Appendix 8: Acoustic report

St John of God Subiaco Redevelopment

WP3A

Acoustic Report

Prepared for: Silver Thomas Hanley

Date: 18 October 2022

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Revision

Revision	Date	Comment	Prepared By	Approved By
001	18/10/2022	Issued for Submission	BH	IK

Contents

1. Introduction

Silver Thomas Hanley has engaged Stantec to provide acoustic services for the proposed redevelopment of St John of God Hospital Subiaco. This report addresses the acoustic design and assessment of noise emissions from Site Energy Plant (SEP) and Site Water Plant (SWP);

The following regulations and guidelines listed below have been referenced as part of the design criteria for the project:

- *"Western Australian Environmental Protection (Noise) Regulation 1997"* (EPNR)

An initial acoustic report for Development Application was prepared dated 22April 2022 *(ref. AC-RE-301250740_WP3A_SD_002).* This updated report captures the changes to the SEP with inclusion of basement carpark, revised equipment selection by services engineers which now also include carpark ventilation fans (discharge on the roof and air intake riser on ground level outside the building) and provision of a third emergency generator has also been included.

The acoustic assessment has been updated to reflect the aforementioned changes, and the resulting noise levels have been assessed against the EPNR assigned levels.

1.1 Study Inputs

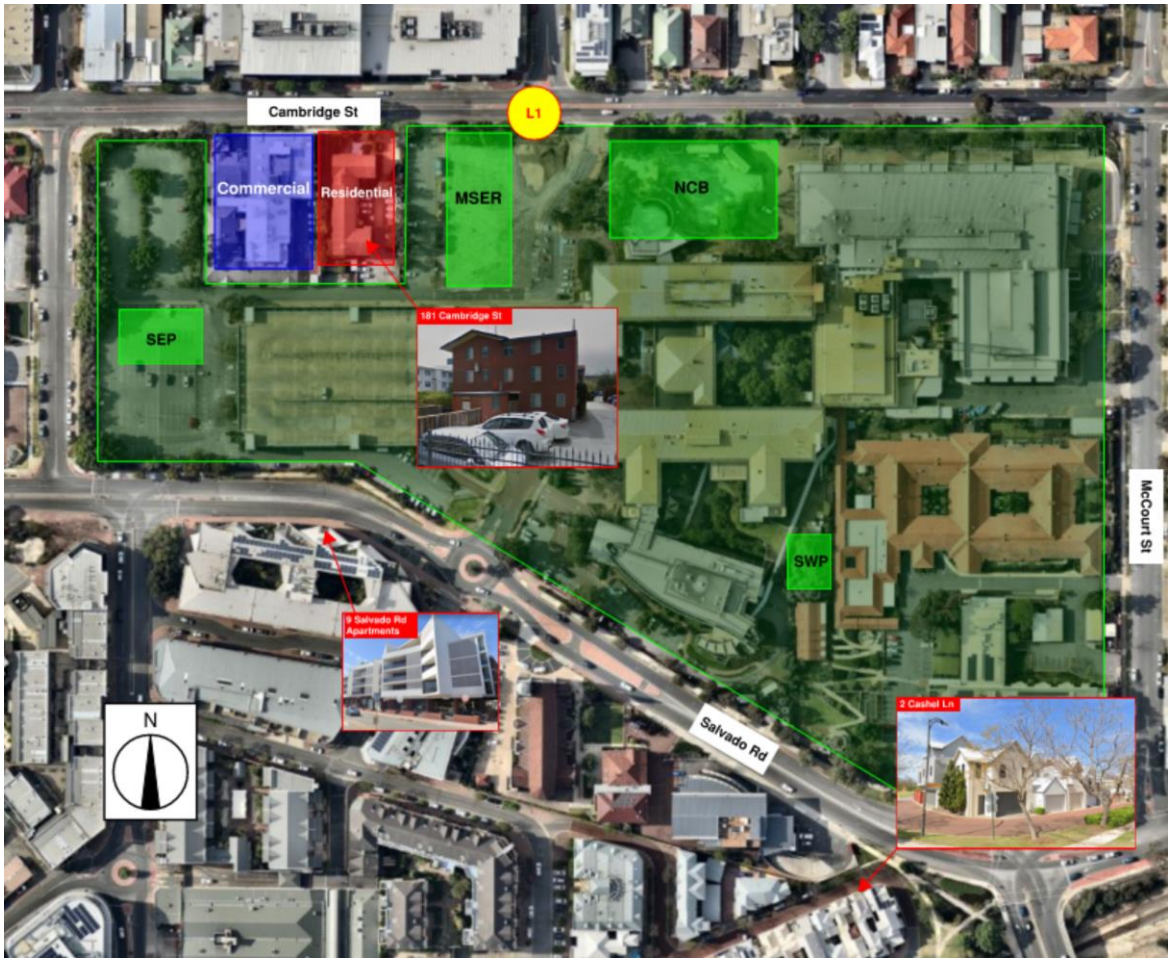
Acoustic assessment and preparation of this report has been based on the received documentation provided in Table 1.

Table 1: Received Documentation

Date	Detail	Prepared By	Format
Sep 2022	*SJOG Subiaco Hospital Site Energy Plant Drawings*	Silver Thomas Hanley Architecture	BIM360
Oct 2022	Mechanical Plant information	SGK	pdf
Oct 2022	Electrical information	Stantec	pdf

1.2 Location Overview

The locations of the various buildings included in the SJOG Subiaco Hospital redevelopment as well as the nearest sensitive noise receivers have been illustrated in Figure 1 for reference.



Source: Nearmaps

Figure 1: Project Overview

1.3 Environmental Protection (Noise) Regulations 1997

Environmental noise impacts resulting from the noise emissions from the project are addressed through the Environmental Protection Act 1986, with the regulatory requirements detailed in the Environmental Protection (Noise) Regulations 1997 (EPNR).

The EPNR establishes the maximum permissible noise emission levels (assigned levels) to be received at all adjacent noise-sensitive premises during specific periods of the day as a result of the cumulative noise emissions from all sources proposed for the project site. Compliance to relevant noise limits outlined in the EPNR is compulsory.

The EPNR states noise emissions from any premises are considered not to significantly contribute to the noise at a receiver if the noise emissions are 5 dB or below the assigned levels.

In brief, the assigned levels are determined by considering of the amount of commercial and industrial zones, as well as main transport corridors and sporting venues surrounding the noise sensitive premises. The assigned levels apply at premises receiving the noise (noise sensitive receiver) and not to areas within the project site or lot. In addition, the Environmental Protection (Noise) Regulations 1997 identify the following in Schedule 3, clause 2A:

> *"If the land within either of the circles is categorised on the land use map as land in respect of which mixed uses are permitted, the use of that land that results in the highest influencing factor is to be used in the determination of the influencing factor."*

The nearest noise sensitive receivers have been considered as the residential properties surrounding the project location, with the closest measurable receivers being 9 Salvado Road, 181 Cambridge St and 2 Cashel Ln. The current *City of Subiaco Local Planning Scheme 5* (COSLPS5) and *Town of Cambridge Local Planning Scheme 1* (TOCLPS1). See Figure 2 and Figure 3 for reference.

Traffic data for roads surrounding the nearest noise sensitive receiver were obtained from *Main Roads Western Australia* (MRWA) on the 15th November 2021. The available traffic data has been presented in Table 2.

Table 2: Traffic vehicle counts (MWRA)

Transport Corridors	EPNR Classification [1)]	Average Daily Traffic Volumes					
		2015/16	2016/17	2017/18	2018/19	2019/20	2020/21
Railway Parade (West Perth Leederville)	Major Road	16,862	—	—	—	—	—
Cambridge St (West of McCourt St)	Major Road	18,971	—	—	—	—	—

1) As defined by the EPNR. Secondary roads have between 6000-15000 vehicles per day. Major roads have greater than 15000 vehicles per day.

1.3.1 Influencing Factor

As worst case the influencing factor for 9 Salvado Road results from identifying major roads, commercial and industrial areas for all nearest noise sensitive receivers.

The overall influencing factor assessment is summarized in Table 3 and the planning maps indicating the land use type (obtained from Intramaps) has been marked up in Figure 2 and Figure 3.

Table 3: Influencing factor (IF) at noise sensitive receiver

Noise Sensitive Premises	Commercial Zones	Transport Corridors	Influencing Factor
9 Salvado Rd 181 Cambridge St 2 Cashel Ln	27 % within a 450 m radius 19% within a 100mm radius	Railway Pde and Cambridge St within a 450m radius	**4 dB**

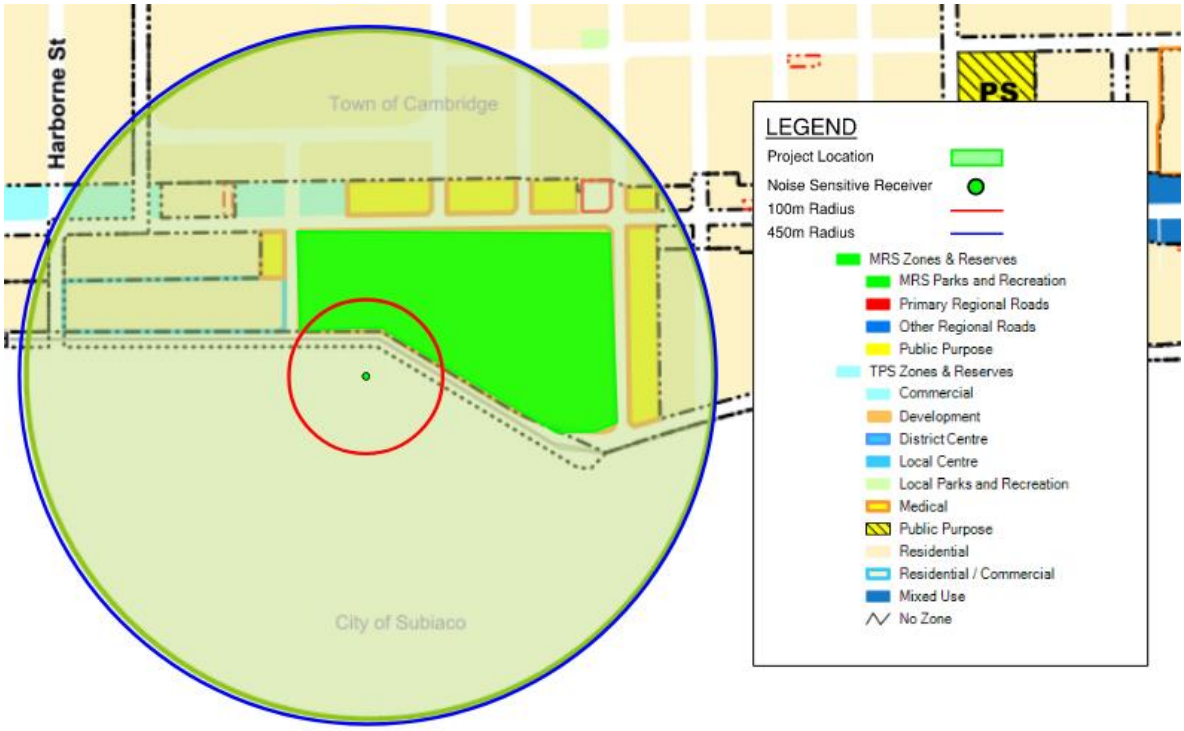


Figure 2: Zoning Map: City of Cambridge Intramaps

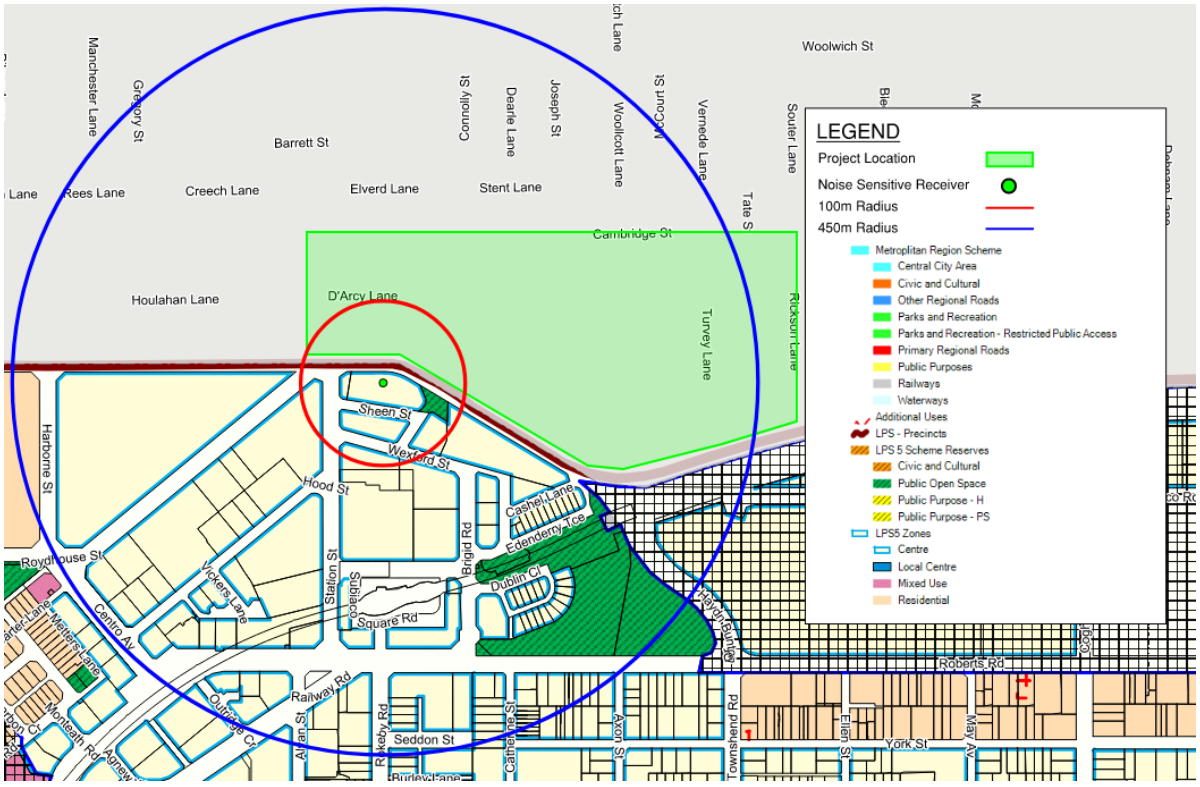


Figure 3: Zoning Map: City of Subiaco Intramaps

1.3.2 Assigned Noise Levels for Nearest Sensitive Receiver

Table 4 summarizes the assigned levels at the nearest noise sensitive premises, which is added to the influencing factor calculated for the receiver detailed in Table 3. It is required that all noise emissions from the development are below the assigned level for all defined periods of the day and at the lot boundary of the receiver or 15m from any associated building. It is noted that the EPNR assigned levels only apply at the premises receiving the noise only and not to noise within the site.

Table 4: Assigned levels for noise sensitive receiver

Type of premises receiving noise	Time of day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise sensitive premises: Highly sensitive area	0700 to 1900 hours Monday to Saturday	49	59	69
	0900 to 1900 hours Sunday & public holidays	44	54	69
	1900 to 2200 hours all days	44	54	59
	2200 hours on any day to 0700 hours Monday to Saturday, and 0900 hours Sunday & public holidays	39	49	59
Noise sensitive premises: any area other than highly sensitive areas	All Hours	60	75	80
Commercial premises	All Hours	60	75	80
Industrial and utility premises	All Hours	65	80	90

1.3.3 Noise Character Adjustments

Regulation 7 states that the noise character must be “free” of annoying characteristics, namely —

- Tonality, e.g. whining, droning;
- Modulation, e.g. like a siren; and
- Impulsiveness, e.g. banging, thumping.

Regulation 9 (1) establishes the methodology for determining noise characteristics. If these characteristics cannot be reasonably and practicably removed, a series of adjustments to the measured levels are required, indicated in Table 5.

Table 5: Noise character adjustment

Adjustment where noise emission is not music. Adjustments are cumulative to a maximum of 15 dB.		
Where tonality is present	Where modulation is present	Where impulsiveness is present
+ 5 dB	+ 5 dB	+ 10 dB

1.3.4 Noise Emissions from Mechanical Plant

It is important that noise emissions from the site do not present any form of tonality, modulation or impulsiveness (as defined by the EPNR).

Given the data from mechanical plant manufacturers is generally limited to broadband data or in 1/1 octave band value, it is not possible to objectively determine tonality, as it is described in the EPNR. 1/3 octave band data is required yet is typically unavailable.

Therefore, a +5dB adjustment shall be conservatively assigned to the noise criteria when assessing noise emissions from proposed mechanical plant.

1.3.5 Emergency Dispensation

Where a non-compliant noise emission from a premise is occurring or is expected to occur, for the purpose of meeting a temporary emergency (a period of less than 14 days), the CEO of the Department of Water and Environmental Regulation

and Conservation (DWER) is able to grant an exemption (orally or in writing) of the EPNR for up to 14 days under Section 75 of the Environmental Protection Act 1986 (EPA). The incident should be reported via the Pollution Incident line on 1300 784 782.

The definition of emergency is not defined in the EPA or in the Interpretation Act 1984, however it is taken to define periods where mains power is disrupted to the site in situations such as cyclonic conditions.

2. Noise Emissions Assessment

As per the Environmental Protection Noise Regulations, all noise emission will need to comply with the criteria in Section 1.3 at the nearest sensitive receivers. Specifically, for the SJOG Subiaco Hospital redevelopment, this includes the following items:

- Site Energy Plant
- Site Water Plant

2.1 Noise Model Inputs

A 3D noise model using SoundPLAN v 8.2 was developed based on the spatial planning layout drawings. The following section details the modelling inputs.

2.1.1 Topography

Current topographical data was accessed from *Nearmap* to determine the ground contours, elevations and *UTM (Universal Transverse Mercator)* coordinate information at and surrounding the project site. The information obtained was imported into to the noise model.

2.1.2 Ground Absorption

A ground factor of 0.6 was assumed in the model to account for attenuation due to ground absorption.

2.1.3 Meteorological Conditions

The *Concawe* algorithm has been selected for meteorological conditions, as presented in Table 6. Meterorological Conditions have therefore been factored into the model in consideration of the worst-case environmental conditions for propagation of noise.

Table 6: Meteorological conditions used for noise modelling

Parameter	Day (0700 – 1900)	Evening / Night (1900 – 0700)
Temperature	20	15
Humidity	50	50
Wind Speed (m/s)	4	3
Wind Direction	All	All
Pasquill Tranquility	E	F

2.2 Site Energy Plant

The Site Energy plant has been proposed to be located on the western side of the existing SJOG Subiaco carpark. The plant itself will be housing mechanical and electrical services equipment including:

- Cooling Towers on the roof;
- Generator plant room;
- Car Park extract and air intake fans;
- Chiller plant room;
- Boiler plant room.

As part of the acoustic assessment, all noise emissions have been assessed at the nearest sensitive receivers are located at 9 Salvado Rd and 181 Cambridge St. This has been illustrated in Figure 4.

Figure 4: Site Energy Plant Location

2.2.1 SEP Assessment Assumptions

This section provides the assumptions and information that has been utilised as part of the noise assessment process for the *Site Energy Plant*.

2.2.1.1 Mechanical Services

The following assumptions have been made based on information currently available from the mechanical consultant:

- All mechanical equipment will be running continuously at all times of the day. Assessed to night time criteria as this is the most stringent the *Environmental Protection Noise Regulations* (EPNR) criteria of L_{A10} 39 dB(A)
- Due to continuous operation, mechanical plant is typically assessed against the L_{A10} assigned levels applicable at all noise sensitive developments.
- Tonality is often present in all mechanical plant types, and therefore, a 5 dB penalty has been assigned to the predicted noise at each receiver for cooling towers, chillers, boilers, pumps and car park fans.
- The upper half of the roof plant deck screens facing Salvado Road will need to be blanked off with solid material (e.g.1mm thick steel). The lower half of the screen can remain perforated in order to aid with the mechanical airflow, as shown in Figure 5.

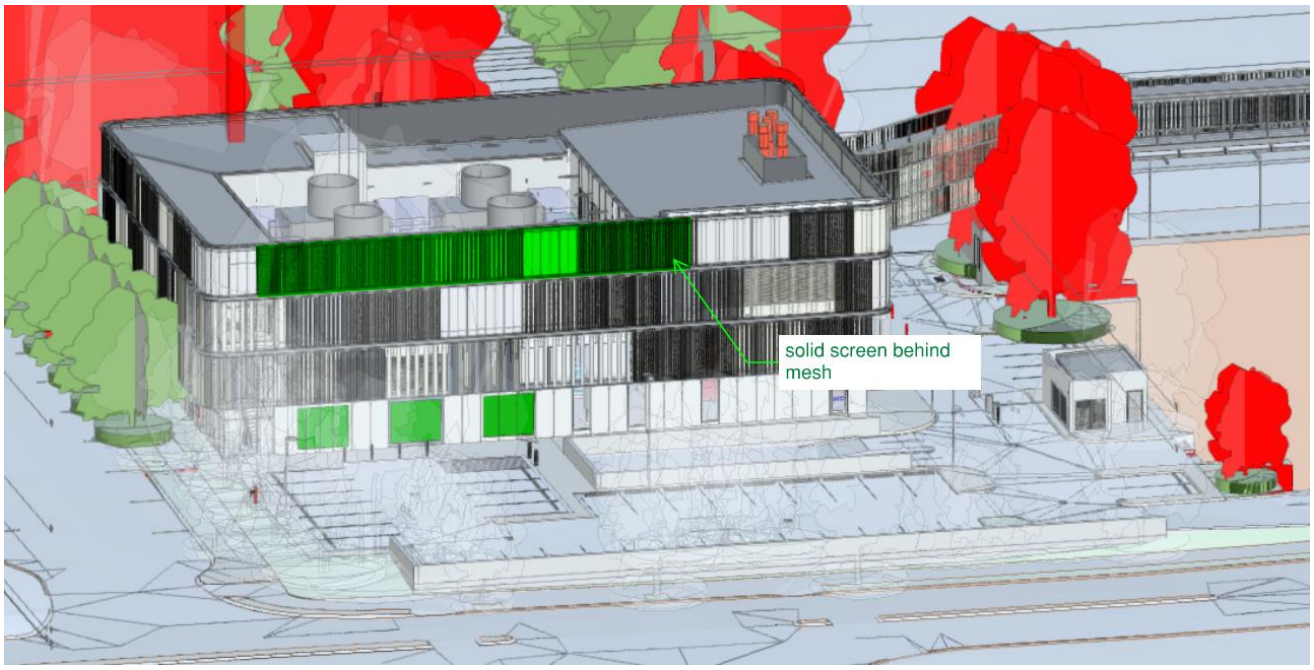


Figure 5: View of BIM 360 Model showing section of screen that requires to be solid

Mechanical equipment information used for the assessment has been summarised in Table 7.

Table 7: Mechanical Services Equipment Information

Equipment	Make and Model	Location	Number of Units	Overall Sound Power Level dB(A)
Cooling Towers	*BAC XES3E-1222-10N/H*	Roof Plant	4	90
Chillers	*Trane CHSWB-2500 kW Water Cooled Chillers*	Level 1 Chiller Plant Room	4	90
Boilers	*Riello RS250*	Level 2 Boiler Plant Room	3	91
Carpark Exhaust Fans	*Fantech AP1006CP6/37*	Level 3 Plant deck	2	89
Carpark Air Intake Fans	*Fantech AP1006CP6/37*	Ground Floor Riser	2	88

2.2.1.2 Electrical Services

The following assumptions have been made based on information currently available from the electrical consultant:

- Generators are considered to only be used during emergencies, where a dispensation can be applied for as per the EPNR (refer Section 1.3.5);
- As periodic testing sessions are required to comply to the EPNR criteria, this has been assessed to the daytime criteria of L_{A10} 49 dB(A).

Electrical equipment information used for the assessment has been summarised in Table 8.

Table 8: Electrical Services Equipment Information

Equipment	Make and Model	Location	Number of Units	Overall Sound Power Level dB(A)
Generators	*Kohler KD3100*	Ground Floor Generator Plant Room	3	124

2.2.2 Predicted Noise Levels (Before Treatments)

The predicted noise levels for the SEP base scenario without any treatments have been summarized in Table 9 with noise contours provided in Appendix B.

Table 9: Predicted Noise Levels from Site Energy Plant (without acoustic treatment)

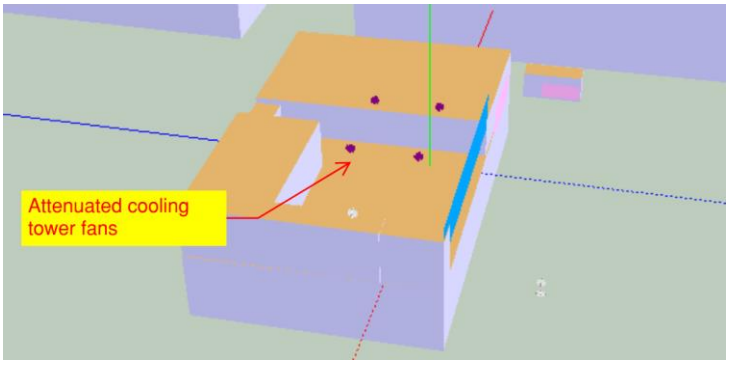
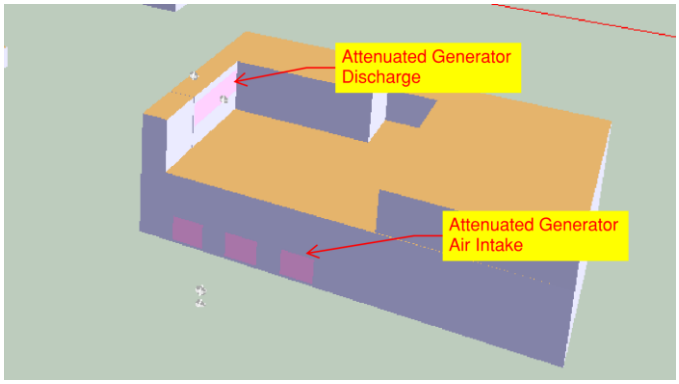
Scenario / Description	Receiver	Highest Predicted Level, dB(A)	Relevant EPNR Criteria [1]	Complies to EPNR
Day Cooling towers, chillers, pumps, boilers and carpark ventilation fans operating at full load. Generator periodic testing expected over 4-hour period every month.	9 Salvado Road (Level 5)	77 (61[1] when generator not running)	L_{A10} 49 dB	**No**
	181 Cambridge St (Level 3)	64 (53[1] when generator not running)		**No**
Evening/ Sunday day Cooling towers, chillers, pumps, boilers and carpark ventilation fans at full load.	9 Salvado Road (Level 5)	61[1]	L_{A10} 44 dB	**No**
	181 Cambridge St (Level 3)	53[1]		**No**
Night 2x Cooling towers, chillers, pumps, boilers and car park ventilation fans at full load.	9 Salvado Road (Level 5)	61[1]	L_{A10} 39 dB	**No**
	181 Cambridge St (Level 3)	53[1]		**No**

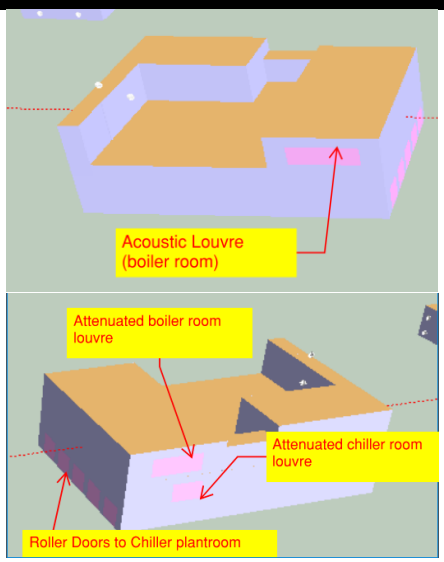
1) Includes a + 5 dB adjustment for tonality

2.2.3 Recommended Noise Mitigation Measures (SEP)

As indicated in Section 2.2.2, the predicted noise levels for the SEP exceeds the EPNR noise criteria for all times of the day at the nearest noise sensitive receivers. As such, the recommended mitigation measures have been provided in Table 10 to control the noise emissions from the SEP.

Table 10: Summary of Recommended Noise Mitigation Measures (SEP)

Recommended Mitigation Measures	Indicative Model Illustration
Cooling Towers (Roof) *Acoustic Attenuator:* Q Seal attenuator with the minimum insertion losses as per Table 11 to be provided to the top of the cooling towers.	
Generator Plant Room *Operational:* Generators to be tested during daytime periods only as per the EPNR. Only one generator unit can be operated at any one time during the testing sessions. *Acoustic Attenuator:* Q Seal attenuator with the minimum insertion losses as per Table 11 to be provided to the top of the cooling towers. *Generator Fume Exhaust:* Fume Exhaust to be provided with a muffler (this can be a double muffler) in order to achieve 47 dB(A) at a distance of 75 metres. *Doors to Plant Room:* Provide R_w 35 rated steel doors 50mm thick.	

Recommended Mitigation Measures	Indicative Model Illustration
Chillers/Boiler/Pump Plant Room *Acoustic Louvre:* Fantech SBL2 with the minimum insertion losses as per Table 11 to be provided to the top of the cooling towers. *Roller Door:* The roller door will need to be solid throughout (e.g. no perforations) and have a minimum surface mass of 4.7kg/m^2. Example product: *Max Door Solutions Shuttermax* or equivalent performing and approved. *Doors to Plantroom:* Provide R_w 35 rated steel doors 50mm thick.	

As part of the recommended mitigation measures stated in Table 10, the minimum octave band static insertion losses for the respective attenuators and louvres have been provided in Table 11 for reference.

Table 11: Minimum Static Insertion Losses for Attenuators/Louvres

Component	Nominal Selection	Minimum Static Insertion Losses (dB)							
		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Cooling Towers attenuator	*Fantech RT07DQS*	7	13	26	40	48	38	27	20
Chiller/Boiler Plantroom acoustic louvre	*Fantech SBL2*	11	16	20	28	33	31	27	23
Generator Intake attenuator	*Fantech RT07GQS*	10	22	38	49	52	47	35	27
Generator Discharge attenuator	*Fantech RT07GQS*	10	22	38	49	52	47	35	27
Car Park Exhaust Fans attenuator	*Fantech C2P-100*	8	11	19	27	29	27	23	19
Car Park Air Intake Fans attenuator	*Fantech C2P-100*	8	11	19	27	29	27	23	19

2.2.4 Predicted Noise Levels (After Treatments)

With the inclusion of the recommended mitigation measures in Section 1), the predicted noise levels at the nearest sensitive receivers due to the noise emission from the Site Energy Plant has been provided in Table 12 and is expected to comply with the EPNR noise criteria. Noise contours have been provided in Appendix B.

Table 12: Predicted Noise Levels from Site Energy Plant (including acoustic treatment)

Scenario / Description	Receiver	Highest Predicted Level, dB(A)	Relevant EPNR Criteria [1]	Complies to EPNR
Day Cooling towers, chillers, pumps, boilers, car park ventilation fans operating at full load. Generator periodic testing.	9 Salvado Road (Level 5)	46 42[1] (excluding generator)	L_{A10} 49 dB	Yes
	181 Cambridge St (Level 3)	37 42[1] (excluding generator)		Yes
Evening/Sunday Day Cooling towers, chillers, pumps, boilers, carpark ventilation fans at full load.	9 Salvado Road (Level 5)	42[1]	L_{A10} 44 dB	Yes
	181 Cambridge St (Level 3)	40[1]		Yes
Night 2x Cooling towers, chillers, pumps, boilers, carpark ventilation fans at full load.	9 Salvado Road (Level 5)	39[1]	L_{A10} 39 dB	Yes
	181 Cambridge St (Level 3)	39[1]		Yes

1) Includes a + 5 dB adjustment for tonality

2.3 Site Water Plant

The Site Water Plant (SWP) is currently located centrally within the existing SJOG Subiaco compound. The plant itself is existing and will be upgraded to include the following hydraulics and fire services equipment including:

- Hydraulic services: Water pumps; and
- Fire services: Fire pumps.

As part of the acoustic assessment, all noise emissions for the SWP have been assessed at the nearest sensitive receivers are located at 2 Cashel Ln, 9 Salvado Rd and 181 Cambridge St. This has been illustrated in Figure 6.

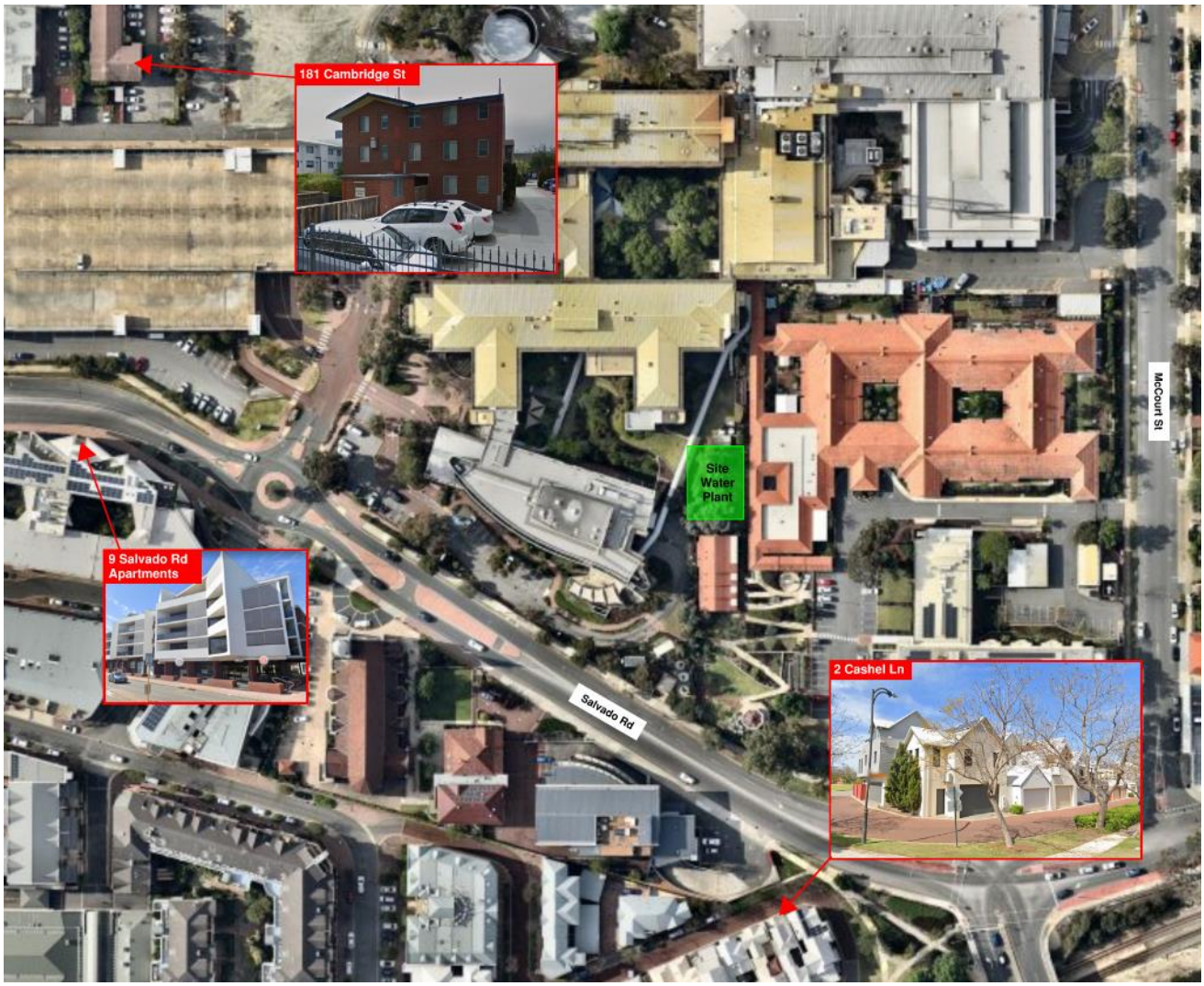


Figure 6: Site Water Plant Location

2.3.1 SWP Assessment Assumptions

This section provides the assumptions and information that has been utilised as part of the noise assessment process for the *Site Water Plant*.

2.3.1.1 Plant Room Construction

At this stage, the construction information regarding the plant room has not been provided. For the purpose of this assessment, the plant room has been assumed to be open.

2.3.1.2 Hydraulic Services

The following assumptions have been made based on information currently available from the mechanical consultant:

- Due to continuous operation the water pumps, they have been assessed to night time criteria as this is the most stringent the *Environmental Protection Noise Regulations* (EPNR) criteria of L_{A10} 39 dB(A)
- Tonality is often present for pump sets, and therefore, a 5 dB penalty has been assigned to the EPNR criteria for each receiver.

The water pump information used for the assessment has been summarised in Table 7.

Table 13: Water Pumps Information

Equipment	Make and Model	Location	Number of Units	Overall Sound Power Level dB(A)
Water Pumps	*Allied Pumps APVS-R455-4C6JF2UV*	SWP	3	69

2.3.1.3 Fire Services

The following assumptions have been made based on information currently available from the fire engineering consultant:

- Fire pumps are considered to only be used during emergencies, where a dispensation can be applied for as per the EPNR (refer Section 1.3.5);
- As periodic testing sessions are required to comply to the EPNR criteria, this has been assessed to the day time criteria of L_{A10} 49 dB(A).

As fire pump sound data information is not available, reasonable assumptions have been made based on similar projects that Stantec have worked on in the past. The typical sound power level for the fire pump expected for a project this size has been summarised in Table 7.

Table 14: Fire Pumps Information

Equipment	Location	Number of Units	Overall Sound Power Level dB(A)
Fire Pumps	SWP	2	109

2.3.2 Predicted Noise Levels (Before Treatments)

The predicted noise levels for the SWP base scenario without any treatments have been summarized in Table 15 with noise contours provided in Appendix B.

Table 15: Predicted Noise Levels from Site Water Plant (without acoustic treatment)

Scenario / Description	Receiver	Highest Predicted Level, dB(A)	Relevant EPNR Criteria [1]	Complies to EPNR
Day Water pump sets at full load Periodic testing of fire pump.	2 Cashel Ln (Ground Level)	70	L_{A10} 49 dB	No
	9 Salvado Road (Level 5)	65		No
	181 Cambridge St (Ground Level)	46		Yes
Evening/Night Water pump sets at full load	2 Cashel Ln (Ground Level)	33	L_{A10} 39 dB	Yes
	9 Salvado Road (Level 5)	27		Yes
	181 Cambridge St (Ground Level)	8		Yes

2.3.3 Recommended Noise Mitigation Measures (SWP)

As indicated in 2.3.2 , the predicted noise levels for the SWP exceeds the EPNR noise criteria during daytime periods at the nearest noise sensitive receiver. The dominating noise source causing this is the fire pump.

As such, the recommended mitigation measures to control the noise emission from the SWP have been provided below:

- Fire Pump:
  - Class 1 attenuation package to be provided.
  - Muffler to be provided to pump exhaust.
  - Only one fire pump unit can be operated at any one time during the testing sessions.
- Where acoustic louvres are being provided, Acoustic louvre to have minimum static insertion loss as specified in Table 16.

Table 16: Site Water Plant Acoustic Louvre Minimum Insertion Loss Performance (dB)

Treatment Type	Example product	Octave Band Insertion Loss Performance (dB)							
		63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz	8 kHz
Acoustic louvre	Fantech SBL2	11	16	20	28	33	31	27	23

In addition, the following plant room construction materials are recommended for best practice noise mitigation:

- Plant room walls and roof to be constructed of:
  - Sheet metal (minimum surface mass of 4.7 kg/m^2). Alternative materials can be used but will require approval by Stantec Acoustics;
- Provide R_w 35 rated steel doors 50mm thick;

2.3.4 Predicted Noise Levels (After Treatments)

With the inclusion of the recommended mitigation measures in Section2.3.3, the predicted noise levels at the nearest sensitive receivers due to the noise emission from the Site Water Plant has been provided in Table 17 and is expected to comply with the EPNR noise criteria. Noise contours have been provided in Appendix B.

Table 17: Predicted Noise Levels from Site Water Plant (including acoustic treatment)

Scenario / Description	Receiver	Highest Predicted Level, dB(A)	Relevant EPNR Criteria [1]	Complies to EPNR
Day Water pump sets at full load Periodic testing of fire pump.	2 Cashel Ln (Ground Level)	46	L_{A10} 49 dB	Yes
	9 Salvado Road (Level 5)	38		Yes
	181 Cambridge St (Ground Level)	22		Yes
Evening/Night Water pump sets at full load	2 Cashel Ln (Ground Level)	33	L_{A10} 39 dB	Yes
	9 Salvado Road (Level 5)	27		Yes
	181 Cambridge St (Ground Level)	8		Yes

3. Vibration Isolation

Acceptable vibration levels from mechanical plant will be achieved with conventional design methodology and mechanical services specifications. The mechanical and hydraulic services must be suitably isolated to prevent structure borne noise transmitting into the building. Detailed treatment recommendations for varying types of equipment have been derived from the ASHRAE guidelines and are provided in Table 18.

Table 18: Vibration Isolation Treatment Recommendations

Equipment Type	Shaft Power kW & Other	RPM	Floor Span												Reference Notes
			Slab on Grade			Up to 6 m			6 to 9 m			9 to 12 m			
			Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	
Refrigeration Machines and Chillers															
Reciprocating	All	All	A	2	6.4	A	4	19	A	4	38	A	4	64	**2,3,12**
Centrifugal,	All	All	A	1	6.4	A	4	19	A	4	38	A	4	38	**2,3,4,8, 12**
Screw	All	All	A	1	25	A	4	38	A	4	64	A	4	64	**2,3,4,12**
Absorption	All	All	A	1	6.4	A	4	19	A	4	38	A	4	38	
Air-cooled recip.,	All	All	A	1	6.4	A	4	38	A	4	38	A	4	64	**2,4,5,12**
Air-cooled screw	All	All	A	4	25	A	4	38	B	4	64	B	4	64	**2,4,5,8,12**
Air Compressors and Vacuum Pumps															
Tank-mounted	≤ 7.5	All	A	3	19	A	3	19	A	3	38	A	3	38	**3,15**
	≥ 11	All	C	3	19	C	3	19	C	3	38	C	3	38	**3,15**
Tank-mounted	All	All	C	3	19	C	3	19	C	3	38	C	3	38	**3,15**
Base-mounted	All	All	C	3	19	C	3	19	C	3	38	C	3	38	**3,14,15**
Large	All	All	C	3	19	C	3	19	C	3	38	C	3	38	**3,14,15**
Pumps															
Close-coupled	≤ 5.6	All	B	2	6.4	C	3	19	C	3	19	C	3	19	**16**
	≥7.5	All	C	3	19	C	3	19	C	3	38	C	3	38	**16**
Large inline	3.7 to 19	All	A	3	19	A	3	38	A	3	38	A	3	38	
	≥22	All	A	3	38	A	3	38	A	3	38	A	3	64	
End suction and	≤ 30	All	C	3	19	C	3	19	C	3	38	C	3	38	**16**
	37 to 93	All	C	3	19	C	3	19	C	3	38	C	3	64	**10,16**
	≥110	All	C	3	19	C	3	38	C	3	64	C	3	89	**10,16**
Packaged pump systems	All	All	A	3	19	A	3	19	A	3	38	C	3	64	
Cooling Towers															
	All	Up to 300	A	1	6.4	A	4	89	A	4	89	A	4	89	**5,8,18**
		301 to 500	A	1	6.4	A	4	64	A	4	64	A	4	64	**5,18**
		501 and up	A	1	6.4	A	4	19	A	4	19	A	4	38	**5,18**

Equipment Type	Shaft Power kW & Other	RPM	Floor Span												
			Slab on Grade			Up to 6 m			6 to 9 m			9 to 12 m			
			Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Reference Notes
Boilers															
Fire-tube	All	All	A	1	6.4	B	4	19	B	4	38	B	4	64	**4**
Water-tube,	All	All	A	1	3	A	1	3	A	1	3	B	4	6.4	
Axial Fans, Plenum Fans, Cabinet Fans, Fan Sections, Centrifugal Inline Fans															
Up to 560 mm diameter	All	All	A	2	6.4	A	3	19	A	3	19	C	3	19	**4,9**
610 mm diameter and up	≤ 500 PaSP	Up to 300	B	3	64	C	3	89	C	3	89	C	3	89	**9,8**
		300 to 500	B	3	19	B	3	38	C	3	64	C	3	64	**9,8**
		501 and up	B	3	19	B	3	38	B	3	38	B	3	38	**9,8**
	≥501 PaSP	Up to 300	C	3	64	C	3	89	C	3	89	C	3	89	**3,8,9**
		300 to 500	C	3	38	C	3	38	C	3	64	C	3	64	**3,8,9**
		501 and up	**C**	**3**	**19**	**C**	**3**	**38**	**C**	**3**	**38**	**C**	**3**	**64**	**3,8,9**

Equipment Type	Shaft Power kW & Other	RPM	Floor Span													
			Slab on Grade			Up to 6 m			6 to 9 m			9 to 12 m			Reference Notes
			Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	
	All	All	B	2	6.4	B	3	19	B	3	19	B	3	38	
		Up to 300	B	3	64	B	3	89	B	3	89	B	3	89	
		300 to 500	B	3	38	B	3	38	B	3	64	B	3	64	
		501 and up	B	3	19	B	3	19	B	3	19	B	3	38	
		Up to 300	C	3	64	C	3	89	C	3	89	C	3	89	
		300 to 500	C	3	38	C	3	38	C	3	64	C	3	64	
		501 and up	C	3	25.4	C	3	38	C	3	38	C	3	64	
		All	A	1	6.4	A	1	6.4	A	1	6.4	A	1	6.4	
		All	A	1	6.4	A	1	6.4	B	4	38	D	4	38	
		All	A	3	19	A	3	19	A	3	19	A/D	3	38	
		All	A	1	6.4	A	4	19	A	4	38	A/D	4	38	
	≤7.5	All	A	3	19	A	3	19	A	3	19	A	3	19	
	≤11	Up to 300	A	3	19	A	3	89	A	3	89	C	3	89	
	≤1 kPa SP	301 to 500	A	3	19	A	3	64	A	3	64	A	3	64	
		501 and up	A	3	19	A	3	38	A	3	38	A	3	38	
	>1 kPa SP11,	Up to 300	B	3	19	C	3	89	C	3	89	C	3	89	
	>1 kPa SP	301 to 500	B	3	19	C	3	38	C	3	64	C	3	64	
		501 and up	B	3	19	C	3	38	C	3	38	C	3	64	
	All	All	A/D	1	6.4	D	3	19			See Reference Note 17				

Equipment Type	Shaft Power kW & Other	RPM	Floor Span												
			Slab on Grade			Up to 6 m			6 to 9 m			9 to 12 m			
			Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Base Type	Isolator Type	Min. Defl. mm	Reference Notes
	≤300L/s	All	A	3	12.7	A	3	12.7	A	3	12.7	A	3	12.7	
	≤30L/s	All	A	3	19	A	3	19	A	3	19	A	3	19	

Base Type:

A. No Base, isolators attached directly to equipment (Note 28)

B. Structural steel rails or base (Notes 29 and 30)

C. Concrete incrtia base (Note 31)

Isolator Types:

1. Pad, rubber, or glass fibre (Notes 20 and 21)
2. Rubber floor isolator or hanger (Notes 20 and 25)
3. Spring floor isolator or hanger (Notes 22,23 and 26)
4. Restrained spring isolator (Notes 22 and 24)
5. Thrust restraint (Note 27)
6. Air spring (Note 25)

Notes for Table 47: Selection Guide for Vibration Isolation

These notes are keyed to the column titled Reference Notes in Table 47and to other reference numbers throughout the table. Although the guide is conservative, cases may arise where vibration transmission to the building is still excessive. If the problem persists after all short circuits have been eliminated, it can almost always be corrected by altering the support path (e.g., from ceiling to floor), increasing isolator deflection, using low-frequency air springs, changing operating speed, improving rotating component balancing, or, as a last resort, changing floor frequency by stiffening or adding more mass. Assistance from a qualified vibration consultant can be very useful in resolving these problems.

Note 1. Isolator deflections shown are based on a reasonably expected floor stiffness according to floor span and class of equipment. Certain spaces may dictate higher levels of isolation. For example, bar joist roofs may require a static deflection of 38 mm over factories, but 64 mm over commercial office buildings.

Note 2. For large equipment capable of generating substantial vibratory forces and structure-borne noise, increase isolator deflection, if necessary, so isolator stiffness is less than one-tenth the stiffness of the supporting structure, as defined by the deflection due to load at the equipment support.

Note 3. For noisy equipment adjoining or near noise-sensitive areas, see the section on Mechanical Equipment Room Sound Isolation.

Note 4. Certain designs cannot be installed directly on individual isolators (type A), and the equipment manufacturer or a vibration specialist should be consulted on the need for supplemental support (base type).

Note 5. Wind load conditions must be considered. Restraint can be achieved with restrained spring isolators (type 4), supplemental bracing, snubbers, or limit stops. Also see Chapter 55.

Note 6. Certain types of equipment require a curb mounted base (type D). Airborne noise must be considered.

Note 7. See section on Resilient Pipe Hangers and Supports for hanger locations adjoining equipment and in equipment rooms.

Note 8. To avoid isolator resonance problems, select isolator deflection so that resonance frequency is 40% or less of the lowest normal operating speed of equipment (see Chapter 8 in the 2009 ASHRAE Handbook—Fundamentals). Some equipment, such as variable-frequency drives, and high-speed equipment, such as screw chillers and vaneaxial fans, contain very-high-frequency vibration. This equipment creates new technical challenges in the isolation of high-frequency noise and vibration from a building's structure. Structural resonances both internal and external to the isolators can significantly

Note 13. Compressors: The two basic reciprocating compressors are (1) single- and double-cylinder vertical, horizontal or L-head, which are usually air compressors; and (2) Y, W, and multihead or multicylinder air and refrigeration compressors. Single- and double-cylinder compressors generate high vibratory forces requiring large inertia bases (type C) and are generally not suitable for upper-story locations. If this equipment must be installed in an upper-story location or at-grade location near noise-sensitive areas, the expected maximum unbalanced force data must be obtained from the equipment manufacturer and a vibration specialist consulted for design of the isolation system.

Note 14. Compressors: When using Y, W, and multi-head and multicylinder compressors, obtain the magnitude of unbalanced forces from the equipment manufacturer so the need for an inertia base can be evaluated.

Note 15. Compressors: Base-mounted compressors through 4 kW and horizontal tank-type air compressors through 8 kW can be installed directly on spring isolators (type 3) with structural bases (type B) if required, and compressors 10 to 75 kW on spring isolators (type 3) with inertia bases
(type C) with a mass 1 to 2 times the compressor mass.

Note 16. Pumps: Concrete inertia bases (type C) are preferred for all flexible-coupled pumps and are desirable for most close-coupled pumps, although steel bases (type B) can be used. Close-coupled pumps should not be installed directly on individual isolators (type A) because the impeller usually overhangs the motor support base, causing the rear mounting to be in tension. The primary requirements for type C bases are strength and shape to accommodate base elbow supports. Mass is not usually a factor, except for pumps over 55 kW, where extra mass helps limit excess movement due to starting torque and forces. Concrete bases (type C) should be designed for a thickness of one-tenth the longest dimension with minimum thickness as follows: (1) for up to 20 kW, 150 mm; (2) for 30 to 55 kW, 200 mm; and (3) for 75 kW and up, 300 mm.
Pumps over 55 kW and multistage pumps may exhibit excessive motion at start-up ("heaving"); supplemental restraining devices can be installed if necessary. Pumps over 90 kW may generate high starting forces; a vibration specialist should be consulted.

Note 17. Packaged Rooftop Air-Conditioning Equipment: This equipment is usually installed on low-mass structures that are susceptible to sound and vibration transmission problems. The noise problems are compounded further by curb-mounted equipment, which requires large roof openings for supply and return air. The table shows type D vibration isolator selections for all spans up to 6 m, but extreme care must be taken for

degrade their performance at high frequencies. Unfortunately, at present no test standard exists for measuring the high-frequency dynamic properties of isolators, and commercially available products are not tested to determine their effectiveness for high frequencies. To reduce the chance of high-frequency vibration transmission, add a 25 mm thick pad (type 1, Note 20) to the base plate of spring isolators (type 3, Note 22, 23, 24). For some sensitive locations, air springs (Note 25) may be required. If equipment is located near extremely noisesensitive areas, follow the recommendations of an acoustical consultant.

Note 9. To limit undesirable movement, thrust restraints (type 5) are required for all ceiling-suspended and floor-mounted units operating at 500 Pa or more total static pressure.

Note 10. Pumps over 55 kW may need extra mass and restraints.

Note 11. See text for full discussion Isolation for Specific Equipment

Note 12. Refrigeration Machines: Large centrifugal, screw, and reciprocating refrigeration machines may generate very high noise levels; special attention is required when such equipment is installed in upper-story locations or near noise-sensitive areas. If equipment is located near extremely noise-sensitive areas, follow the recommendations of an acoustical consultant.

equipment located on spans of over 6 m, especially if construction is open web joists or thin, low-mass slabs. The recommended procedure is to determine the additional deflection caused by equipment in the roof. If additional roof deflection is 6 mm or less, the isolator should be selected for 10 times the additional roof deflection. If additional roof deflection is over 6 mm, supplemental roof stiffening should be installed to bring the roof deflection down below 6 mm, or the unit should be relocated to a stiffer roof position.

For mechanical units capable of generating high noise levels, mount the unit on a platform above the roof deck to provide an air gap (buffer zone) and locate the unit away from the associated roof penetration to allow acoustical treatment of ducts before they enter the building. Some rooftop equipment has compressors, fans, and other equipment isolated internally. This isolation is not always reliable because of internal short-circuiting, inadequate static deflection, or panel resonances. It is recommended that rooftop equipment over 135 kg be isolated externally, as if internal isolation was not used.

Note 18. Cooling Towers: These are normally isolated with restrained spring isolators (type 4) directly under the tower or tower dunnage. High-deflection isolators proposed for use directly under the motor- fan assembly must be used with extreme caution to ensure stability and safety under all weather conditions. See Note 5.

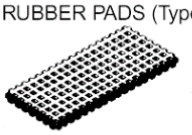
Note 19. Fans and Air-Handling Equipment: Consider the following in selecting isolation systems for fans and air-handling equipment:

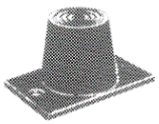
1. Fans with wheel diameters of 560 mm and less and all fans operating at speeds up to 300 rpm do not generate large vibratory forces. For fans operating under 300 rpm, select isolator deflection so the isolator natural frequency is 40% or less than the fan speed. For example, for a fan operating at 275 rpm, 0.4 ⍰ 275 = 110 rpm. Therefore, an isolator natural frequency of 110 rpm or lower is required. This can be accomplished with a 75 mm deflection isolator (type 3).
2. Flexible duct connectors should be installed at the intake and discharge ofall fans and air-handling equipment to reduce vibration transmission to air duct structures.
3. Inertia bases (type C) are recommended for all class 2 and 3 fans and airhandling equipment because extra mass allows the use of stiffer springs, which limit heaving movements.
4. Thrust restraints (type 5) that incorporate the same deflection as isolators should be used for all fan heads, all suspended fans, and all base-mounted and suspended air-handling equipment operating at 500 Pa or more total static pressure. Restraint movement adjustment must be made under normal operational static pressures.

Vibration Isolators: Materials, Types, and Configurations

Notes 20 through 32 include figures to assist in evaluating commercially available isolators for HVAC equipment. The isolator selected for a particular application depends on the required deflection, life, cost, and compatibility with associated structures.

RUBBER PADS (Type 1)

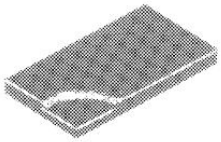




RUBBER MOUNTS (Type 2)

Note 20. Rubber isolators are available in pad (type 1) and molded (type 2) configurations. Pads are used in single or multiple layers. Molded isolators come in a range of 30 to 70 durometer (a measure of stiffness). Material in excess of 70 durometer is usually ineffective as an isolator. Isolators are designed for up to 13 mm deflection, but are used where 8 mm or less deflection is required. Solid rubber and composite fabric and rubber pads are also available. They provide high load capacities with small deflection and are used as noise barriers under columns and for pipe supports. These pad types work well only when they are properly loaded and the mass load is evenly distributed over the entire pad surface. Metal loading plates can be used for this purpose.

GLASS FIBER PADS (Type 1)



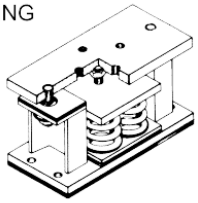
Note 21. Glass fiber with elastic coating (type 1). This type of isolation pad is precompressed molded fiberglass pads individually coated with a flexible, moisture-impervious elastomeric membrane. Natural frequency of fiberglass vibration isolators should be essentially constant for the operating load range of the supported equipment. Mass load is evenly distributed over the entire pad surface. Metal loading plates can be used for this purpose.

SPRING ISOLATOR (Type 3)

Note 22. Steel springs are the most popular and versatile isolators for HVAC applications because they are available for almost any deflection and have a virtually unlimited life. Spring isolators may have a rubber acoustical barrier to reduce transmission of high-frequency vibration and noise that can migrate down the steel spring coil. They should be corrosion-protected if installed outdoors or in a corrosive environment. The basic types include the following:

Note 23. Open spring isolators (type 3) consist of top and bottom load plates with adjustment bolts for leveling equipment. Springs should be designed with a horizontal stiffness of at least 80% of the vertical stiffness (kx/ky) to ensure stability. Similarly, the springs should have a minimum ratio of 0.8 for the diameter divided by the deflected spring height.

RESTRAINED SPRING ISOLATOR (Type 4)



Note 24. Restrained spring isolators (type 4) have hold-down bolts to limit vertical as well as horizontal movement. They are used with (a) equipment with large variations in mass (e.g., boilers, chillers, cooling towers) to restrict movement and prevent strain on piping when water is removed, and (b) outdoor equipment, such as condensing units and cooling towers, to prevent excessive movement due to wind loads. Spring criteria should be the same as open spring isolators, and restraints should have adequate clearance so that they are activated only when a temporary restraint is needed.

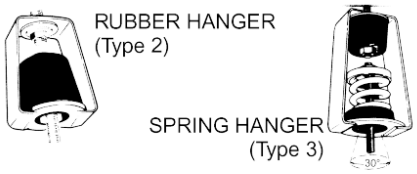
Closed mounts or housed spring isolators consist of two telescoping housings separated by a resilient material. These provide lateral snubbing and some vertical damping of equipment movement, but do not limit the vertical movement. Care should be taken in selection and installation to minimize binding and short-circuiting.

AIR SPRINGS

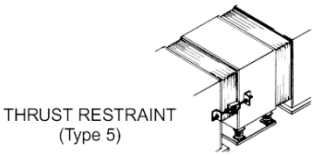
ROLLING LOBE

BELLOWS

Note 25. Air springs can be designed for any frequency, but are economical only in applications with natural frequencies of 1.33 Hz or less (150 mm or greater deflection). They do not transmit high-frequency noise and are often use to replace high-deflection springs on problem jobs (e.g., large transformers on upper-floor installations). A constant air supply (an air compressor with an air dryer) and levelling valves are typically required.



Note 26. Isolation hangers (types 2 and 3) are used for suspended pipe and equipment and have rubber, springs, or a combination of spring and rubber elements. Criteria should be similar to open spring isolators, though lateral stability is less important. Where support rod angular misalignment is a concern, use hangers that have sufficient clearance and/or incorporate rubber bushings to prevent the rod from touching the housing. Swivel or traveller arrangements may be necessary for connections to piping systems subject to large thermal movements. Pre-compressed spring hangers incorporate some means of pre-compression or preloading of the isolator spring to minimize movement of the isolated equipment or system. These are typically used on piping systems that can change mass substantially between installation and operation.

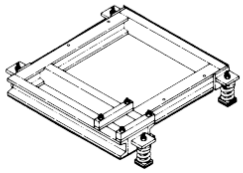


Note 27. Thrust restraints (type 5) are similar to spring hangers or isolators and are installed in pairs to resist the thrust caused by air pressure. These are typically sized to limit lateral movement to 6.4 mm or less.

DIRECT ISOLATION (Type A)

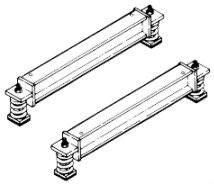
Note 28. Direct isolation (type A) is used when equipment is unitary and rigid and does not require additional support. Direct isolation can be used with large chillers, some fans, packaged air-handling units, and air-cooled condensers. If there is any doubt that the equipment can be supported directly on isolators, use structural bases (type B) or inertia bases (type C), or consult the equipment manufacturer.

STRUCTURAL BASES (Type B)



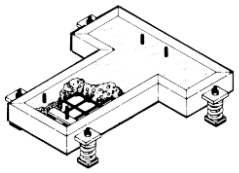
Note 29. Structural bases (type B) are used where equipment cannot be supported at individual locations and/or where some means is necessary to maintain alignment of component parts in equipment. These bases can be used with spring or rubber isolators (types 2 and 3) and should have enough rigidity to resist all starting and operating forces without supplemental hold-down devices. Bases are made in rectangular configurations using structural members with a depth equal to one-tenth the longest span between isolators. Typical base depth is between 100 and 300 mm,
except where structural or alignment considerations dictate otherwise.

STRUCTURAL RAILS (Type B)

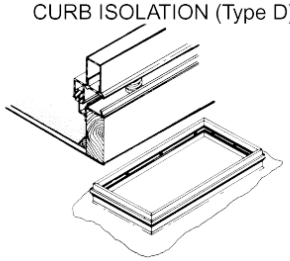


Note 30. Structural rails (type B) are used to support equipment that does not require a unitary base or where the isolators are outside the equipment and the rails act as a cradle. Structural rails can be used with spring or rubber isolators and should be rigid enough to support the equipment without flexing. Usual practice is to use structural members with a depth one-tenth of the longest span between isolators, typically between 100 and 300 mm, except where structural considerations dictate otherwise.

CONCRETE BASES (Type C)



Note 31. Concrete bases (type C) are used where the supported equipment requires a rigid support (e.g., flexible-coupled pumps) or excess heaving motion may occur with spring isolators. They consist of a steel pouring form usually with welded-in reinforcing bars, provision for equipment hold-down, and isolator brackets. Like structural bases, concrete bases should be sized to support piping elbow supports, rectangular or T-shaped, and for rigidity, have a depth equal to one-tenth the longest span between isolators. Base depth is typically between 150 and 300 mm unless additional depth is specifically required for mass, rigidity, or component alignment.

CURB ISOLATION (Type D) 	**Note 32**. Curb isolation systems (type D) are specifically designed for curb-supported rooftop equipment and have spring isolation with a watertight, and sometimes airtight, assembly. Rooftop rails consist of upper and lower frames separated by nonadjustable springs and rest on top of architectural roof curbs. Isolation curbs incorporate the roof curb into their design as well. Both kinds are designed with springs that have static deflections in the 25 to 75 mm range to meet the design criteria described in type 3. Flexible elastomeric seals are typically most effective for Weatherproofing between the upper and lower frames. A continuous sponge gasket around the perimeter of the top frame is typically applied to further weatherproof the installation.

Appendix A Glossary of Acoustic Terms

NOISE	Description
Acoustic Barrier:	Solid walls or partitions, solid fences, earth mounds, earth berms, buildings, etc. used to reduce noise.
Ambient Noise:	The all-encompassing noise associated within a given environment at a given time, usually composed of sound from all sources near and far.
Assessment Period:	The period in a day over which assessments are made.
Assessment Location	The position at which noise measurements are undertaken or estimated.
Background Noise:	Background noise is the term used to describe the underlying level of noise present in the ambient noise, measured in the absence of the noise under investigation, when extraneous noise is removed. It is described as the average of the minimum noise levels measured on a sound level meter and is measured statistically as the A-weighted noise level exceeded for ninety percent of a sample period. This is represented as the L90 noise level.
Decibel [dB]:	The units of sound pressure level.
dB(A):	A-weighted decibels. Noise measured using the A filter.
Extraneous Noise:	Noise resulting from activities that are not typical of the area. Atypical activities include construction, and traffic generated by holidays period and by special events such as concert or sporting events. Normal daily traffic is not considered to be extraneous.
Free Field:	An environment in which there are no acoustic reflective surfaces. Free field noise measurements are carried out outdoors at least 3.5m from any acoustic reflecting structures other than the ground
Frequency:	Frequency is synonymous to pitch. Frequency or pitch can be measured on a scale in units of Hertz (Hz).
Impulsive Noise:	Noise having a high peak of short duration or a sequence of such peaks. A sequence of impulses in rapid succession is termed repetitive impulsive noise.
Intermittent Noise:	Level that drops to the background noise level several times during the period of observation.
L_{Amax}	The maximum A-weighted sound pressure level measured over a period.
L_{A1}	The A-weighted sound pressure level that is exceeded for 1% of the time for which the sound is measured.
L_{A10}	The A-weighted sound pressure level that is exceeded for 10% of the time for which the sound is measured.
L_{A90}	The A-weighted level of noise exceeded for 90% of the time. The bottom 10% of the sample is the L90 noise level expressed in units of dB(A).
L_{Aeq}	The A-weighted “equivalent noise level” is the summation of noise events and integrated over a selected period of time.
$L_{Aeq,T}$	The constant A-weighted sound which has the same energy as the fluctuating sound of the traffic, averaged over time T.
Reflection:	Sound wave changed in direction of propagation due to a solid object met on its path.
R_w:	The Sound Insulation Rating R_w is a measure of the noise reduction performance of the partition.
Sound Absorption:	The ability of a material to absorb sound energy through its conversion into thermal energy.

NOISE	Description
Sound Level Meter:	An instrument consisting of a microphone, amplifier and indicating device, having a declared performance and designed to measure sound pressure levels.
Sound Pressure Level:	The level of noise, usually expressed in decibels, as measured by a standard sound level meter with a microphone.
Sound Power Level:	Ten times the logarithm to the base 10 of the ratio of the sound power of the source to the reference sound power.
Tonal noise:	Containing a prominent frequency and characterised by a definite pitch.

Appendix B Noise Contours

SJOG SUBIACO SEP (GENERATOR)

Without Treatments

18/10/2022
BH

Daytime

Noise Contours at Level 5 (13.5 meters)

Noise level
in dB L_{A10}

	< 60.0
60.0 <=	< 62.5
62.5 <=	< 65.0
65.0 <=	< 67.5
67.5 <=	< 70.0
70.0 <=	< 72.5
72.5 <=	< 75.0
75.0 <=	< 77.5
77.5 <=	< 80.0
80.0 <=	< 82.5
82.5 <=	< 85.0
85.0 <=	< 87.5
87.5 <=	< 90.0
90.0 <=	< 92.5
92.5 <=	< 95.0
95.0 <=	< 97.5
97.5 <=	< 100.0
100.0 <=	< 102.5
102.5 <=	< 105.0
105.0 <=	

Signs and symbols
- Mechanical Plant

Stantec

SJOG SUBIACO SEP (GENERATOR) With Acoustic Treatments

18/10/2022
BH

Daytime

Noise Contours at Level 5
(13.5

Noise level
in dB L_{A10}

	< 39.0
39.0 <=	< 44.0
44.0 <=	< 49.0
49.0 <=	< 54.0
54.0 <=	< 59.0
59.0 <=	< 64.0
64.0 <=	< 69.0
69.0 <=	< 74.0
74.0 <=	< 79.0
79.0 <=	

Signs and symbols
- Mechanical Plant

Stantec

SJOG SUBIACO
SEP
(Mechanical Plant)

Without Treatments

18/10/2022
BH

Evening / Sunday Day

Noise Contours at Level 5
(13.5 meters)

Includes +5 dB tonality
adjustment

Noise level
in dB L_{A10}

	< 39.0
39.0 <=	< 44.0
44.0 <=	< 49.0
49.0 <=	< 54.0
54.0 <=	< 59.0
59.0 <=	< 64.0
64.0 <=	< 69.0
69.0 <=	< 74.0
74.0 <=	< 79.0
79.0 <=	

Signs and symbols
Mechanical Plant

Stantec

SJOG SUBIACO SEP (Mechanical Plant) With Acoustic Treatments

18/10/2022
BH

Evening / Sunday Day

Noise Contours at Level 5 (13.5 meters)

Includes +5 dB tonality adjustment

Noise level
in dB L_{A10}

	< 39.0
39.0 <=	< 44.0
44.0 <=	< 49.0
49.0 <=	< 54.0
54.0 <=	< 59.0
59.0 <=	< 64.0
64.0 <=	< 69.0
69.0 <=	< 74.0
74.0 <=	< 79.0
79.0 <=	

Signs and symbols
Mechanical Plant

Stantec

SJOG SUBIACO
SEP
(Mechanical Plant)

Without Treatments

18/10/2022

BH

Night time

Noise Contours at Level 5
(13.5 meters)

Includes +5 dB tonality
adjustment

Noise level
in dB L_{A10}

	< 39.0
39.0 <=	< 44.0
44.0 <=	< 49.0
49.0 <=	< 54.0
54.0 <=	< 59.0
59.0 <=	< 64.0
64.0 <=	< 69.0
69.0 <=	< 74.0
74.0 <=	< 79.0
79.0 <=	

Signs and symbols

Mechanical Plant

Stantec

SJOG SUBIACO SEP - With Acoustic treatments (Mechanical Plant)

18/10/2022
BH

Night time

Noise Contours at Level 5 (13.5 meters)

Includes +5 dB adjustement for tonality

Noise level
in dB L_{A10}

	< 39.0
39.0 <=	< 44.0
44.0 <=	< 49.0
49.0 <=	< 54.0
54.0 <=	< 59.0
59.0 <=	< 64.0
64.0 <=	< 69.0
69.0 <=	< 74.0
74.0 <=	< 79.0
79.0 <=	

Signs and symbols
- Mechanical Plant

Stantec

SJOG SUBIACO SWP

26-Nov-21
MXC

Day Time
(After Treatments)

Noise Contours at Level 5
(1.5 meters)

Includes Tonality +5dB

181 Cambridge St

9 Salvado Rd

SWP

<49 dB(A)

<46.5 dB(A)

1 Cashel Ln

2-22 Cashel Ln

Noise level
in dB(A)

	< 39.0
39.0 <=	< 41.5
41.5 <=	< 44.0
44.0 <=	< 46.5
46.5 <=	< 49.0
49.0 <=	< 51.5
51.5 <=	< 54.0
54.0 <=	< 56.5
56.5 <=	< 59.0
59.0 <=	< 61.5
61.5 <=	< 64.0
64.0 <=	< 66.5
66.5 <=	< 69.0
69.0 <=	< 71.5
71.5 <=	< 74.0
74.0 <=	< 76.5
76.5 <=	< 79.0
79.0 <=	

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Stantec

SJOG SUBIACO SWP

26-Nov-21
MXC

Night Time
(After Treatments)

Noise Contours at Level 5
(1.5 meters)

Includes Tonality +5dB

181 Cambridge St

9 Salvado Rd

SWP

1 Cashel Ln

2-22 Cashel Ln

<36.5 dB(A)

<34 dB(A)

<31.5 dB(A)

<29 dB(A)

Noise level
in dB(A)

	< 29.0
29.0 <=	< 31.5
31.5 <=	< 34.0
34.0 <=	< 36.5
36.5 <=	< 39.0
39.0 <=	< 41.5
41.5 <=	< 44.0
44.0 <=	< 46.5
46.5 <=	< 49.0
49.0 <=	< 51.5
51.5 <=	< 54.0
54.0 <=	< 56.5
56.5 <=	< 59.0
59.0 <=	< 61.5
61.5 <=	< 64.0
64.0 <=	< 66.5
66.5 <=	< 69.0
69.0 <=	

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Stantec

Design with
community in mind

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