pass by			

MONITORING LOCATION 3				
LOCATION:	2-4 East Crescent Street, McMahon's Point			
ACTIVITIES:	Truck deliveries, forklift movement, crane and alimak activities			
PLANT:	8T forklift			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
21:23	21:40	49	54	BP_02
L _{aeq} (dBA)	L _{max} (dBA)	L _{min} (dBA)	L _{A10} (dBA)	L _{A90} (dBA)
47	70	40	50	43
PREDICTED NOISE LEVEL (dBA):		41		
L _{aeq} ABOVE PREDICTED NOISE LEVEL:		6.0		
Measured Construction Contribution (dBA)		N/A		
Measured Construction Contribution Above Predicted Noise Level			N/A	
MONITORING COMMENTS	21:26 Forklift reversing 21:30 Train pass by 21:31 Police siren 21:33 Car pass by 21:34 Pedestrian talking on the phone Note that it was very windy during this measurement, which resulted in higher ambient noise levels. Construction noise was inaudible during the measurement (except for the forklift quackers reverse alarm, which was barely audible from time to time when there is no wind). As a result, the measured construction contribution could not be determined.			

MONITORING LOCATION 4				
LOCATION:	1A Henry Lawson Avenue			
ACTIVITIES:	Truck deliveries, forklift movement, crane and alimak activities			
PLANT:	Trucks, 130T crane and Alimak			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
21:46	22:00	49	54	BP 02
L _{aeq} (dBA)	L _{max} (dBA)	L _{min} (dBA)	L _{A10} (dBA)	L _{A90} (dBA)
48	63	42	51	45
PREDICTED NOISE LEVEL (dBA):		52		
L _{aeq} ABOVE PREDICTED NOISE LEVEL:		-4.0		
Measured Construction Contribution (dBA)		48.0		
Measured Construction Contribution Above Predicted Noise Level			-4.0	
MONITORING COMMENTS	21:46 Bus pass by 21:46 Crane operating 21:48 Alimak operating 21:49 Crane operating 21:50 Crane operating 21:51 Alimak operating 21:52 Crane operating 21:53 Pedestrian pass by 21:56 Train pass by 21:57 Car pass by 21:58 Truck leaving the site 21:59 Ferry pass by			

MONITORING LOCATION 5				
LOCATION:	14-28 Blues Point Road, McMahon's Point (Blues Point Tower)			
ACTIVITIES:	No construction activities during this measurement			
PLANT:	No construction activities were audible during this measurement			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
22:03	22:18	40	45	BP_01
L _{aeq} (dBA)	L _{max} (dBa)	L _{min} (dBA)	L _{A10} (dBA)	L _{A90} (dBA)
49	68	42	52	44
PREDICTED NOISE LEVEL (dBA):		<35		
L _{aeq} ABOVE PREDICTED NOISE LEVEL:		N/A		
Measured Construction Contribution (dBA)		N/A		
Measured Construction Contribution Above Predicted Noise Level			N/A	
MONITORING COMMENTS	22:07 Train pass by 22:11 Train pass by 22:15 Train pass by Note that there were no audible construction activities during this measurement.			
	It can be seen that the measured L _{Aeq} was 49dB. This was the ambient noise level at Blues Point (including wind noise, road and rail traffic noise, harbour noise and suburban sounds). Construction noise was inaudible during the measurement.			

MONITORING LOCATION 6				
LOCATION:	Intersection of Blues Point Road and Hentry Lawson Avenue (representing 1 Warung Street), McMahon's Point			
ACTIVITIES:	Light vehicle entering the site			
PLANT:	Light vehicle			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
22:22	22:38	40	45	BP_02
L _{aeq} (dBA)	L _{max} (dBa)	L _{min} (dBA)	L _{A10} (dBA)	L _{A90} (dBA)
44	67	37	47	40
PREDICTED NOISE LEVEL (dBA):		36		
Laeq ABOVE PREDICTED NOISE LEVEL:		8.0		
Measured Construction Contribution (dBA)		N/A		

Measured Construction Contribution Above Predicted Noise Level		N/A
MONITORING COMMENTS	22:23 Bus pass by 22:27 Train pass by 22:27 Ute entering the BP site 22:27 Traffic controller closing the gate 22:28 Car pass by 22:29 Ute idling on site 22:32 Car pass by 22:34 Car pass by 22:36 Train pass by Note that it was very windy during this measurement, which resulted in higher ambient noise levels. Construction noise was inaudible during the measurement. The construction vehicle movement and gate closure was visibly observed, and was audible for less than one minute during the measurement period.	

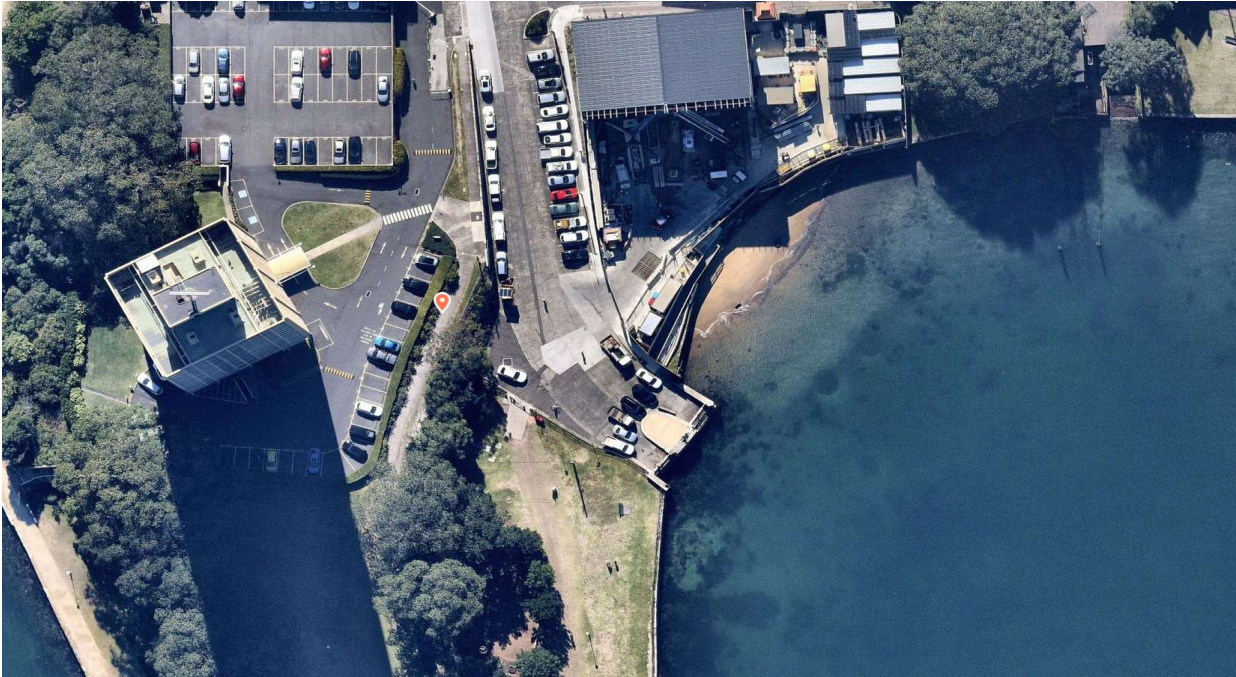
MONITORING LOCATION 7				
LOCATION:	1A Henry Lawson Avenue			
ACTIVITIES:	Light vehicle leaving the site			
PLANT:	Light vehicle			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
22:45	23:00	40	45	BP_02
L _{aeq} (dBA)	L _{max} (dBA)	L _{min} (dBA)	L _{A10} (dBA)	L _{A90} (dBA)
47	57	40	49	43
PREDICTED NOISE LEVEL (dBA):		42		
L _{aeq} ABOVE PREDICTED NOISE LEVEL:		5.0		
Measured Construction Contribution (dBA)		N/A		
Measured Construction Contribution Above Predicted Noise Level		N/A		
MONITORING COMMENTS	22:46 Ute leaving the site 22:47 Bus pass by 22:48 Police car pass by 22:49 Train pass by 22:51 Ferry pass by 22:53 Train pass by 22:56 Train pass by 22:58 Pedestrian talking 22:59 Ferry pass by Note that it was very windy during this measurement, which resulted in higher ambient noise levels. Construction noise was inaudible during the measurement. The construction vehicle movement was visibly observed, but this was barely audible over the ambient noise level during the emasurement period.			

Location 1 & 5

DIAGRAMS AND PHOTOS

Insert:

- Photo of works being monitored
- Map showing monitoring location or Screenshot of GPS Location

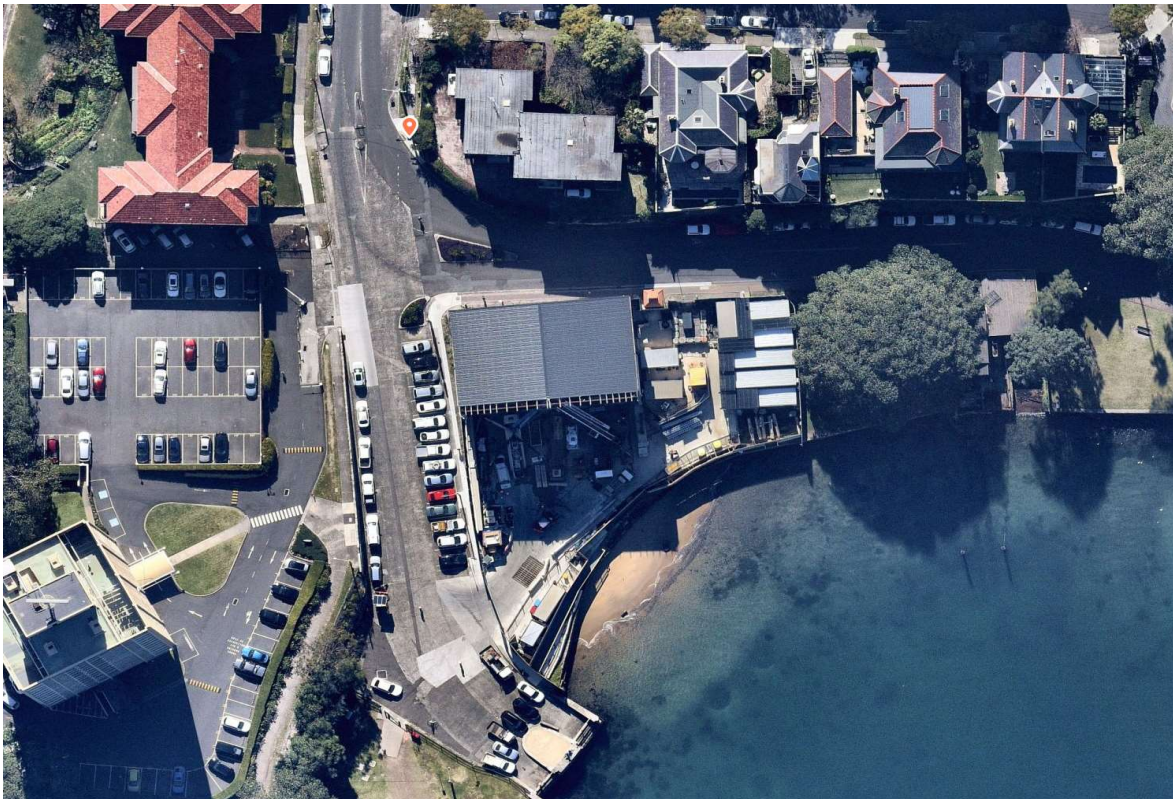


Location 2 & 6

DIAGRAMS AND PHOTOS

Insert:

- Photo of works being monitored
- Map showing monitoring location or Screenshot of GPS Location



Location 3

DIAGRAMS AND PHOTOS

Insert:

- Photo of works being monitored
- Map showing monitoring location or Screenshot of GPS Location

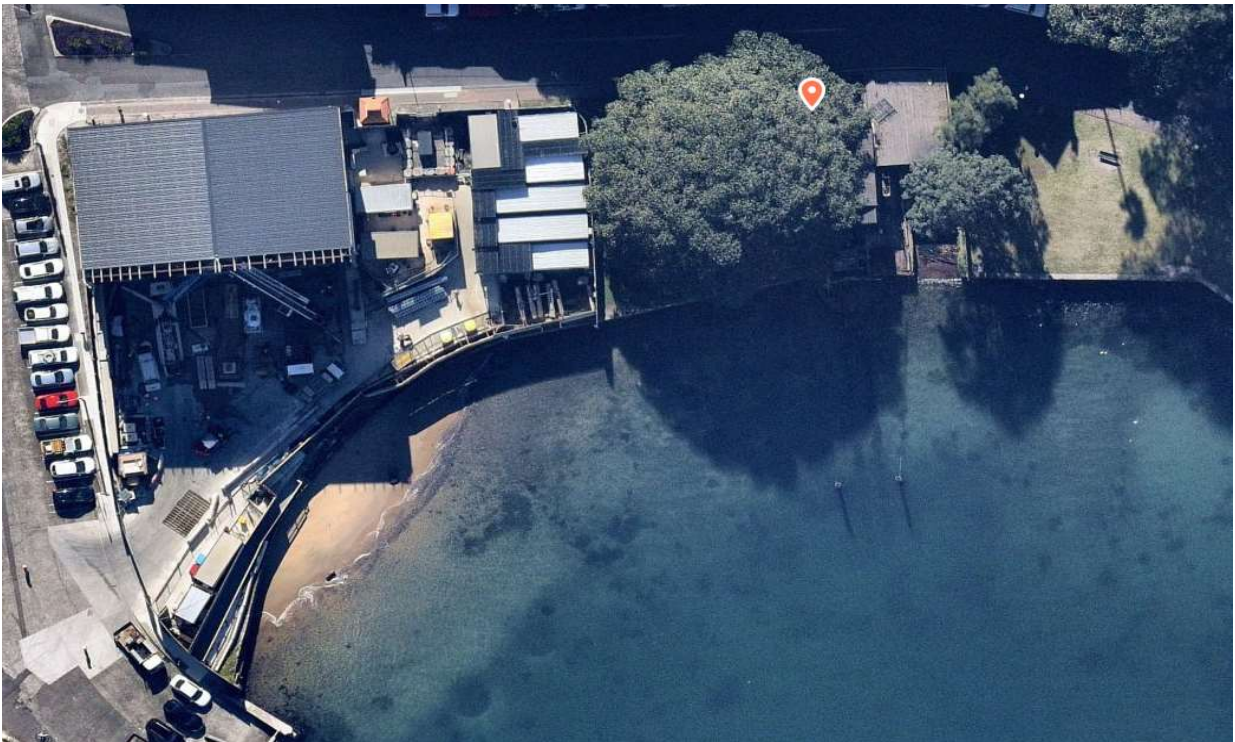


Location 4 & 7

DIAGRAMS AND PHOTOS

Insert:

- Photo of works being monitored
- Map showing monitoring location or Screenshot of GPS Location



Noise Monitoring Record Sheet

DATE:	09-September-2021	MAIN ACTIVITY	Blues Point HV and Materials Delivery
CONDUCTED BY:	Raihan Zhafranata	LOCATION OF WORKS:	Within the Blues Point Site
METEROLOGICAL CONDITIONS:	Clear sky; air temperature 22.8°C, wind speed <5 m/s, relative humidity 68%		
DAY, EVENING OR NIGHT PERIOD?	Evening and Night period		
MAKE / MODEL:	XL2	SERIAL NUMBER:	A2A-02386-D2
TIME WEIGHTING:	FAST / SLOW	FREQUENCY WEIGHTING:	A / C / FLAT
FIELD CALIBRATION:	93.9	POST CALIBRATION CHECK:	94
COMMUNITY NOTIFICATIONS GONE OUT FOR THE WORKS?		YES / NO	
LIGHT SPILL into residences?	No (potential light spill into residences at Blues Point Tower)		
Are noise mitigation measures installed?	Yes (acoustic shed)		

MONITORING LOCATION 1				
LOCATION:	14-28 Blues Point Road, McMahon's Point (Blues Point Tower)			
ACTIVITIES:	Forklift movement, crane and alimak activities			
PLANT:	8T forklift, 130T crane and Alimak			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
19:49	20:05	49	54	BP_01
L _{aeq}	L _{max}	L _{min}	L _{A10}	L _{A90}
55	76	44	59	48
PREDICTED NOISE LEVEL (dBA):		61		
LAeq ABOVE PREDICTED NOISE LEVEL:		-6.5		
Measured noise level with no construction activity (if applicable)				
MONITORING COMMENTS	19:49 Alimak (LAF 56) 19:50 Crane (LAF 60) 19:51 Crane (LAF 60) 19:53 Crane (LAF 60) 19:55 Car pass by (LAF 60) 19:57 Dropped material in the bottom of the shaft (LAF 63) 19:58 Alimak (LAF 60) 19:59 Pedestrian talking on the phone (LAF 62) 20:00 Motorcycle pass by (LAF 65) 20:01 Bus pass by (LAF 55) 20:01 Alimak (LAF 60) 20:04 Forklift moving around the site and forks colliding with a ramp (LAF 75) 20:05 Forklift reversing (LAF 62) 20:07 Forklift moving around the site (LAF 60)			

MONITORING LOCATION 2				
LOCATION:	Intersection of Blues Point Road and Henry Lawson Avenue (representing 1 Warung Street), McMahon's Point			
ACTIVITIES:	Forklift movement and alimak activities			
PLANT:	8T forklift and Alimak			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA

20:07	20:24	49	54	BP_02
L _{aeq} (dBA)	L _{max} (dBA)	L _{min} (dBA)	L _{A10} (dBA)	L _{A90} (dBA)
49	68	37	51	40
PREDICTED NOISE LEVEL (dBA):		53		
L _{aeq} ABOVE PREDICTED NOISE LEVEL:		-4.0		
Measured noise level with no construction activity (if applicable)				
MONITORING COMMENTS	20:08 Car pass by (LAF 62)			
	20:09 Forklift reversing (LAF 46)			
	20:09 Alimak (LAF 45)			
	20:10 Car pass by (LAF 68)			
	20:11 Pedestrian talking (LAF 44)			
	20:11 Worker closing Blues Point Site entrance gate (LAF 50)			
	20:12 Bus pass by (LAF 73)			
	20:13 Dropped material in the bottom of the shaft (LAF 60)			
	20:14 Car pass by (LAF 62)			
	20:14 Forklift reversing (LAF 50)			
	20:15 Car pass by (LAF 58)			
	20:17 Car pass by (LAF 57)			
	20:18 Motorcycle pass by (LAF 64)			
	20:19 Motorcycle pass by (LAF 67)			
	20:20 Car pass by (LAF 67)			
	20:21 Alimak (LAF 45)			
20:22 Car pass by (LAF 50)				
20:22 Pedestrian pass by (LAF 56)				

MONITORING LOCATION 3				
LOCATION:	2-4 East Crescent Street, McMahon's Point			
ACTIVITIES:	Forklift movement, crane and alimak activities			
PLANT:	8T forklift			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
20:28	20:43	49	54	BP_02
L _{aeq} (dBA)	L _{max} (dBa)	L _{min} (dBA)	L _{A10} (dBA)	L _{A90} (dBA)
44	67	36	46	39
PREDICTED NOISE LEVEL (dBA):		41		
L _{aeq} ABOVE PREDICTED NOISE LEVEL:		3.0		
Measured noise level with no construction activity (if applicable)			44.0	
MONITORING COMMENTS	20:28 Bus pass by (LAF 52) 20:33 Ferry pass by (LAF 44) 20:36 Train pass by (LAF 42) 20:37 Pedestrian pass by (LAF 54) 20:38 Car pass by (LAF 53) 20:39 Forklift quackers alarm (LAF 41, barely audible) 20:39 Motorcycle pass by (LAF 73) 20:40 Forklift quackers alarm (LAF 39, barely audible) 20:41 Motorcycle pass by (LAF 52) 20:42 Pedestrian talking (LAF 50) Construction noise was inaudible during the measurement (except for the forklift quackers reverse alarm, which was barely audible from time to time when there is no wind).			

MONITORING LOCATION 4				
LOCATION:	1A Henry Lawson Avenue			
ACTIVITIES:	Truck deliveries, forklift movement, crane and alimak activities			
PLANT:	Trucks, 8T forklift and Alimak			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
20:49	21:04	49	54	BP_02
L_{aeq} (dBA)	L_{max} (dBa)	L_{min} (dBA)	L_{A10} (dBA)	L_{A90} (dBA)

50	72	43	53	46
PREDICTED NOISE LEVEL (dBA):		52		
Laeq ABOVE PREDICTED NOISE LEVEL:		-2.0		
Measured noise level with no construction activity (if applicable)				
MONITORING COMMENTS	20:49 Forklift reversing (LAF 48) 20:50 Motorcycle pass by (LAF 61) 20:50 Forklift revving engine (LAF 57) 20:51 Truck idling on site (LAF 48) 20:51 Car pass by (LAF 67) 20:53 Motorcycle pass by (LAF 53) 20:53 Truck idling (LAF 48) 20:56 Truck idling (LAF 45) 20:57 Forklift revving engine (LAF 51) 20:58 Bus pass by (LAF 81) 21:00 Forklift moving around the site (LAF 53) 21:00 Alimak (LAF 50) 21:01 Forklift reversing (LAF 49) 21:02 Alimak (LAF 53) 21:02 Truck reversing out of the site (LAF 54) 21:03 Truck leaving the site (LAF 49)			

MONITORING LOCATION 5				
LOCATION:	1A Henry Lawson Avenue			
ACTIVITIES:	No construction activities during this measurement			
PLANT:	No construction activities were audible during this measurement			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
22:24	22:39	40	45	BP_02
L _{aeq} (dBA)	L _{max} (dBA)	L _{min} (dBA)	L _{A10} (dBA)	L _{A90} (dBA)
47	68	41	50	43
PREDICTED NOISE LEVEL (dBA):		42		
L _{aeq} ABOVE PREDICTED NOISE LEVEL:		5.0		
Measured noise level with no construction activity (if applicable)			47.0	
MONITORING COMMENTS	Construction noise was inaudible during this measurement. It can be seen that the measured L _{aeq} (consisting of the ambient environment) is higher than the predicted noise level. 22:27 Bus pass by (LAF 71) 22:28 Pedestrian putting glass bottles in the bin (LAF 60) 22:30 Train pass by (LAF 51) 22:31 Ferry pass by (LAF 51) 22:37 Train pass by (LAF 49)			

MONITORING LOCATION 6				
LOCATION:	Intersection of Blues Point Road and Hentry Lawson Avenue (representing 1 Warung Street), McMahons Point			
ACTIVITIES:	No construction activities during this measurement			
PLANT:	No construction activities were audible during this measurement			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
22:41	22:56	40	45	BP_02
L _{aeq} (dBA)	L _{max} (dBA)	L _{min} (dBA)	L _{A10} (dBA)	L _{A90} (dBA)
42	61	37	44	38
PREDICTED NOISE LEVEL (dBA):		36		
L _{aeq} ABOVE PREDICTED NOISE LEVEL:		6.0		
Measured noise level with no construction activity (if applicable)			42.0	
MONITORING COMMENTS	Construction noise was inaudible during this measurement. It can be seen that the measured L _{aeq} (consisting of the ambient environment) is higher than the predicted noise level. 22:42 Ferry pass by (LAF 43) 22:44 Car pass by (LAF 64) 22:45 Car pass by (LAF 65) 22:46 Car pass by (LAF 64) 22:47 Car pass by (LAF 66) 22:48 Car pass by (LAF 61) 22:50 Bus pass by (LAF 84) 22:51 Train pass by (LAF 47)			

22:52 Car pass by (LAF 68)

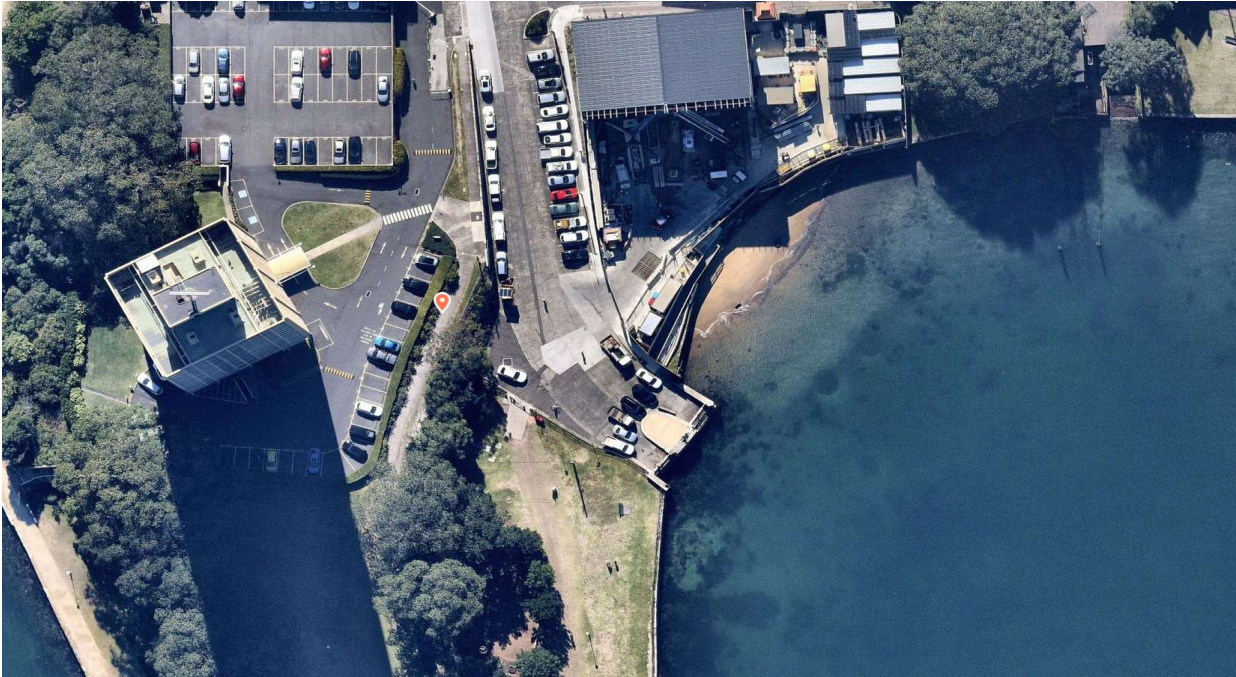
MONITORING LOCATION 7				
LOCATION:	14-28 Blues Point Road, McMahons Point (Blues Point Tower)			
ACTIVITIES:	No construction activities during this measurement			
PLANT:	No construction activities were audible during this measurement			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
22:59	23:14	40	45	BP_02
L _{aeq} (dBA)	L _{max} (dBA)	L _{min} (dBA)	L _{A10} (dBA)	L _{A90} (dBA)
45	58	40	47	42
PREDICTED NOISE LEVEL (dBA):		<35		
Laeq ABOVE PREDICTED NOISE LEVEL:		5.0		
Measured noise level with no construction activity (if applicable)			45.0	
MONITORING COMMENTS	Construction noise was inaudible during this measurement. It can be seen that the measured Laeq (consisting of the ambient environment) is higher than the predicted noise level. 23:00 Train pass by (LAF 57) 23:04 Bus pass by (LAF 60) 23:06 Motorcycle pass by (LAF 47) 23:07 Train pass by (LAF 54)			

Location 1&7

DIAGRAMS AND PHOTOS

Insert:

- Photo of works being monitored
- Map showing monitoring location or Screenshot of GPS Location

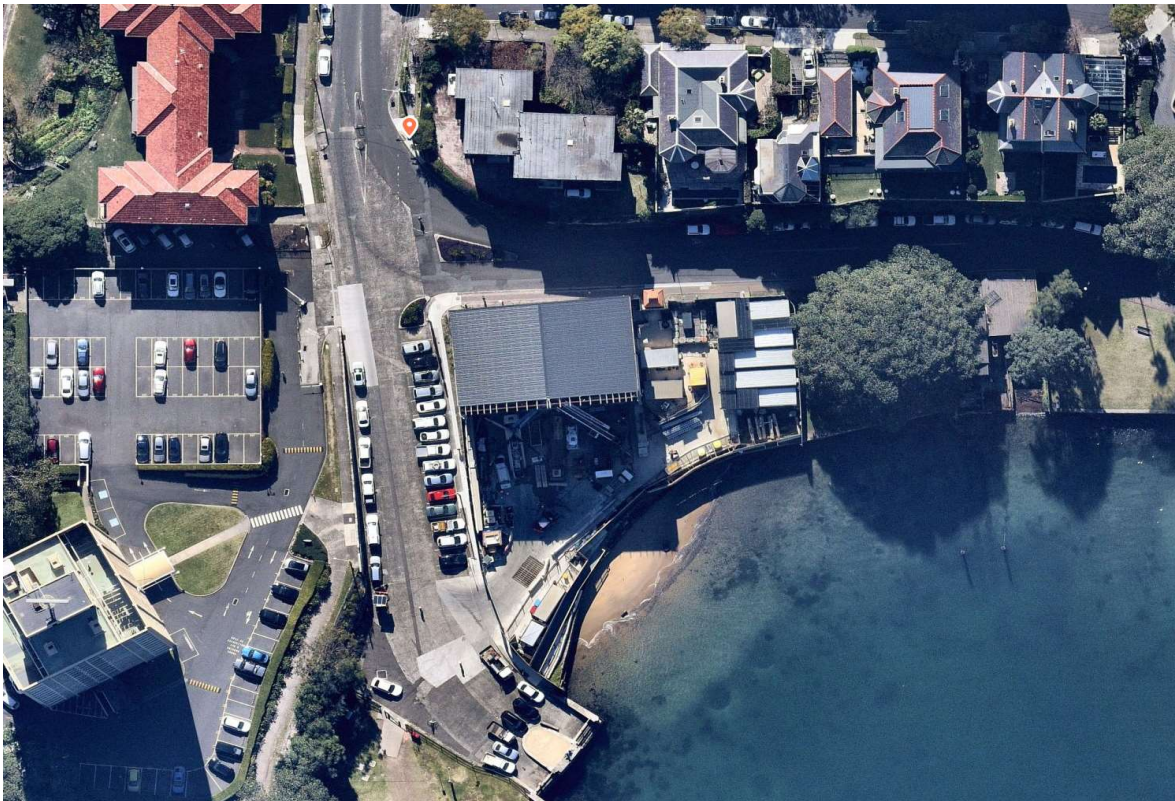


Location 2&6

DIAGRAMS AND PHOTOS

Insert:

- Photo of works being monitored
- Map showing monitoring location or Screenshot of GPS Location

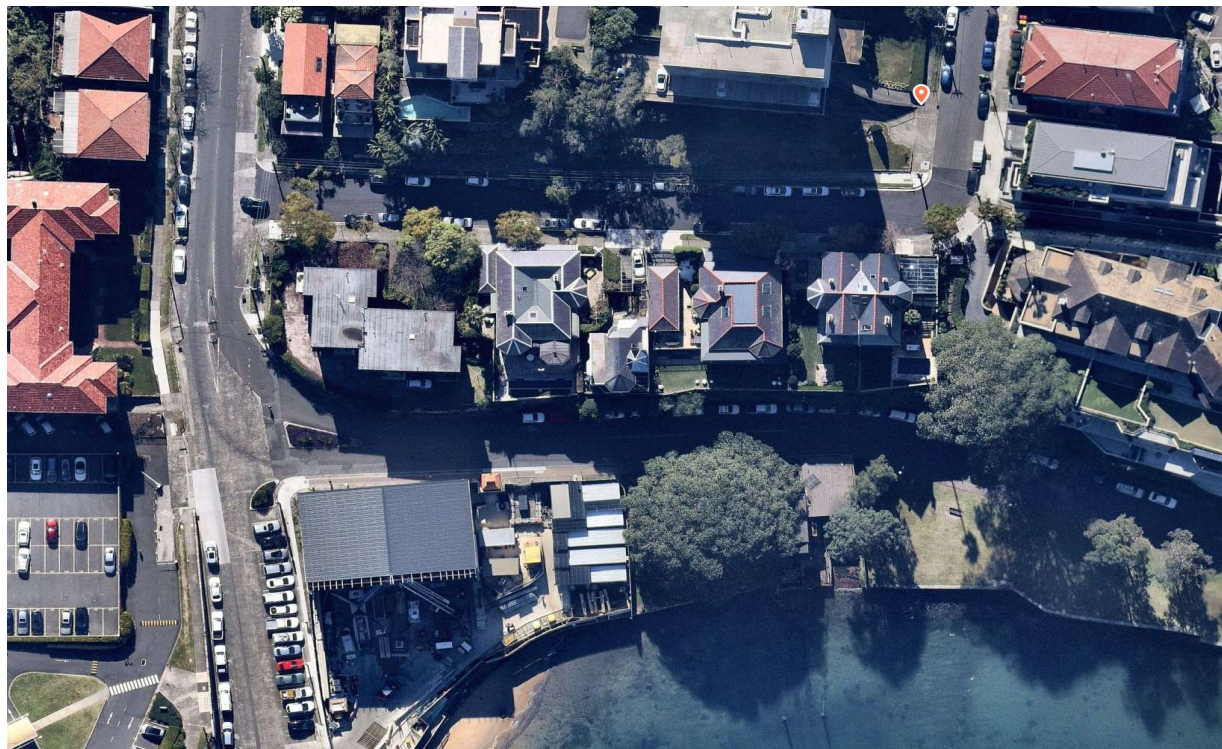


Location 3

DIAGRAMS AND PHOTOS

Insert:

- Photo of works being monitored
- Map showing monitoring location or Screenshot of GPS Location

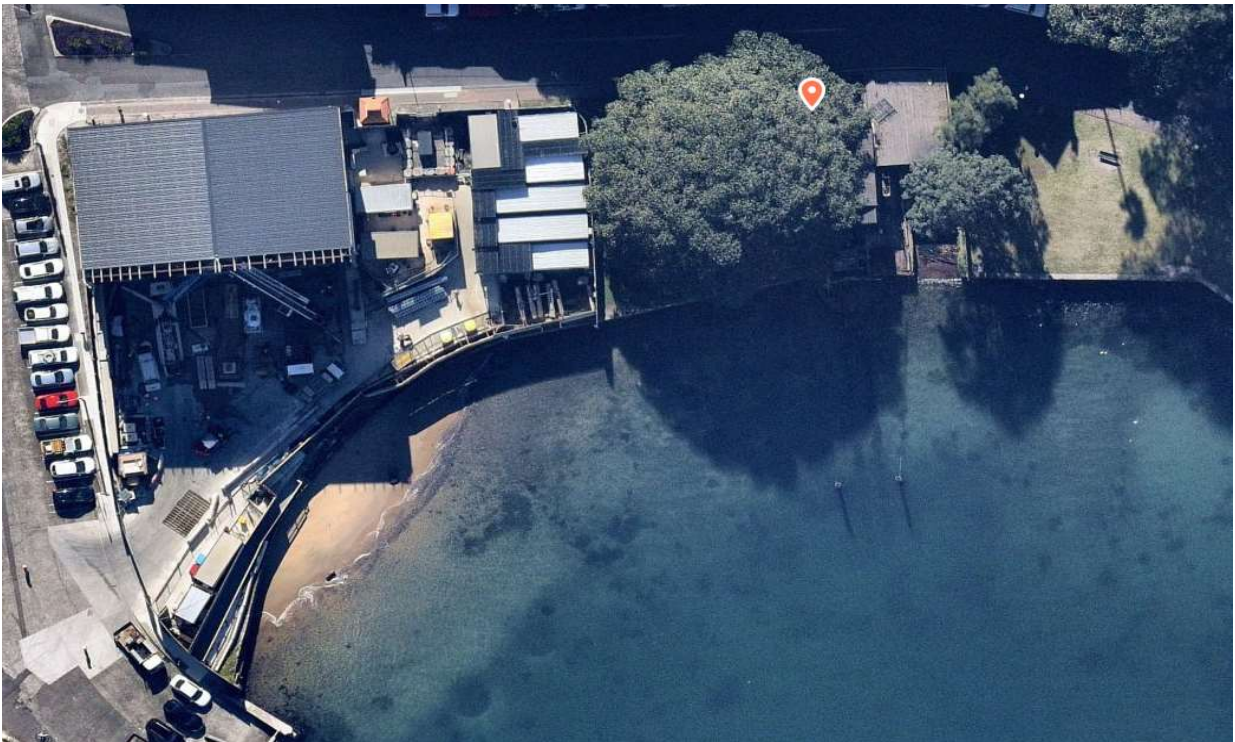


Location 4&5

DIAGRAMS AND PHOTOS

Insert:

- Photo of works being monitored
- Map showing monitoring location or Screenshot of GPS Location



Noise Monitoring Record Sheet

DATE:	10-September-2021	MAIN ACTIVITY	Rock breaking
CONDUCTED BY:	Evelyn Cardona/ Nadia Eisenlohr	LOCATION OF WORKS:	Canterbury TSS
METEROLOGICAL CONDITIONS:	Fine, sunny		
DAY, EVENING OR NIGHT PERIOD?	Day		
MAKE / MODEL:	RION	SERIAL NUMBER:	
TIME WEIGHTING:	FAST / SLOW	FREQUENCY WEIGHTING:	A / C / FLAT
FIELD CALIBRATION:	94	POST CALIBRATION CHECK:	
COMMUNITY NOTIFICATIONS GONE OUT FOR THE WORKS?	YES / NO		
LIGHT SPILL into residences?	N/A		
Are noise mitigation measures installed?	No noise mitigation installed. Noise mitigation to be installed after monitoring.		

MONITORING LOCATION 1				
LOCATION:	6 Hutton St			
ACTIVITIES:	Breaking rock			
PLANT:	Saw and 20t excavator with hammer attachment.			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
8:22	8:40			S2B_03
L_{aeq}	L_{max}	L_{min}	L_{A10}	L_{A90}
75	89	52	79	54
PREDICTED NOISE LEVEL (dBA):				
L_{Aeq} ABOVE PREDICTED NOISE LEVEL:				
Measured Construction Contribution (dBA)				
Measured Construction Contribution Above Predicted Noise Level				
MONITORING COMMENTS	Plant getting in position 64 Plant idling 59 20t jack hammer 79-89 sucker truck passing 82 No works w/ freight train passing 72 Rock saw 62			
MONITORING LOCATION 2				
LOCATION:	30 Hurlstone Avenue			
ACTIVITIES:	Rock breaking			
PLANT:	Rock saw and 20t excavator with hammer attachment.			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
8:42	8:59			S2B_03
L_{aeq} (dBA)	L_{max} (dBa)	L_{min} (dBA)	L_{A10} (dBA)	L_{A90} (dBA)
72	82	58	77	62
PREDICTED NOISE LEVEL (dBA):				
L_{Aeq} ABOVE PREDICTED NOISE LEVEL:				
Measured Construction Contribution (dBA)				

Measured Construction Contribution Above Predicted Noise Level	
MONITORING COMMENTS	
	Jack hammer 72-78
	Rock saw 63
	truck passing 72

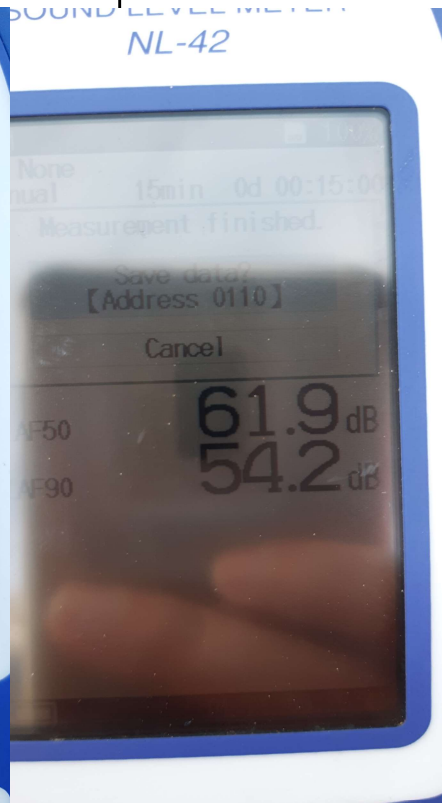
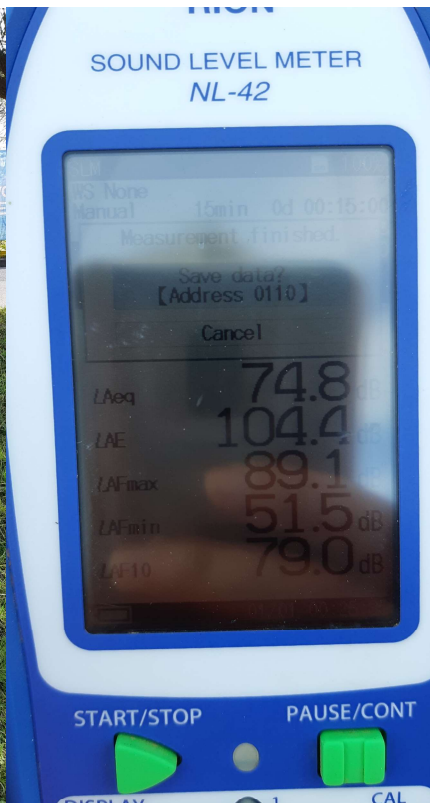
MONITORING LOCATION 3				
LOCATION:	Canberra St near Melford St			
ACTIVITIES:	Rock breaking			
PLANT:	Rock saw and 20t jackhammer			
START TIME	END TIME	RBL (dBA)	NML (dBA)	NCA
9:04	9:19	49	54	S2B_04
L _{aeq} (dBA)	L _{max} (dBA)	L _{min} (dBA)	L _{A10} (dBA)	L _{A90} (dBA)
70	80	46	74	54
PREDICTED NOISE LEVEL (dBA):				
Laeq ABOVE PREDICTED NOISE LEVEL:				
Measured Construction Contribution (dBA)		N/A		
Measured Construction Contribution Above Predicted Noise Level			N/A	
MONITORING COMMENTS	jack hammer 68-77			
	rock saw 57			
	car passing 68			
	freight train passing 67			
	Idling plant 46			

Location 1

DIAGRAMS AND PHOTOS

Insert:

- Photo of works being monitored
- Map showing monitoring location or Screenshot of GPS Location

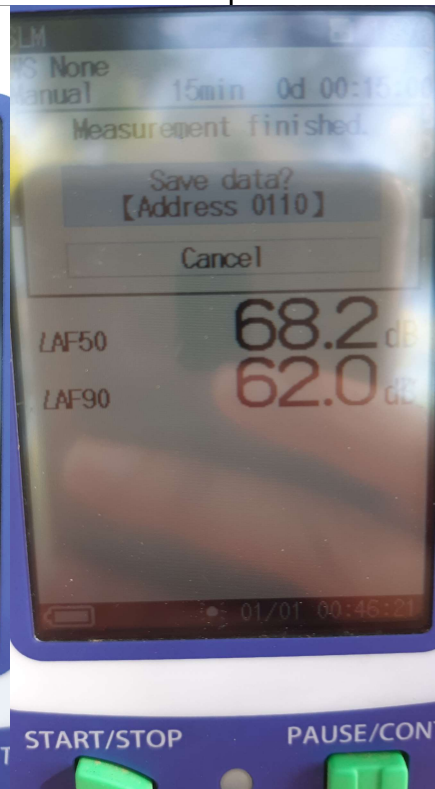
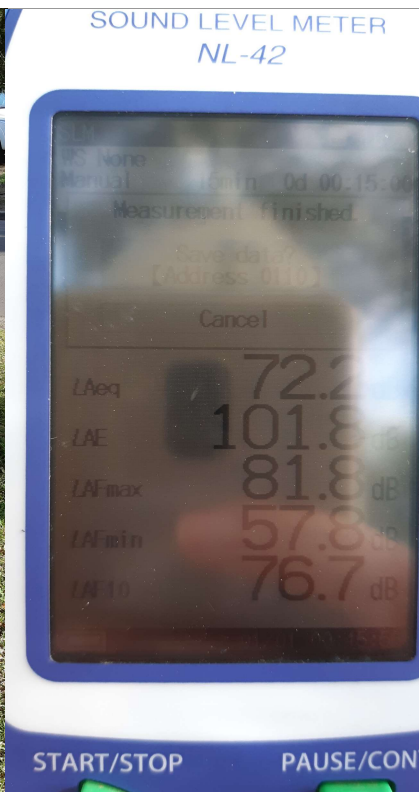


Location 2

DIAGRAMS AND PHOTOS

Insert:

- Photo of works being monitored
- Map showing monitoring location or Screenshot of GPS Location

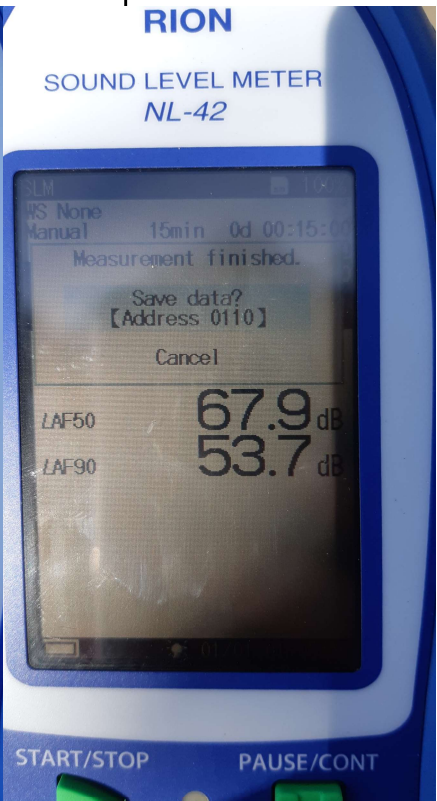
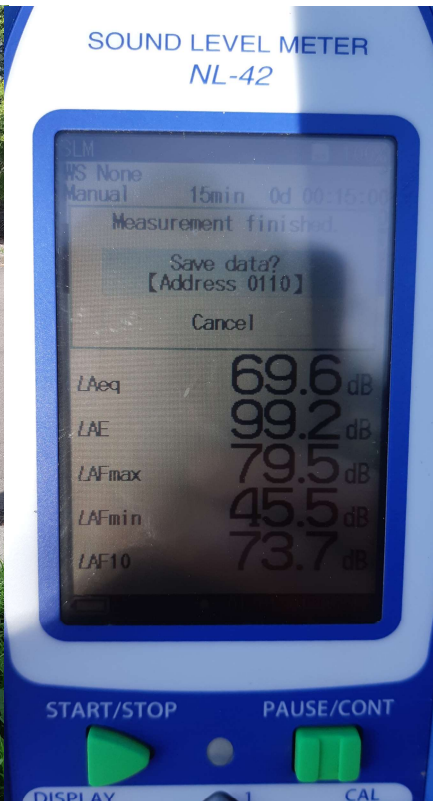


Location 3

DIAGRAMS AND PHOTOS

Insert:

- Photo of works being monitored
- Map showing monitoring location or Screenshot of GPS Location



Appendix G: Systems Connect Vibration Monitoring Register

Systems Connect Vibration Monitoring Register

Start Date	End Date	Conducted By	Location	Detailed Monitoring Location	Attended or Continuous	Vibration Criteria mm/s	Compliant with Vibration Criteria or Monitorong Protocol Y/N
29/08/2021	2/09/2021	Dean Kellett	BPS Surry Hills	106 Albion Street, Surry Hills	Attended	7.5	Y
15/09/2021	21/09/2021	Dean Kellett	BPS Campsie	Pat O'Connor Reserve / Cup and Saucer Creek	Attended	10	Y
13/12/2021	16/12/2021	Renzo Tonin	Waterloo	163 Regent Street, Redfern	Unattended	0.4 (Human comfort criteria)	Y
3/02/2022	3/02/2022	Renzo Tonin	Blues Point	Blues Point Site	Attended	7.5	Y

Appendix H: Vibration Monitoring Report Samples

14 February 2022

TK685 1_100_3-21-01F01 Waterloo-CS VIB Mon (r1)

Systems Connect

Level 1, 116 Miller Street

North Sydney NSW 2060

Sydney Metro Line Wide Works - Waterloo-Central Works - Vibration Monitoring 163 Regent Street, Redfern

1 Introduction

Renzo Tonin & Associates was engaged by Systems Connect to conduct vibration monitoring during out of hours works in the rail tunnels between Waterloo Station and Central Station between 13-14 December 2021.

The vibration monitoring was conducted to evaluate the potential impact of construction-related activities occurring within the rail tunnel at 163 Regent Street, Redfern.

The purpose of the investigation was to identify whether the use of the rail tunnel between Waterloo and Central Stations by Systems Connect is generating vibration above the relevant criteria related to human disturbance within the residential dwelling.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

2 Methodology

The instrumentation used for these vibration measurements is summarised Table 2-1.

Table 2-1 – Instrumentation

Location	Type	Make / Model
Waterloo-Central 'UP' tunnel	Type 1 Signal Analyser	XL2, Serial No. A2A-13528-E0
	Accelerometer	PCB 393B12 (4)
163 Regent Street, Redfern	Type 1 Signal Analyser	Soundbook-1
	Accelerometer	PCB 393B12 (1); PCB 393B12 (2); PCB 393B12 (3)
	Microphone	B&K 4189, Serial No. 2887448

The accelerometers and signal analysers used in the measurements have current calibration certificates.

The monitoring locations are shown in Figure 2-1 and the instrumentation set up is shown in Figure 2-2 and Figure 2-3. At the time of the monitoring, the only construction activity being undertaken within the rail tunnels was the use of the Up tunnel rail line to transport hi-rail vehicles between Waterloo Station and Central Station.

Monitoring was undertaken inside the Up tunnel (M1) to confirm that rail pass-by events were occurring and the timing of each event. A second vibration monitor (M2) was set up inside the ground floor, front room of the residence at 163 Regent Street, Redfern.

The monitoring equipment was set up in the tunnel and residence at approximately 7:00 pm on 13 December 2021 and retrieved at approximately 6:00 pm on 14 December 2021. The clocks of the two vibration monitoring systems were synchronised.

Figure 2-1 – Vibration monitoring locations at Waterloo-Central tunnel and residential receiver



Figure 2-2 Instrumentation set up – tunnel

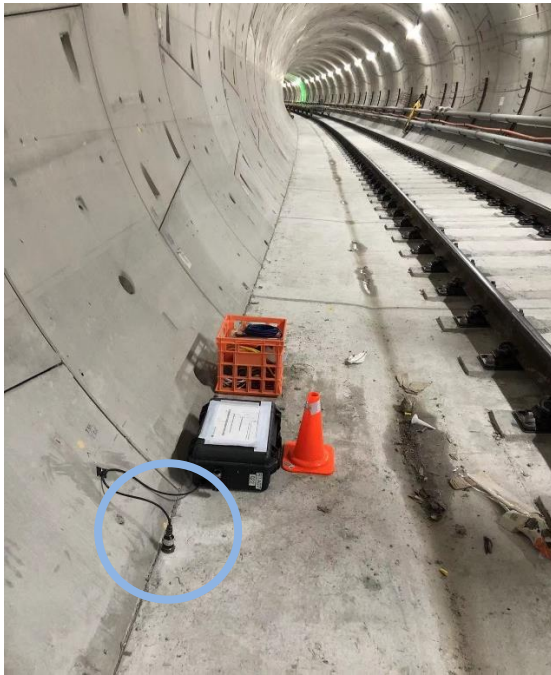


Figure 2-3 Instrumentation set up – residence



3 Vibration criteria

The *Sydney Metro – City and Southwest – Construction Noise and Vibration Management Plan*¹ (CNVMP) outlines that the Line-wide Works shall be constructed with the aim of managing potential disturbance from construction vibration in accordance with the guideline ‘Assessing Vibration; a technical guideline’ (AVTG)², consistent with the *Sydney Metro – Construction Noise and Vibration Strategy* (SM-CNVS). The AVTG provides criteria which are based on the British Standard BS 6472-1992 ‘*Guide to evaluation of human exposure to vibration in buildings (1- 80Hz)*’³.

BS6472-1992 nominates guideline values for various categories of disturbance, the most stringent of which are the levels of building vibration associated with a “low probability of adverse comment” from occupants. BS 6472-1992 was amended in 2008 to extend the use of the Vibration Dose Values (VDV) to all types of vibration (i.e. continuous, impulsive and intermittent). The vibration dose value is dependent upon the level and duration of short-term vibration events, as well as the number of events occurring during the daytime or night-time period.

To assess the potential for vibration impact on human comfort, an initial (conservative) screening test will be done based on peak velocity units, as this metric is also used for the cosmetic damage vibration

¹ Systems Connect 2020, Construction Noise and Vibration Management Plan – C2B Line Wide Works Contract Sydney Metro City & Southwest Document number: SMCSWLWC-SYC-1NL-PM-PLN-000032

² NSW Department of Environment and Conservation (DEC)(2006) Assessing Vibration: a technical guideline, DEC, Sydney

³ BS 6472:2008 Guide to evaluation of human exposure to vibration in buildings, British Standards Institution, London, UK

assessment. The screening test is based on the continuous vibration velocity (i.e. vibration that continues uninterrupted for a defined period). If the predicted vibration exceeds the initial screening test, the total estimated Vibration Dose Value (i.e. eVDV) will be determined based on the level and duration of the vibration event causing exceedance.

The initial screening test values and eVDVs recommended in BS 6472-1992 for which various levels of adverse comment from occupants may be expected are presented in Table 3-1.

Table 3-1: Vibration management levels for disturbance to building occupants

Place and Time	Initial screening test Velocity, PEAK, mm/s (>8Hz)	*Low probability of adverse comment eVDV m/s ^{1.75}	Adverse comment possible eVDV m/s ^{1.75}	Adverse comment probable eVDV m/s ^{1.75}
Critical areas (day or night)**	0.28	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8
Residential buildings 16 hr day	0.56	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8 hr night	0.40	0.13 to 0.26	0.2 to 0.4	0.4 to 0.8
Offices, schools, educational institutions and places of worship (day or night)	1.10	0.4 to 0.8	0.8 to 1.6	1.6 to 2.4
Workshops (day or night)	2.20	0.8 to 1.6	1.6 to 3.2	3.2 to 6.4

Notes: *These values are consistent with the acceptable vibration dose values for intermittent vibration specified in the "Assessing vibration: a technical guideline (DEC, 2006) and in the CNVMP.

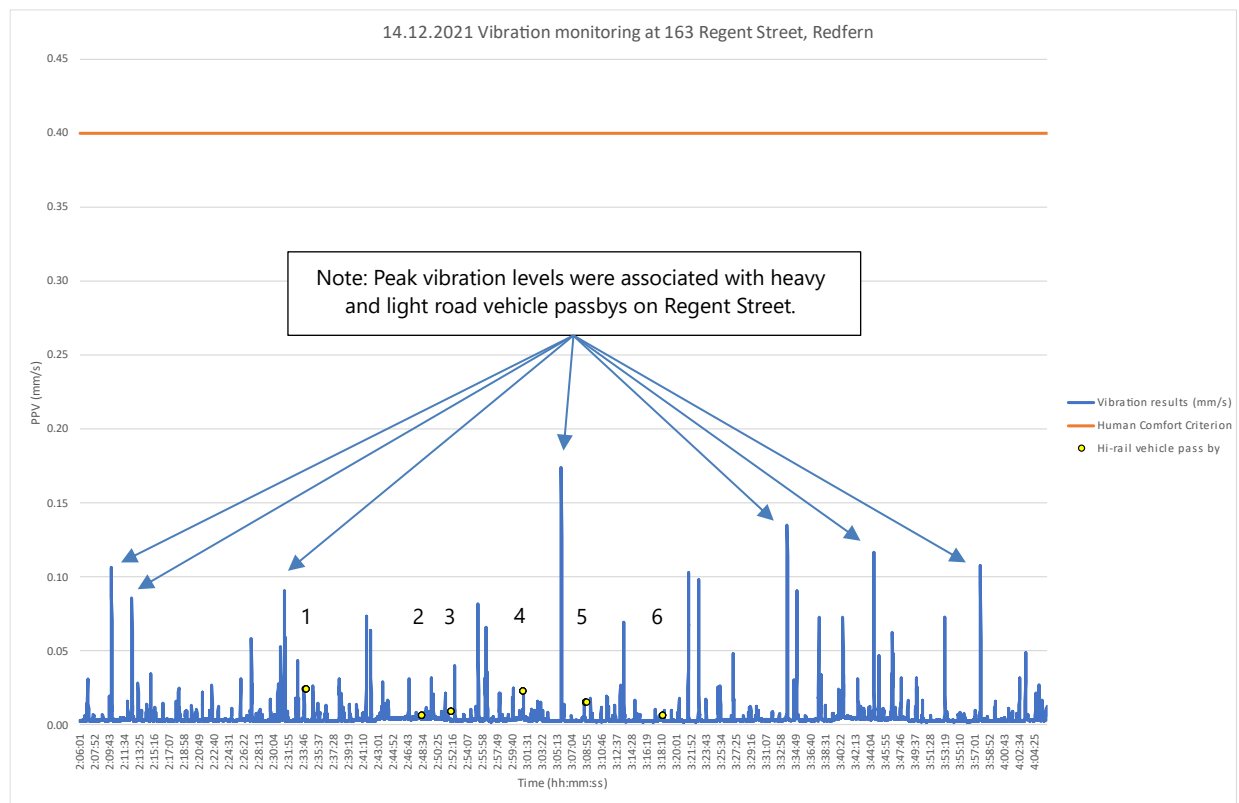
**Examples include hospital operating theatres and precision laboratories where sensitive operations are occurring. There may be cases where sensitive equipment or delicate tasks require more stringent criteria than the human comfort criteria specify above.

4 Vibration monitoring results

The results of the unattended vibration measurements are summarised in the table below. The construction site team advised that the first hi-rail transfer occurred at 2:30 am. There were six hi-rail vehicle passbys in total, approximately every 10 minutes until 3:30 am, when works ceased. Vibration monitoring conducted in the Up tunnel, below the residence, confirmed the presence of works over this period. The tunnel-based monitoring system detected passbys at 2:33 am, 2:48 am, 2:51 am, 3:00 am, 3:08 am and 3:18 am.

The results of the unattended vibration measurements from the M2 monitor inside the residence between 2:00 am and 4:00 am are presented in Figure 4-1.

All measurement results are below the initial night-time screening criterion of 0.4 mm/s for residential buildings.

Figure 4-1 – Unattended vibration monitoring results inside residential building

The discussion of the unattended vibration monitoring results associated with each hi-rail passby is summarised in Table 4-1.

Table 4-1 – Unattended vibration monitoring results and discussion

Event ID	Date and Time	Comment
1	14.12.2021 2:33am	At this time, the peak vibration level measured was 0.024 mm/s ppv. Note that during this hi-rail vehicle passby, review of the audio and vibration data confirmed that there was a road traffic passby that occurred. The peak vibration level of 0.024 mm/s was caused by the road traffic passby.
2	14.12.2021 2:48am	At this time, the peak vibration level measured was 0.006 mm/s ppv.
3	14.12.2021 2:51 am	At this time, the peak vibration level measured was 0.009 mm/s ppv.
4	14.12.2021 3:00am	At this time, the peak vibration level measured was 0.023 mm/s ppv. Note that during this hi-rail vehicle passby, review of the audio and vibration data confirmed that there was a road traffic passby that occurred. The peak vibration level of 0.023 mm/s was caused by the road traffic passby.
5	14.12.2021 3:08am	At this time, the peak vibration level measured was 0.015 mm/s ppv. Note that during this hi-rail vehicle passby, review of the audio and vibration data confirmed that there was a road traffic passby that occurred. The peak vibration level of 0.015 mm/s was caused by the road traffic passby.
6	14.12.2021 3:18am	At this time, the peak vibration level measured was 0.006 mm/s ppv.

The vibration monitoring results presented above show that vibration generated by construction hi-rail vehicles in the tunnels between Waterloo and Central Station are below the limits for

disturbance to building occupants at night. The peak vibration level was of 0.17 mm/s ppv at 3:05 am, outside of any hi-rail pass-by activity. Review of the audio recordings confirmed that this event was caused by a heavy vehicle passby on Regent Street.

5 Conclusion

Renzo Tonin & Associates was engaged by Systems Connect to conduct vibration monitoring during hi-rail activities in the Up tunnel between Waterloo Station and Central Station. Vibration monitoring was undertaken to establish whether vibration levels within a residence above the tunnel (163 Regent Street, Redfern) were within the limits associated with a “low probability of adverse comment” from occupants of the building, in accordance with BS6472-1992 and the AVTG.

The results of the attended vibration monitoring indicated that vibration levels were well below the “low probability of adverse comment” vibration limit associated with night-time construction activities. The cause of the highest measured vibration events during the monitoring period were light and heavy vehicle passbys on Regent Street.

Document control

Date	Revision history	Non-issued revision	Issued revision	Prepared	Instructed	Reviewed / Authorised
14.02.2022	Initial issue	0	1	T. Gowen/ R. Zhafranata	-	C. Weber
File Path: \\SYD-SERVER\rtagroups\syd\AssocSydProjects\TK651-TK700\TK685 PK SMCSW Linewide Works (CPB UGL)\1 Docs\100 CONSTRUCTION\3-21 VIB MON Waterloo-Central tunnels\TK685 1_100_3-21-01F01 Waterloo-CS VIB Mon (r1).docx						

Important Disclaimers:

The work presented in this document was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian/New Zealand Standard AS/NZS ISO 9001.

This document is issued subject to review and authorisation by the suitably qualified and experienced person named in the last column above. If no name appears, this document shall be considered as preliminary or draft only and no reliance shall be placed upon it other than for information to be verified later.

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In preparing this report, we have relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, we have not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

We have derived data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination and re-evaluation of the data, findings, observations and conclusions expressed in this report.

We have prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

The information contained herein is for the purpose of acoustics only. No claims are made and no liability is accepted in respect of design and construction issues falling outside of the specialist field of acoustics engineering including and not limited to structural integrity, fire rating, architectural buildability and fit-for-purpose, waterproofing and the like. Supplementary professional advice should be sought in respect of these issues.

External cladding disclaimer: No claims are made and no liability is accepted in respect of any external wall and/or roof systems (eg facade / cladding materials, insulation etc) that are: (a) not compliant with or do not conform to any relevant non-acoustic legislation, regulation, standard, instructions or Building Codes; or (b) installed, applied, specified or utilised in such a manner that is not compliant with or does not conform to any relevant non-acoustic legislation, regulation, standard, instructions or Building Codes.

8 February 2022

TK685-03-11F03 Blues Point Vibration Monitoring Report (r1)

Systems Connect

Level 3, 116 Miller Street

North Sydney NSW 2060

Sydney Metro Line Wide Works - Northern Connection Works - Blues Point Vibration Monitoring Results

1 Introduction

Renzo Tonin and Associates was engaged by Systems Connect to conduct vibration monitoring during the concrete removal works at the Blues Point site. The concrete removal works would be undertaken with a 30T excavator with hammer attachment. Vibration monitoring was undertaken to establish the site specific minimum working distances for the 30T excavator with hammer attachment, to minimise the potential vibration impact to the nearby heritage seawall.

The work documented in this report was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian Standard / NZS ISO 9001.

2 Methodology

The instrumentation used for these vibration measurements are summarised Table 2-1. The monitoring locations are shown in Figure 2-1 and instrumentation set up is shown in Figure 2-2.

Table 2-1 – Instrumentation

Type	Make / Model
Type 1 Signal Analyser	Soundbook-2
Accelerometer	Endevco 61C3

The accelerometers used in the measurements have current calibration certificates.

Figure 2-1 - Monitoring locations – Blues Point attended vibration monitoring

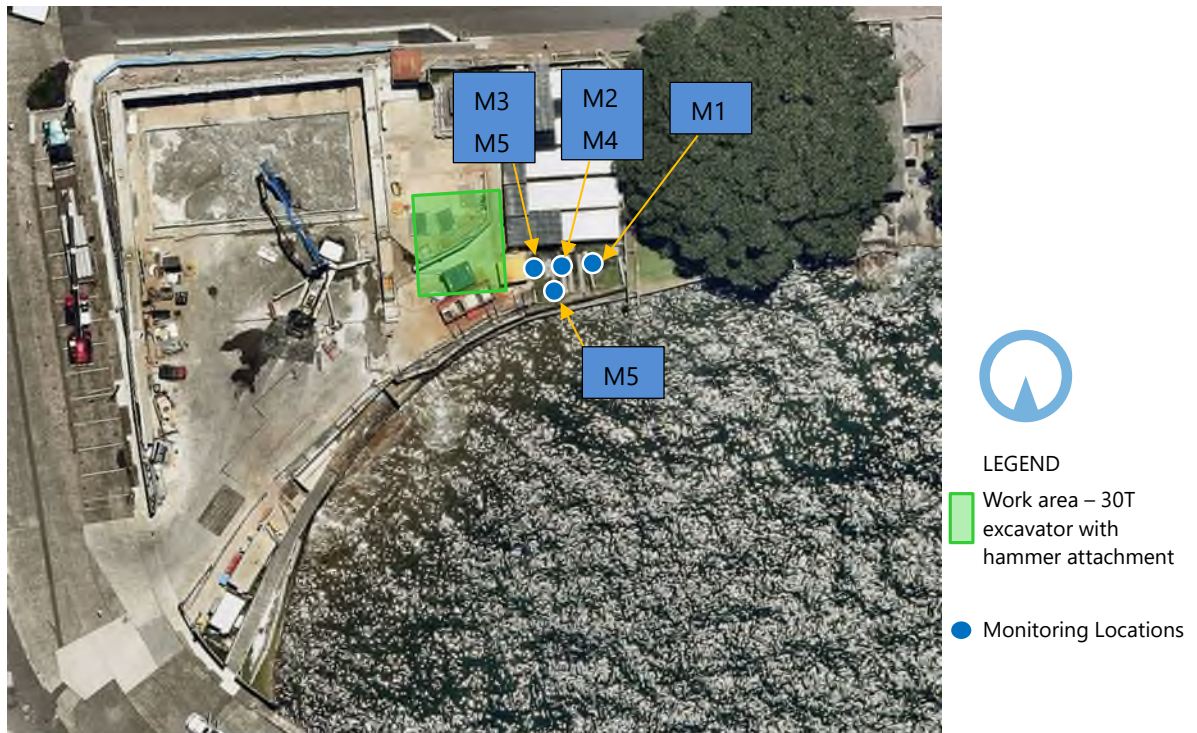


Figure 2-2 Instrumentation set up – Blues Point site



3 Vibration criteria

The established vibration criteria in the *Sydney Metro – City and Southwest – Construction Noise and Vibration Management Plane* are given below:

3.1 Cosmetic damage to buildings

BS7385 suggests levels at which 'cosmetic', 'minor' and 'major' categories of damage might occur. The 'cosmetic' damage levels set by BS 7385 are considered 'safe limits' up to which no damage due to vibration effects has been observed for particular building types. Damage comprises minor non-structural effects such as hairline cracks on drywall surfaces, hairline cracks in mortar joints and cement render, enlargement of existing cracks and separation of partitions or intermediate walls from load bearing walls. 'Minor' damage is considered possible at vibration magnitudes which are twice those given and 'major' damage to a building structure may occur at levels greater than four times those values.

Table 3-1 sets out the recommended limits from BS7385 for transient vibration to ensure minimal risk of cosmetic damage to residential, commercial and industrial buildings.

These limits relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table 3-1 may need to be reduced by up to 50 for Residential Buildings.

Note: rock breaking/hammering and sheet piling activities are considered to have the potential to cause dynamic loading in some structures (e.g. residences) and it may be appropriate to reduce the transient values by 50%. In addition, for most construction activities involving intermittent vibration sources such as rock breakers, piling rigs, vibratory rollers, excavators and the like, the predominant vibration energy occurs at frequencies greater than 4 Hz (and usually in the 10 Hz to 100 Hz range). On this basis, consistent with the SM-CNVS a conservative vibration damage screening level per receiver type is given below:

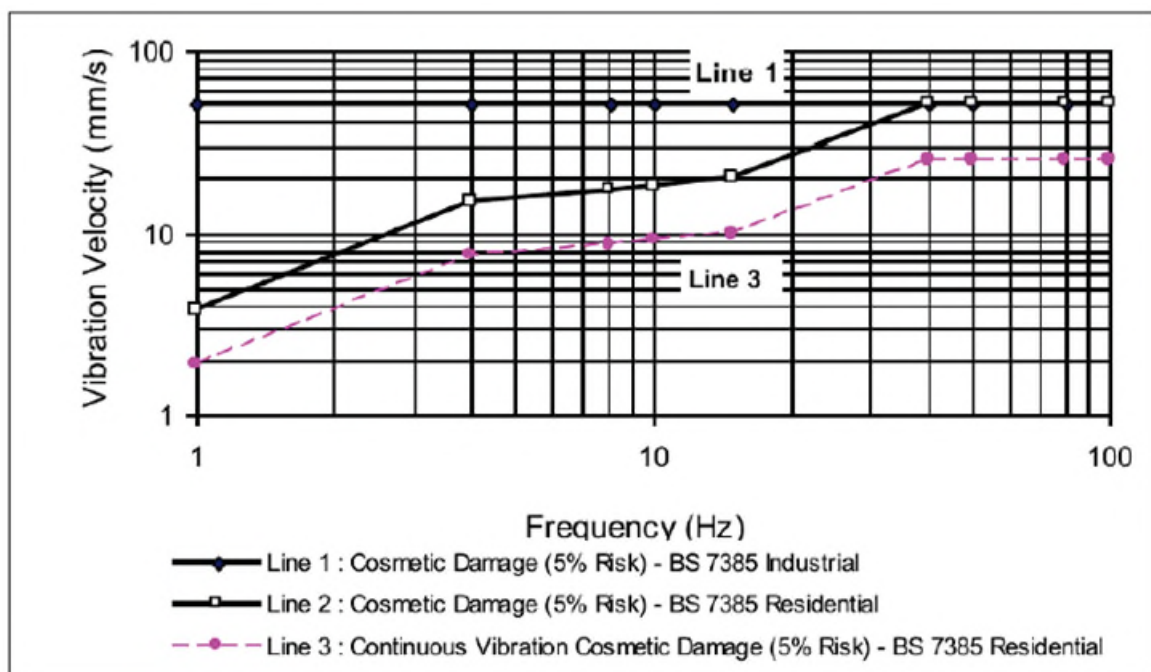
- Reinforced or framed structures (Line 1): 25.0 mm/s
- Unreinforced or light framed structures (Line 2): 7.5 mm/s

At locations where the predicted and/or measured vibration levels are greater than shown above (peak component particle velocity), a more detailed analysis of the building structure, vibration source, dominant frequencies and dynamic characteristics of the structure would be required to determine the applicable safe vibration level. The analysis would take into consideration the transient vibration guide values for minimal risk of cosmetic damage set out in Table 3-1 and Figure 3-1 following.

Table 3-1 Transient vibration guide values – minimal risk of cosmetic damage (BS 7385) – peak component particle velocity

Line	Type of structure	Frequency range 4 to 15 Hz	Frequency range 15 to 40 Hz	Frequency range 40 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s	50 mm/s	50 mm/s
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4Hz, increasing to 20 mm/s at 15Hz	20 mm/s at 15Hz, increasing to 50 mm/s at 40Hz	50 mm/s

Figure 3-1 Graph of Transient Peak Component Particle Velocity Vibration Guide Values for Cosmetic Damage



3.2 Heritage Structures

The vibration management strategy in relation to heritage structures that may be impacted by Line-wide Works is detailed below.

The British Standard BS 7385 states that, "A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive."

If a heritage building or structure is found to be structurally unsound (following inspection) a more conservative cosmetic damage objective of 2.5 mm/s peak component particle velocity (from DIN 4150) would be considered. Unless otherwise advised, heritage buildings and structures would be assessed as per the screening criteria in Section 5.5.1 as they should not be assumed to be more sensitive to

vibration unless they are found to be structurally unsound. This approach is consistent with the EIS and the SM-CNVS.

The approach to manage potential vibration impact on heritage items shall be to:

1. Identify heritage items where the 2.5 mm/s peak component particle velocity objective may be exceeded during specific construction activities
2. Structural engineering report to be undertaken on identified heritage items, to confirm structural integrity of the building and confirm if item is 'structurally sound'
3. If item confirmed as 'structurally sound', the screening criteria in Section 5.5.1 shall be adopted, or
4. If item confirmed as 'structurally unsound', the more conservative cosmetic damage objectives of 2.5 mm/s peak component particle velocity would be adopted.

4 Vibration monitoring results

The vibration measurements were conducted at the following locations:

Table 4-1 – Attended vibration measurement locations

Measurement ID	Assessment Point	Date	Time	Measured plant	Approx. distance to measured plant
M1	Blues Point site (Figure 2-1)	03.02.2022	02:27pm – 02:29pm	30T excavator with hammer attachment	7m
M2	Blues Point site (Figure 2-1)	03.02.2022	02:29pm – 02:31pm	30T excavator with hammer attachment	5m
M3	Blues Point site (Figure 2-1)	03.02.2022	02:29pm – 02:31pm	30T excavator with hammer attachment	3m
M4	Blues Point site (Figure 2-1)	03.02.2022	02:40pm – 02:41pm	30T excavator with hammer attachment	4m
M5	Blues Point site (Figure 2-1)	03.02.2022	02:40pm – 02:41pm	30T excavator with hammer attachment	2m

The results of the attended vibration measurements are summarised in the table below.

Table 4-2 – Attended vibration measurement results summary

Measurement ID	Assessment point	Plant	Distance from source	Baseline 95 th percentile PPV	95 th percentile PPV (mm/s)	Maximum PPV (mm/s)	Comments
M1	Blues Point site	30T excavator with hammer attachment	7m	0.07	2.24	3.53*	At 7 metres away, the 30T excavator with hammer attachment produced vibration levels (95 th percentile PPV) that are below the screening level of 2.5mm/s. The site specific minimum working distance for the 2.5mm/s criterion is 7 metres away from the heritage seawall.
M2	Blues Point site	30T excavator with hammer attachment	5m	0.07	5.42	8.74*	At 5 metres away, the 30T excavator with hammer attachment produced vibration levels (95 th percentile PPV) that are above the screening level of 2.5mm/s. However, the measured vibration levels were below the screening level of 7.5mm/s.
M3	Blues Point site	30T excavator with hammer attachment	3m	0.07	6.38	10.97*	At 3 metres away, the 30T excavator with hammer attachment produced vibration levels (95 th percentile PPV) that are above the vibration screening level of 2.5mm/s. However, the measured vibration levels were below the screening level of 7.5mm/s. The site specific minimum working distance for the 7.5mm/s criterion is 3 metres away from the heritage seawall.
M4	Blues Point site	30T excavator with hammer attachment	4m	0.07	6.30	5.74*	At 4 metres away, the 30T excavator with hammer attachment produced vibration levels (95 th percentile PPV) that are above the vibration screening level of 2.5mm/s. However, the measured vibration levels were below the screening level of 7.5mm/s.

Measurement ID	Assessment point	Plant	Distance from source	Baseline 95 th percentile PPV	95 th percentile PPV (mm/s)	Maximum PPV (mm/s)	Comments
M5	Blues Point site	30T excavator with hammer attachment	2m	0.07	15.26	16.29*	At 2 metres away, the 30T excavator with hammer attachment produced vibration levels (95 th percentile PPV) that are above the vibration screening level 7.5mm/s criterion. As a result, the 30T excavator with hammer attachment shall not be used when the hammering works are 2 metres away from the heritage seawall.

Notes: *Maximum PPV occurred during the initial impact of the rockhammering activity (start-up of the operation). In accordance with the DIN 4150, the exceedances caused by the start-up operation of the rockhammering activity is allowed as it is only short-term.

From Table 4-2, the site specific minimum working distances for the 30T excavator with hammer attachment working near the heritage seawall are:

- 7 metres to maintain vibration levels (95th percentile PPV) below the vibration screening level of 2.5 mm/s;
- 3 metres to maintain vibration levels (95th percentile PPV) below the vibration screening level of 7.5 mm/s .

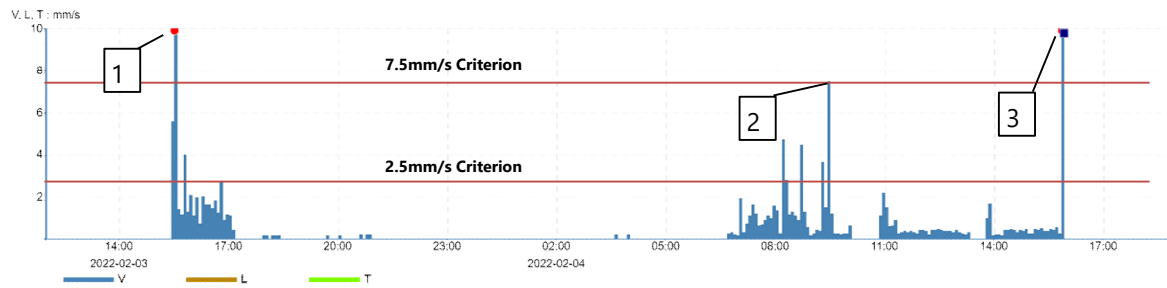
For concrete removal works that are within 3 metres away from the heritage seawall, an alternative method with a lower source of vibration shall be adopted.

For the remaining concrete removal works within the established minimum working distances, unattended monitoring was conducted. The measurement location of the unattended vibration monitoring is described in Table 4-3 and Figure 2-1.

Table 4-3 – Unattended vibration monitoring summary

Measurement ID	Assessment Point	Date	Time	Measured plant	Approx. distance to measured plant
M6	Heritage seawall (Figure 2-1)	03.02.2022 – 04.02.2022	03:30pm – 03:50pm	30T excavator with hammer attachment	3m - 10m

The results of the unattended vibration measurements are presented in Figure 4-1.

Figure 4-1 – Unattended vibration monitoring results

Where the vibration from rockhammering activity initially exceeded the 2.5 mm/s criterion, the works were paused and the heritage seawall was inspected for any signs of cosmetic damage. When no signs were found, the works proceeded with caution. Where the vibration from rockhammering activity initially exceeded the 7.5 mm/s criterion, the works were paused until the source of the exceedance was identified. Where it was confirmed that this was not due to rockhammering activity, the works continued.

The discussion of the unattended vibration monitoring is summarised in Table 4-4 below.

Table 4-4 – Unattended vibration monitoring discussion

Exceedance ID	Date and Time	Cause of exceedance
1	03.02.2022 03:30pm	At this time, the vibration monitor was mounted on the ground spike to commence monitoring. Exceedance was not caused by the nearby rockhammering activity.
2	04.02.2022 09:26am	At this time, the site engineer confirmed that the instantaneous exceedance was caused by the impact of the walls of the concrete platform being knocked over on site and falling to the ground. Exceedance was not caused by the nearby rockhammering activity.
3	04.02.2022 03:50pm	At this time, the vibration monitor was removed from the ground spike to complete the monitoring. Exceedance was not caused by the nearby rockhammering activity.

It can be seen in Figure 4-1 that the vibration levels produced from the nearby rockhammering activity is generally below 7.5 mm/s. Note that there were events that resulted in an instantaneous vibration level of above 7.5 mm/s. However, these were not caused by the nearby rockhammering activity, as justified in Table 4-4.

Photos of the heritage seawall was taken on the 4th of February after the rockhammering activity, which indicated no apparent cosmetic damage to the heritage seawall.

As a result, no further vibration monitoring is required when the rockhammering works are outside of the established site specific minimum working distances.

5 Conclusion

Renzo Tonin and Associates was engaged by Systems Connect to conduct vibration monitoring during the concrete removal works at the Blues Point site. Vibration monitoring was undertaken to establish the site specific minimum working distances for the 30T excavator with hammer attachment, to minimise the potential vibration impact to the nearby heritage seawall.

The results of the attended vibration monitoring indicated that the site specific minimum working distance for the 2.5 mm/s and 7.5 mm/s criteria is 7 metres and 3 metres respectively. For concrete removal works that is within 3 metres away from the heritage seawall, an alternative method with a lower source of vibration shall be adopted.

The results of the unattended vibration monitoring indicated that the vibration levels produced from the nearby rockhammering activity is generally below 7.5 mm/s. Note that there were events that resulted in an instantaneous vibration level of above 7.5 mm/s. However, these were not caused by the nearby rockhammering activity, as justified in Table 4-4.

Document control

Date	Revision history	Non-issued revision	Issued revision	Prepared	Instructed	Reviewed / Authorised
08.02.2022	First Issue	0	1	D. Auld / R. Zhafranata	T. Gowen	T. Gowen
File Path: \\syd-server\rtagroups\syd\AssocSydProjects\TK651-TK700\TK685 PK SMCSW Linewide Works (CPB UGL)\1 Docs\100 CONSTRUCTION\3-11 CNVIS C2S_P3 BP\TK685-03-11F03 Blues Point Vibration Monitoring Report (r1).docx						

Important Disclaimers:

The work presented in this document was carried out in accordance with the Renzo Tonin & Associates Quality Assurance System, which is based on Australian/New Zealand Standard AS/NZS ISO 9001.

This document is issued subject to review and authorisation by the suitably qualified and experienced person named in the last column above. If no name appears, this document shall be considered as preliminary or draft only and no reliance shall be placed upon it other than for information to be verified later.

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We have derived data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination and re-evaluation of the data, findings, observations and conclusions expressed in this report.

We have prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

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Vibration Monitoring Record Sheet

START DATE:	15/09/2021	PROJECT AREA:	Campsie BPS Bridge (Pat O'Connor Reserve)
FINISH DATE:	20/09/2021	MAIN ACTIVITY	Piling Works
CONDUCTED BY:	Dean Kellet	LOCATION OF WORKS:	Pat O'Connor Reserve / Cup and Saucer Creek
DAY, EVENING OR NIGHT PERIOD:	Day		
MONITORING EQUIPMENT:	Sigicom INFRA C12 vibration monitor (supplied by Renzo Tonin)		
VIBRATION MONITORING PLAN:	TK685-151-100-3-03F01 BPS Campsie Piling Works monitoring plan, dated: 31.05.2021, revision 1		

MONITORING LOCATION 1					
LOCATION:	Pat O'Connor Reserve / Cup and Saucer Creek (Ausgrid side)				
DATES:	15-20 September 2021				
ACTIVITIES:	Piling works for bridge foundations				
PLANT:	20t excavator with auger attachment				
STRUCTURE TYPE:	Channel structure for Cup and Saucer and Creek				
VIBRATION CRITERIA:	Unreinforced structure: 10 mm/s				
APPLICABLE MWD:	5m	ACTUAL WORKING DISTANCE:		1.5 m	
VIBRATION MONITOR MOUNTING METHOD:			Steel baseplate stuck with adhesive to concrete channel surface		
EXCEEDENCES OF VIBRATION CRITERIA (Refer to monitoring data for all results)					
Date	Time	V (mm/s)	T (mm/s)	L (mm/s)	Reason
15/09/2021	9:08:00 AM	9.45	9.31	6.53	Turning on monitor
16/09/2021	5:25:00 PM	3.84	2.68	5.92	Auger withdrawal then reinsertion and centering
17/09/2021	4:06:00 PM	7.53	0.72	1.55	Auger removed from borehole to replace teeth
20/09/2021	3:09:00 PM	7.91	0.41	0.85	Auger withdrawal then reinsertion and centering
20/09/2021	3:27:00 PM	6.77	0.34	0.76	Auger piling through hard rock at depth
COMPLIANT WITH VIBRATION CRITERIA:			Yes		
MONITORING COMMENTS OR ACTIONS TAKEN TO ADDRESS EXCEEDENCES OF VIBRATION CRITERIA					
No vibration exceedance above the criteria of 10 mm/s during piling works					

DIAGRAMS



- Pile Locations
- Vibration Monitor Location

PHOTOS



15/09/2021

9:58:00 AM



16/09/2021

5:29:00 PM



17/09/2021

8:58:00 AM



20/09/2021

3:30:00 PM

