Appendix K: Operational Waste Management

Design Brief

Byford Rail Extension

Rev_1

Project No. 23-1451

MetCONNX

20 June 2023

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Revision	Drafted by	Reviewed by	Date issued
Rev_0	K Oliver / K Howarth	J Campbell	20 June 2023

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1 Development details

This Design Brief has been prepared for the following project:

Project name	**Byford Rail Extension**
Client	MetCONNX
Architect	Hames Sharley
Main point of contact	Flavia Melo Tarmo, MetCONNX
Planning status	DA submission
Green rating / sustainability objectives	Armadale train station is expected to have a formal 5 star Green Star rating and Byford a 4 Star Green Star rating. Both stations are registered with the Green Building Council of Australia under the Railways tool v1.1.
Overview of development	Rail extension project including 2 train stations: 1. Armadale train station will be demolished and replaced with upgraded infrastructure 2. The Armadale train line will be extended to include the new Byford train station and supporting infrastructure
Architectural plans / area schedule / development information	• Architectural plans received from Hames Sharley on 30 May 2023 • Area schedule received from Hames Sharley on 30 May 2023 • Dynamic Pedestrian Analysis received from Hames Sharley on 30 May 2023
Local Government Authorities	City of Armadale and Shire of Serpentine Jarrahdale have not indicated they require Waste Management Plans for each train station for DA. Encycle will confirm with each council whether a WMP is required for DA. City of Armadale and Shire of Serpentine Jarrahdale do not have clear waste guidelines and requirements in regards to train stations. Therefore details of waste services and considerations will need to be established through liaison with both local governments.

2 Actions – design team

This report is not a Waste Management Plan (WMP) or an Operational Waste Management Plan (OWMP). The purpose of this report is to provide information to the design team so that compliant waste management and recycling systems can be incorporated into the architectural plans for each train station.

For Encycle to prepare and finalise the Operational Waste Management Plans for each Green Star submission, the actions in Table 1 are required to be carried out by the design team for each train station. The following actions are also required for the WMPs for each Development Application (if these documents are required by each council).

Allow up to two (2) weeks after completion of actions for Encycle to issue the Waste Management Plan.

Table 1: Action list

Action list	Document reference
☐ Check and confirm project parameters are correct ☐ Check and confirm assumptions are correct ☐ Confirm management assumptions are correct ☐ Address design considerations	**Section 3**
Send to Encycle the final area schedule with: ☐ commercial tenancy NLAs and uses (where relevant)	**Section 3**
☐ Create and send to Encycle the swept path analysis drawings	**Section 4**
☐ Confirm collection point/s and method ☐ Include waste collection access requirements in design	**Section 4**
☐ Incorporate number of bin stores and number of bins per bin store in design	**Section 5**
☐ Create and send to Encycle bin store plans including bins and equipment are marked up as outlined in 'Bin store design'	**Section 5 and Section 6**
☐ Interior designers to include waste streams/bin stations in interior design plans for those stations that have tenancies	**Section 7**

3 Project parameters, assumptions and design considerations

3.1 Project parameters

The train stations when operational will include the following areas:

Armadale

- Concourse 1,321 m^2
- Platform 2,153 m^2
- Kiosk 32 m^2
- Staff crib facilities 31 m^2
- Public amenities 54 m^2
- Staff amenities 69 m^2

Byford

- Platform 1,672 m^2
- Concourse 250 m^2
- Kiosk 67 m^2
- Staff crib facilities 30 m^2
- Public amenities 53 m^2
- Staff amenities 68 m^2

3.2 Assumptions

In calculating the waste generation for the development, the following assumptions have been made:

- The waste generation for both stations has been estimated utilising the current waste generation at Armadale station in line with the projected patron numbers until 2051No grease trap or cooking oil storage will be required for the kiosk/takeaway tenancies
- The kiosk tenancy will be occupied by only takeaway or retail businesses and will operate up to 7 days a week, unlicensed
- As waste generation will be minimal, only commingled recycling will be segregated (including cardboard and paper)

The separation of waste streams relies on good internal and external infrastructure for bins and signage

3.3 Management assumptions

It is assumed that the following management measures in Table 2 will be in place when the train stations become operational.

Table 2: Management assumptions

Management measure	Assumption
Maintenance of the bin stores – ensuring stores are clean and tidy	Public Transport Authority cleaners/facilities management
Setting bins out on the verge or in the bin store for collection (if required)	Public Transport Authority cleaners/facilities management
Communication with staff about source separation of waste streams	Public Transport Authority facilities management
Communication with staff about correct use of the waste and recycling systems/equipment	Public Transport Authority facilities management

3.4 Design considerations

Table 3 sets out the key design considerations for good waste management planning and a summary of the design approach for the stations which addresses these considerations.

Table 3: Design considerations

Design consideration	Current design approach
Bin store	Bin stores need to be provided for each station that are positioned in a location that is convenient to where waste will be generated and the vehicle collection point for servicing the bins (where possible).
Frequency of collections	General waste: three times weekly Commingled recycling: weekly
Waste service provider	Private service provider as per State Government procurement guidelines
Collection vehicle type/sizes	Rear-lift vehicle
Service vehicle access	4m height clearance is required Collection point should allow other vehicles to pass the stationery waste vehicle to avoid traffic obstructions

3.5 Local Government Guidelines

The following have been used in the development of this report:

- WALGA Commercial and Industrial Waste Management Plan Guidelines (2018)
- Green Star Railway Stations v1.1 – Credit 8 Operational Waste

3.6 Local Government requirements and discussions

- Encycle have contacted the local councils but have not been able to get direct feedback on their waste management policies. When the councils provide feedback we shall provide this information to the design team
- The design team has advised Waste Management Plans have not been required as part of the Development Application process

3.7 Green Star requirements

Armadale train station is expected to have a formal 5 star Green Star rating through the Green Building Council of Australia. Byford station is expected to achieve a 4 star Green Star equivalent rating. This Design Brief includes all requirements for each station to achieve the Operational Waste credit of the Green Star Railway Station v1.1 rating tool. The performance pathway of the credit (8A) is targeted, which is to develop an Operational Waste Management Plan that:

- Identifies the site boundary, the waste streams relevant to the project, and the individual roles responsible for delivering and reviewing the OWMP;
- Sets diversion from landfill targets and/or targets for reducing total materials generation (general waste materials and recyclable/reusable materials), as well as monitoring and measurement procedures for waste and recycling streams by weight
- Outlines methods for encouraging the separation of waste streams, such as bins, storage areas, or recycling facilities in public areas as required
- Identifies storage areas for all waste streams and outline best practice safety and access requirements for their collection
- Identify safe methods for vehicle access and transfer of waste
- Incorporate a review process to assess the success of the OWMP and make improvements based on operational experience

4 Vehicle access and collection

4.1 Service providers and vehicle types

A private service provider will service the general waste and recycling bins, including those from the kiosk tenancies. A range of rear-lift vehicles will require access to the bin store at each train station.

4.2 Collection point and method – Armadale

The recommended collection point for waste and recycling vehicles at Armadale train station is from the bin store adjacent to the drop off area (Kiss & Ride) at street level, provided vehicle access is adequate.

It is recommended that on collection days rear-lift vehicles for general waste and commingled recycling will enter the station drop off area from Commerce Avenue. The vehicles will drive in a forwards direction and stop outside the bin store at street level. The operatives will retrieve and service the bins, and then return the empty bins to the same location. The waste vehicle will then exit in a forwards direction back on to Commerce Avenue.

4.3 Collection point and method – Byford

The current architectural plans show a collection point for waste and recycling vehicles at the Byford train station within the bus interchange from the rubbish refuse collection bay.

Encycle support this location for the collection of waste and recycling however it is recommended that confirmation from the PTA is sought to use the bus interchange for waste collection as soon as possible.

On collection days rear-lift vehicles for general waste and commingled recycling, will enter the bus interchange from Evans Way. The vehicles will drive in a forwards direction and stop in the refuse bay. The operatives will retrieve and service the bins from the main bin store, and then return the empty bins to the same location. The waste vehicle will then exit in a forwards direction back on to Evans Way.

4.4 Swept path analysis

The vehicle sizes provided in Appendix B should be used to carry out a swept path analysis to determine accessibility of the rear-lift vehicles to the collection area for each station. Swept path analysis for the largest vehicle is required for the Waste Management Plan (WMP and OWMP). Accommodating the largest vehicle will enable the PTA facility management to have a wider choice of waste service providers in operation and may decrease service costs relative to relying on small (less efficient) vehicles. Vehicle access must comply with access requirements outlined in Table 4 below.

4.5 Vehicle access requirements

Access requirements are outlined in Table 4 below.

Table 4: Vehicle access requirements

Item	Requirement
Access for waste collection vehicles	Waste collection vehicles must be able to safely enter, operate and exit the collection points without or with minimal reversing or manoeuvring Rear-lift vehicles will require the rear of the vehicle to be as close as possible to where the bins are stored/presented to minimise labour and time manually transferring bins
Vehicle head height clearance	Head height clearance required for waste and recycling collection vehicles where vehicles will enter a building or need to move under overhead restrictions Additional space is required as a buffer between the ceiling, pipes, walls and duct work etc. and the vehicle and its operating components
Walkways	Provide safe access walkways to waste collection vehicle points to reduce the risk of accidents

5 Bin stores, bin numbers and equipment

5.1 Waste generation rates

WALGA waste generation rates are used as a guide for the Kiosk and staff facilities in addition to data from the existing Armadale train station to calculate the generation of waste and recyclables for both stations.

5.2 Number of bin stores required - Armadale

Three bin stores will be required to service the Armadale train station public and staff areas, and commercial tenancy of the development separately:

i. Main bin store (for waste and recycling generated by the public)

ii. Station bin store (a store room for storing bins for use by cleaners to service smaller bins and transfer to the main bin store)

iii. Kiosk bin store

The main bin store could be used as the collection location for all bins on collection days to prevent kiosk bins being presented in an open location near where the service vehicle will park. The main bin store could also be used as the area for all bins to be washed.

The waste generation and bin numbers for both stations have been calculated by using the current volumes of waste produced at Armadale Station, increased in line with the projected 2051 patronage increases. A reduction of 25% of the total volume has been assumed to take into consideration the improvements in waste reduction through best practice waste management. If volumes continue to decrease, the collection frequency of bins can be reduced accordingly.

The bin numbers to be stored in each bin store are set out in Table 5, Table 6 and Table 7.

Table 5: Number of bins to be stored in the Armadale main bin store

Waste stream	Bin size (L)	Number of bins	Collection frequency	Colour code*
General waste	660	3	Three times weekly	**W**
Commingled recycling	660	3	Three times weekly	**CM**

***Note**: colour codes should be used in the architectural plans to easily identify bin types

Table 6: Number of bins to be stored in the Armadale station cleaners bin store

Waste stream	Bin size (L)	Number of bins	Collection frequency	Colour code*
General waste	240	1	As required (into main bin store bins)	**W**

Commingled recycling	240	1	As required (into main bin store bins)	**CM**

***Note**: colour codes should be used in the architectural plans to easily identify bin types.

Table 7 Number of bins to be stored in the Armadale kiosk bin store

Waste stream	Bin size (L)	Number of bins	Collection frequency	Colour code*
General waste	240	1	Weekly	**W**
Commingled recycling	240	1	Fortnightly	**CM**

***Note**: colour codes should be used in the architectural plans to easily identify bin types.

5.3 Number of bin stores required - Byford

Two bin stores will be required to service the Byford train station public and staff areas, and commercial tenancy of the development separately:

i. Main bin store

ii. Kiosk bin store

However the main bin store could be used as the collection location for all bins on collection days to prevent kiosk bins being presented in an open location near where the service vehicle will park. The main bin store could also be used as the area for all bins to be washed.

The waste generation and bin numbers for both stations have been calculated by using the current volumes of waste produced at Armadale Station (since Byford is a new station) increased in line with the projected patronage increases. A reduction of 25% of the total volume has been assumed to take into consideration the improvements in waste reduction through best practice waste management. If volumes continue to decrease, the collection frequency of bins can be reduced accordingly.

The bin numbers to be stored in each bin store are set out in Table 8 and Table 9.

Table 8: Number of bins to be stored in the Byford main bin store

Waste stream	Bin size (L)	Number of bins	Collection frequency	Colour code*
General waste	660	4	Three times weekly	**W**
Commingled recycling	660	4	Three times weekly	**CM**
Bins for cleaner use only				
General waste	240	1	N/A	**W**
Commingled recycling	240	1	N/A	**CM**

***Note**: colour codes should be used in the architectural plans to easily identify bin types.

Table 9: Number of bins to be stored in the Byford kiosk bin store

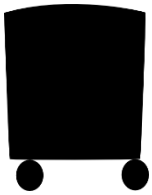
Waste stream	Bin size (L)	Number of bins	Collection frequency	Colour code*
General waste	240	1	Weekly	**W**
Commingled recycling	240	1	Fortnightly	**CM**

***Note**: colour codes should be used in the architectural plans to easily identify bin types.

5.4 Dimensions – mobile garbage bins

Bin store layout must be designed to take into account the dimensions of the bins in Table 9. Please note that the dimensions of bins vary slightly between manufacturers and should be used as a guide only.

Table 9: Dimensions of mobile garbage bin

Volume	*240L*	*660L*
		
Height (mm)	*1060*	*1200*
Depth (mm)	*730*	*780*
Width (mm)	*585*	*1260*
Footprint (m^2)	*0.43*	*0.98*

6 Bin store design

Best practice bin store design is an essential component of waste management. See Table 10 below for a checklist of bin store design requirements.

Table 10: Bin store design requirements

Location	□ On street level □ On same level as collection point □ Near to lifts and vehicle collection point □ **Show on plan** – bin store location □ **Show on plan** – finished floor level/relative level
Fully enclosed	□ Bin stores fully enclosed and weatherproof □ Only accessible by tenants, cleaners, PTA facility management and waste service provider
Spatial requirements	□ Accommodate bins and equipment as set out above □ Allow sufficient space to manoeuvre and wash the bins
Layout of bins	□ Locate same waste stream bins together □ Locate heavy/difficult to move streams near the door □ Bins can go over bin wash area, ensuring there is space to move them when washing is in progress □ **Show on plan** – bin store layout of bins (labelled with waste/recycling stream) and equipment
Bin wash	□ Impermeable walls and floors grading to an industrial floor waste □ Charged 'water-trap' connected to sewer or an approved septic system □ Hose cock to enable bins and/or the bin store to be washed out □ 100 mm floor waste gully to waste outlet □ Cold running water available □ Allow 2-3 m x 2-3 m depending upon the overall size of the bin store □ **Show on plan** – cold taps and floor waste
Doors	□ Ventilated internal and external doors □ Self-closing doors to eliminate access to vermin □ Openings (e.g. doors) should be able to be locked open □ Widths of doors minimum 1100 mm to enable bins to be easily wheeled into and out □ **Show on plan** – widths of doors/access to bin stores
Security	□ Security measures installed to limit access to the bin stores, e.g. PIN code (not key cards as easy to lose) □ Waste service providers allowed access to bin stores (to reduce operational costs of cleaning staff putting bins out for collection)
Walls and ceilings	□ Internal walls to be cement rendered (solid and impervious) □ Ceilings finished with a smooth faced, non-absorbent material □ Walls and ceilings finished or painted in a light colour

Floors	□ Floor constructed in concrete in accordance with AS 2870 □ Floor evenly graded to an approved liquid refuse disposal system □ Slab thickness minimum of 100 mm □ Slab impervious and with a brush finish treatment
Ventilation and odour	□ Provide adequate separate ventilation system that complies with Australian Standard 1668 (AS 1668) □ Ventilation outlet not in the vicinity of windows or intake vents associated with other ventilation systems
Lighting	□ Artificial lighting installed, with sensor or switch controls both internal and external to the bin stores □ Artificial lighting provided in car parks, bus exchange and access walkways to bin stores, to ensure staff safety and decrease antisocial behaviour
Noise	□ Noise minimised through considering the location of the bin stores and collection point and the timing of collections
Signage	□ Visual aids and signage to be provided to ensure that the areas work as intended

7 Bin store locations and internal transfer

7.1 Bin store location

Currently there are bin stores included in the architectural plans at Armadale and Byford stations. It is recommended that both stations have a bin store to ensure PTA public litter bins from the platform, bus exchanges and car parks can be easily consolidated and waste and recycling bins stored and collected. The bin stores should be located in an area that is convenient for the PTA facilities manager and the waste collection staff to access. Please note the vehicle collection points shown in sections 7.1.1 to 7.1.3 are indicative only and will need to be confirmed by PTA and relevant traffic consultant.

7.1.1 Armadale Station

It is recommended that Armadale train station has three bin stores: one temporary bin store for the station area for the use by the cleaning contractor, one for the kiosk to store their waste and recycling directly at the tenancy, and a main bin store adjacent to the kiss & ride. The location for the main bin store, which would be allocated for bins to be transferred to for collection, is the store labelled 'bulk bin store' shown in Figure 1. Current architectural plans show a total of three stores, including one for the bus interchange. A bin store for the bus interchange is not essential, however could be included if required by PTA.

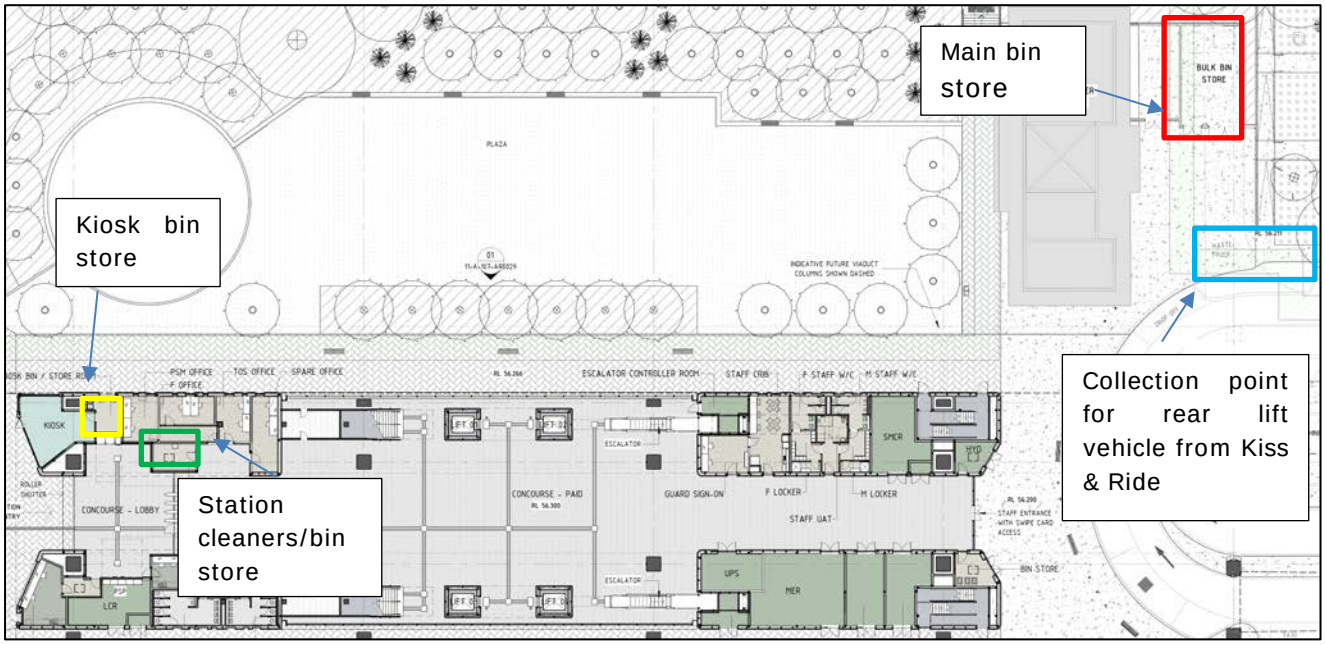


Figure 1: Armadale station potential bin store locations and collection point

7.1.2 Byford

Byford train station has three bin stores indicated on the current architectural plans: one bin store for the main station area, one for the kiosk and a bin store within the bus interchange island (refer Figure 2). A bin store for the bus interchange is not essential, however could be included if required by PTA. The waste collections should take place from

the bus interchange and it is recommended that waste service provider operatives service the bins directly from the main bin store so that the bins are not left out for collection and exposed (public interference or vandalised) whilst waiting for collection.

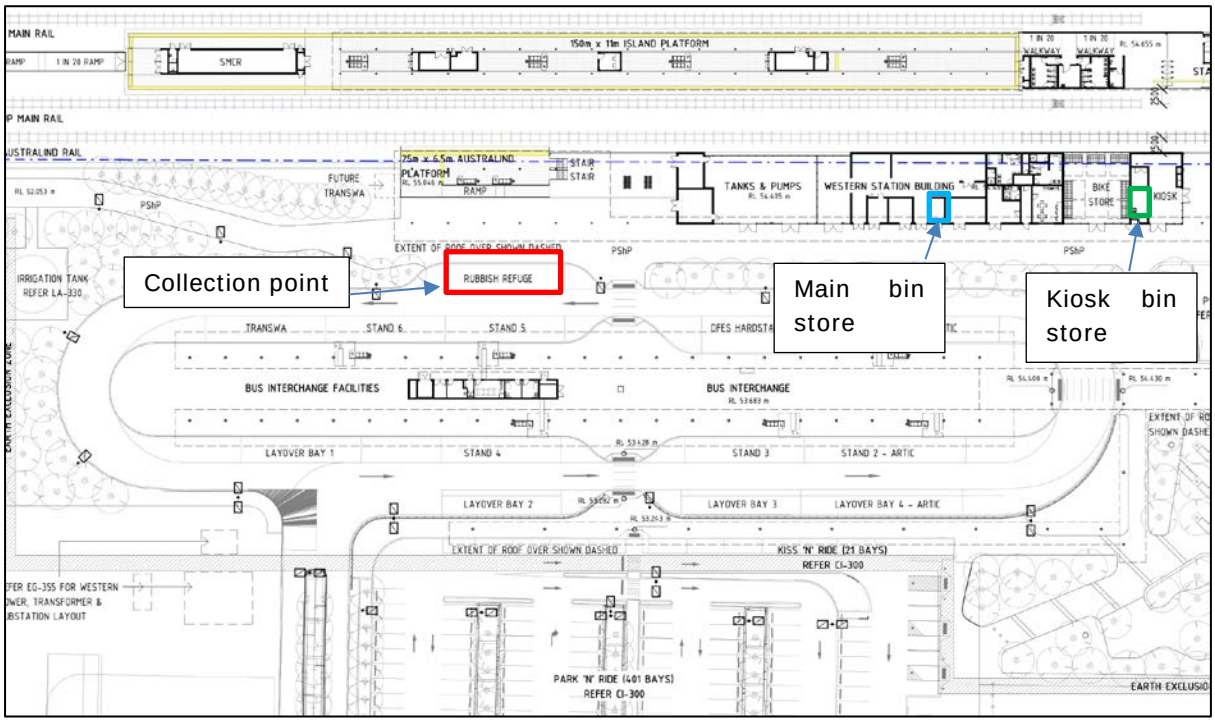


Figure 2: Byford station bin store locations and potential collection point

7.2 Internal transfer route

PTA facility managers will be responsible for arranging cleaners to empty all bins within the PTA offices and common use areas, including platforms, car parks and bus exchange areas daily or more frequently as required. It is assumed the cleaners will empty all waste and commingled recycling contained in litter bins (refer Section 9) into separate 240 L wheeled bins from the main or station cleaners bin stores, ensuring commingled recycling is kept segregated. The 240 L bins will be taken from the bin stores and transported via the lift to service the platform bins. The waste will be removed from the 60 L bins in bin bags, and transferred to the main bin store in 240 L bins to be consolidated into the larger 660 L bins. The cleaners will be responsible for ensuring the bins are available for collection within the main bin stores.

The kiosk tenants will be responsible for presenting their commercial bins for collection within the main bin store or a hardstand area, and returning them to the kiosk bin store on bin collection days. Clear, safe access between the kiosk bin store and the collection area must be provided.

7.3 Internal access requirements

Access requirements are outlined in Table 11 below.

Table 11: Internal access requirements

Item	Requirement
User access route	Avoid stairs/steps and steep ramps (grade of slope <1:14) and other potential hazards between points of waste generation, storage and collection Avoid moving bins, particularly when full, over significant distances
Manual handling	Exclude manual handling of waste in garbage bags from the waste management systems wherever possible
Aisle door and lift width	All doors, corridors and lifts on the transfer route must fit the largest bin (i.e. be at least 1100 mm wide)
Walkways	Provide safe access walkway to bin store for cleaners/staff

8 Interior bins

For all office areas and staff crib areas, internal bins will be needed in bin stations located centrally for all users similar to those in Figure 2. Under desk bins should be avoided to encourage greater recycling segregation, cleaning efficiencies and encourage staff to move away from their desks.

The waste streams which will need separate bins are general waste and commingled recycling.

Figure 3 below shows example bin stations from a company called Method.[1]

Figure 3: **Example internal bin station set up**

[1] Method Recycling | Office Recycling Bins Made Beautiful NZ

9 PTA Public litter bins

The main waste streams generated from the train station public areas are likely to be:

- Recyclable drinks containers. It is likely that the majority of the recyclable items in the public space will be beverage containers eligible under the Container Deposit Scheme (CDS), for example bottles and cans).
- General waste (other waste such as coffee cups, food packaging, food and dog waste bags)

Currently PTA provide 60 L steel bin enclosures in public areas within the train stations, bus exchanges and car parks for general waste collection only as shown in Figure 6.

Figure 6: **Standard 60 L PTA public litter bin**

Provision for public place recycling bins in the public areas of the stations are recommended, in line with Green Star requirements. As recycling bins in public place areas are often highly contaminated with non-recyclable items, it is recommended that public recycling bins target containers that are eligible under the CDS. Most aluminium, glass, plastic, steel and liquid paperboard drink containers between 150ml and 3L (excluding bottles for wine, spirits and milk) are eligible for a refund. By targeting only beverage containers, it will be easier to communicate what is and is not acceptable in the recycling bin. Excluding paper and cardboard will assist with reducing contamination levels as in a public place setting, these items are often contaminated with food.

9.1 Public Place recycling bin design considerations

The recommended approach is to have bins that are easy to use, maintain and service and that are clearly signed as to the items that can be recycled. The proposed approach is for

the contents of the bins to be contained in a clear bag or receptacle as this can be an additional security measure.

Standard design considerations for bins include:

- **Aesthetics** – in keeping with the 'look' and branding of the area
- Bins are **robust** (and weatherproof if placed outside)
- **Colours, shapes** or other means are used to clearly distinguish waste from recycling
- **Apertures** are shaped appropriate for the material accepted to reinforce the message (i.e. round holes for drinks containers, larger openings for general waste)
- **Rosettes or bristles** are in place on recycling bins to act as a deterrent to general waste (a barrier makes the bin user choose this option more carefully than the readily available general waste option adjacent to it

Examples of dual public place waste and recycling bins provided on railway stations in other parts of Australia and the world are shown in Figure 7. Example specifications are provided in Appendix C.

Figure 7: Examples of bin infrastructure for train stations

9.2 Signage

Signage should be clear and simple, using the recycling symbol for recycling bins and avoiding the use of generic language such as '*recycling'* but preferably stipulating exactly what is to be placed in the bin; e.g. "***bottles and cans only***".

Signage should include CDS signage and clear indication about where any profits from the refunded deposits will go (e.g. a local charity).

General waste bin signage should reinforce that this is where non-recyclable contaminants should be disposed: e.g. ***"Other waste, including coffee cups, food / food packaging and dog waste bags"***.

Both words and symbols should be used to describe what should be disposed of into each bin. Not all users of the bins will necessarily be able to read English and many English-speakers may have a preference for symbols over written language, making the use of simple symbols a powerful way to communicate.

Preferably, signage is at eye-level to enable users to very easily read/see the bin type without needing to bend down or search out the description of accepted material.

Signage needs to be consistent throughout the precinct and within the public areas of buildings and align with the branding and messaging of the stations.

- Signage at eye level is most effective if possible. Users of the bins do not always like to ‘hunt’ for the correct instructions for use
- Bins can be an opportunity for branding/communicating sustainability and ethos of the stations

Appendix A: Glossary of terms and acronyms

Collection point	The permitted area on a footpath, roadway or private property (where applicable) that waste, recyclables and bulky waste are loaded into collection vehicles.
Commingled recycling	Common recyclables such as glass, plastics, aluminium, steel, or liquid paper board (milk cartons). Commingled recycling may include paper but often, and particularly in offices, paper and cardboard are collected separately.
Container Deposit Scheme (CDS)	Also known as Containers for Change. In Western Australia 'eligible containers' (usually for soft and alcoholic drinks) have a 10 cent deposit which can be refunded when the container is redeemed at a refund facility.
General waste	Material that is intended for disposal to landfill (or in some States, incineration), normally what remains after the recyclables have been collected separately.
POS	Public open space
POS waste	Public open space waste refers to the waste created within the local council areas outside of PTA controlled areas.
PTA	Public Transport Authority
Public waste	Public waste refers to waste generated within PTA controlled areas including the train platform, bus exchanges, concourse, and carparks.
Recyclable	Material that can be collected separately from the general waste stream and sent for recycling. The precise definition will vary, depending upon location (i.e. systems exist for the recycling of some materials in some areas and not in others).
Recycling	Where a material or product undergoes a form of processing to produce a feedstock suitable for the manufacture of new products.

Appendix B: Vehicle dimensions

Rear-lift vehicles servicing bins

Dimension	Cleanaway	Veolia
Truck length – travel (m)	9.7	10.1
Truck – operation (m)	Allow 3 m to rear of vehicle for operative access	Allow 3 m to rear of vehicle for operative access
Truck width (m)	2.85	2.4
Vehicle height (travel) (m)	3.62	3.9
Vehicle height (during bin lifting) (m)	3.62	3.9
Turning Circle (m)	17.5	15.3
Axles	6 x 4	6 x 4
Max weight (t)	23	22.5

- **Please note that the figures provided are the dimensions of the vehicles only. Additional room is required to allow for a buffer between the ceiling, pipes, walls and duct work etc. and the vehicle and its operating components.**

Appendix C: Example bin specifications

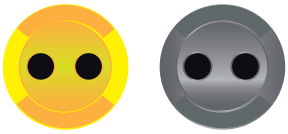
Manufactured from recycled materials

Nexus® C-Thru

This large capacity recycling unit provides a stylish solution to enhance efficiency in any environment. Colour-coded apertures and clear graphics make the units easily identifiable and assist in preventing cross contamination of different waste streams.

SELECT FROM YOUR APERTURE

Cans & bottles apertures



Open top apertures

SELECT FROM STANDARD GRAPHIC OPTIONS

RIBCO BINS

750-752 Koorlong Ave
Irymple Vic 3498
Telephone: 0459 277 255
Email: rmsimms1@bigpond.com
www.bins4recycling.com.au

Partners in Australia
Glasdon

TECHNICAL INFORMATION

CAPACITY

Nexus C-Thru	180 Litres
Number of 330ml cans	210
Number of 500ml plastic bottles	185

WEIGHT

Body and aperture	8 kg

DIMENSIONS

Height	978 mm
Depth	576 mm
Width	576 mm

APERTURE OPTIONS

Open top	Black, grey, red & blue
Cans & bottles	Grey & yellow

Oval shaped waste apertures

Keyed locking mechanism

Cans & bottles waste apertures

Orbis with free standing post

Orbis™ Sack Holder

DESIGN FEATURES
- Recycle Now graphic options.
- Choice of co-ordinating lid colours (can fit any colour body).
- Strong and robust moulding.
- Weather and vandal resistant – does not corrode.
- Neat, tidy and strong sack retention system.
- Robust two stop knuckle hinge.
- Available with or without lid.
- Anti-flyposting and easy graffiti removal finish.
- Fixing points for wall or post mounting.

OPTIONAL EXTRAS
- Surface mounting post.
- Free-standing post.
- Extended post.
- Mobile base kit.
- Mounting bracket (2, 3 or 4 units).
- Rail mounting bracket.
- Polycarbonate cage.
- Steel mesh cage with Armortec® coating for wall or post mounting.
- Sack retention bungee cord.
- Choice of fixing options.
- External ballast for free standing unit.
- Extended beach post kit.

MATERIALS
Body and lid: Durapol® material

SPECIFICATIONS
Height: (with lid): 184mm
Height: (without lid): 135mm
Overall depth: 456mm
Capacity: 110 litres (depending on sack size)
Diameter: 412mm

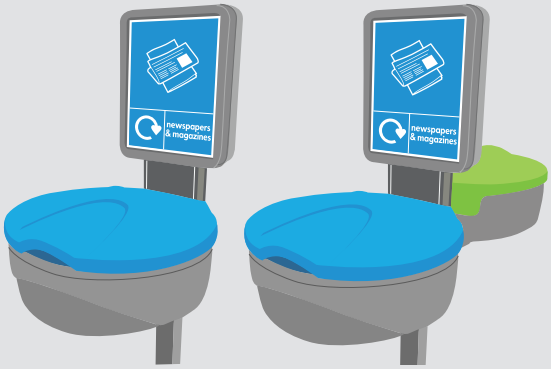
OPTIONAL EXTRAS

Mounting brackets for two, three or four units.

Orbis with free standing post, ideal for indoor environments.

Armortec coated steel mesh cage is available if required.

Transparent polycarbonate cage is also available.

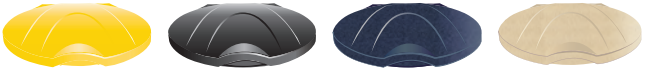


A4 Sign Kit

Versatile A4 Sign Kit can be single or double sided. The Sign Kit helps to create a clearly identifiable recycling point in any location, as well as providing an easy and effective way of personalising the products.

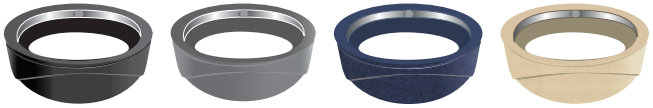
LID COLOURS

Bright Red | Light Blue | Grey (RAL 7016) | Light Green



Yellow | Black | Millstone | Sandstone

BODY COLOURS



Black | Grey (RAL 7016) | Millstone | Sandstone

STANDARD GRAPHICS*

EXAMPLE SIGN KITS+

+Price on application.

*Other options are available upon request.

External Recycling Bins Fixing Options

	Page Number	Paving Fixing Kit	Concrete Foundation Fixing Bolts	Concrete-in Anchor (Adjustable Depth)	Flush Ground Fixing	Ground Lock	External Ballast	Internal Ballast
		(A)	(B)	(C)	(D)	(E)	(F)	(G)
Please refer to the corresponding illustrations on the next page for more details on these fixing options.								
Electra Curve	56	✔	✔	✔	x	x	x	x
Gemini	62	✔ **Incl.**	✔ **Incl.**	✔	x	x	x	x
Glasdon Jubilee 110	58	✔	✔	✔	✔	✔*	x	✔
Glasdon Jubilee 240	58	✔	x	✔	x	x	x	✔
Modus	76	x	✔ **Incl.**	✔	x	x	x	x
Nexus City 140	64	x	✔	✔	x	x	x	✔
Nexus City 240	64	x	✔	✔	x	x	✔	✔
Nexus Evolution City	58	✔	✔	✔	x	x	x	x
Nexus 200	60	✔ **Incl.**	✔ **Incl.**	✔	x	x	x	✔
Nexus 360	68	✔ **Incl.**	✔ **Incl.**	✔	x	x	x	x
Streamline Jubilee	58	✔	✔	✔	x	x	x	✔
Visage	74	x	✔ **Incl.**	✔	x	x	x	x
Ground Surface		Concrete Paving Flagstone	Existing Concrete Foundation, or Concrete Pad Set in Soft Ground	New Concrete Foundation		Soft Earth	Suitable for Even Ground	

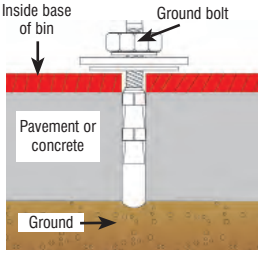
✔ Optional Extra

✔ **Incl.** Fixings are Free of Charge

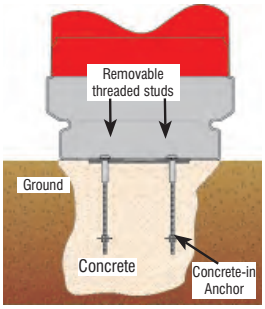
X Not Available for this Recycling Bin

✔* Requires Reinforcing Plinth

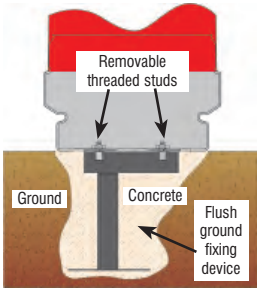
(A+B) Ground Fixing Bolts



(C) Concrete-in Anchor (Adjustable Depth)

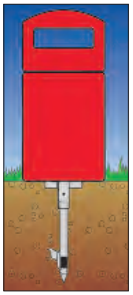


(D) Flush Ground Fixing

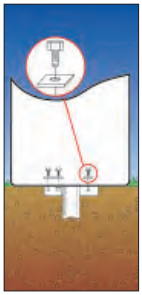


For use where bins may be removed and later resited. Flush ground fixing means that there is no trip hazard from protruding objects above ground level.

(E) Ground-Lock™ System



Litter bin installed with Ground-Lock system.

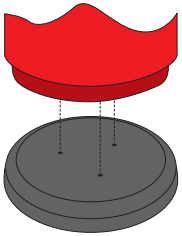


Internal view of litter bin showing bolt fixing to Ground-Lock system.

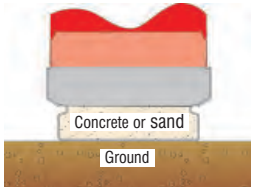
Glasdon Ground-Lock system is a versatile fixing system for securing hooded, open-topped and post-mounted litter bins in 'soft' or unsurfaced ground. Quick and easy to install, without excavating or concreting, the system has a unique 'remove and resite' locking feature, so bins can be relocated. Ground-Lock system is also vandal-resistant, the secure siting keeps waste in its place. (Ground-Lock system fixing tool required. One tool supplied free with every 3 Ground-Lock systems ordered.) Please see above which bins require a reinforcing plinth with the Ground-Lock option.

(F) External Ballast

Depending on the litter bin a universal recycled polymer plinth, a concrete plinth or a metal plinth can be attached with bolts to the litter bin.

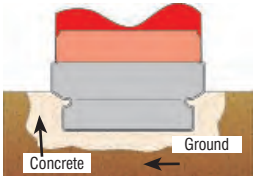


(G) Internal Ballast

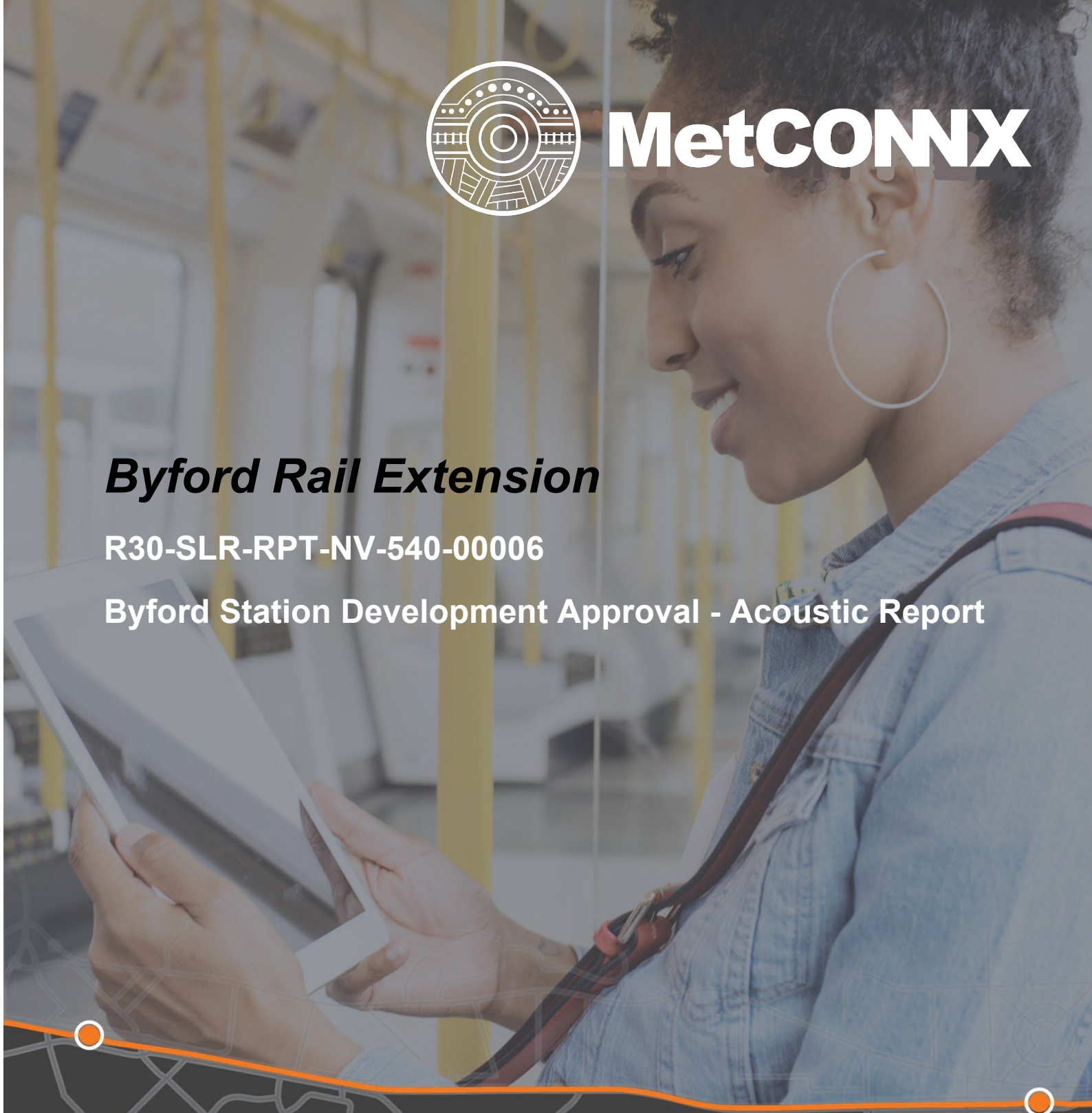


(H) Concreting-In

Bin set into concrete foundation



Appendix L: Acoustics Report



MetCONNX

Byford Rail Extension

R30-SLR-RPT-NV-540-00006

Byford Station Development Approval - Acoustic Report

Connecting communities.
Creating opportunities.

GOVERNMENT OF WESTERN AUSTRALIA

METRONET

BYFORD RAIL EXTENSION

Document details	
Title	Byford Station Development Approval - Acoustic Report
Project	Byford Rail Extension (BRE) Design and Construction Project
Laing O'Rourke Project No.	R30
Client	Public Transport Authority of Western Australia
Client contract No.	PTA200142
MetCONNX Document No.	R30-SLR-RPT-NV-540-00006

Rev	Date	Revision Description	Prepared by	Reviewed by	Approved by
A03	04-July-2023	Issued for Review	Ying Liu	Luke Zoontjens	
A02	14-Dec-2022	Issued for Review	Natalia Bigaj	Luke Zoontjens	
A01	24-Oct-2022	Issued for Review	Natalia Bigaj	Luke Zoontjens	Alyssa Edwards

Table of Contents

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Tables

1.0 Executive Summary

An assessment of environmental noise emissions from the proposed Byford Station and associated station facilities has been undertaken to support development approval.

Predicted noise emissions from the station have been compared with targets derived from a review of relevant state noise policies and industry guidelines.

The predicted results indicate that external noise emissions from the proposed Byford Station and associated station facilities are compliant with applicable state noise policy at all existing and anticipated future noise sensitive receptors.

Acknowledgment of Country

MetCONNX acknowledges the Whadjuk People and the Gnala Karla Booja People as the Traditional Custodians of the land and waters on which Byford Rail Extension Project is located. We pay our respects to Elders, past, present and emerging, and thank them for their continuing connection to country, culture and community.

2.0 Project overview

2.1 METRONET Vision and Objectives

As one of the largest single investments in Perth's public transport, METRONET will transform the way the people of Perth commute and connect. It will create jobs and business opportunities and stimulate local communities and economic development to assist communities to thrive. The METRONET vision is for a well-connected Perth with more transport, housing and employment choices. In delivering METRONET, the WA Government has considered peoples' requirements for work, living and recreation within future urban centres with a train station at the heart.

The objectives are to:

- Support economic growth with better-connected businesses and greater access to jobs
- Deliver infrastructure that promotes easy and accessible travel and lifestyle options
- Create communities that have a sense of belonging and support Perth's growth and prosperity
- Plan for Perth's future growth by making the best use of our resources and funding
- Lead a cultural shift in the way government, private sector and industry work together to achieve integrated land use and transport solutions for the future of Perth.

2.2 Byford Rail Extension overview

The Byford Rail Extension (BRE) Project has been identified as an essential component of the METRONET program. The Project will extend the electrified passenger rail service from Armadale to Byford, providing a strong transport connection between these two centres, supporting economic growth and providing greater access to jobs. The Project has been developed in line with policy objectives for highly integrated transport and land use planning.

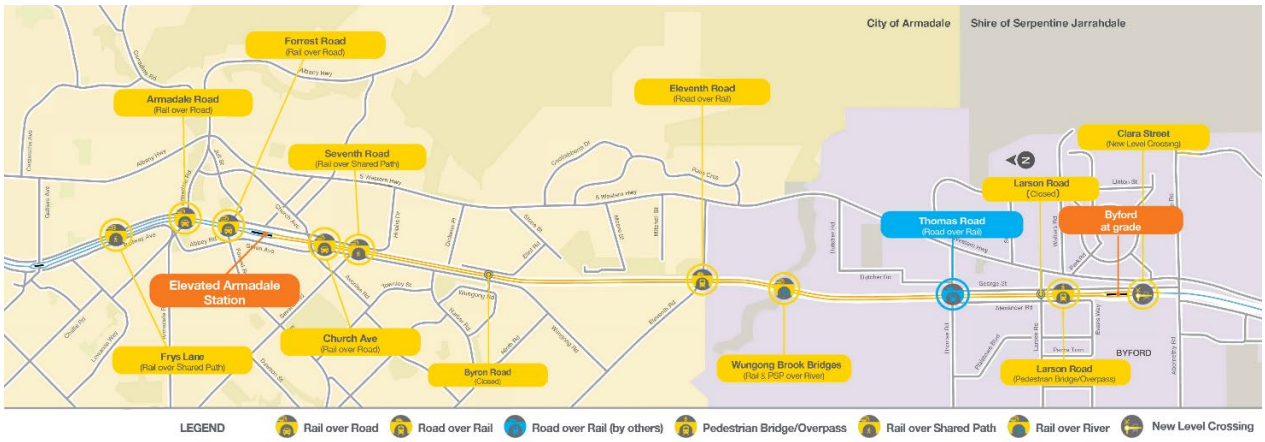

Figure 1: METRONET Byford Rail Extension Project

2.2.1 Project features

Transport infrastructure works for the BRE Project include:

- Demolition of existing station at Armadale and construction of a new elevated station
- Construction of a new Byford station at grade (Base Case)
- Construction of approximately 8km of dual track narrow gauge electrified passenger railway line extending from Byford station to the newly created Byford station, with a dedicated platform for the Australind line
- Removal of level crossings between the Armadale and Byford stations
- Construction of PSPs and associated infrastructure (including 'rail over road' and 'road over rail' bridges and roads)
- Parking areas at Armadale and Byford stations
- Bus interchange at Armadale and Byford stations
- Upgrade of local roads surrounding both Armadale and Byford stations.

2.2.2 General scope of works

The Project's general scope of works includes designing, procuring, manufacturing, constructing, installing and commissioning all rail infrastructure and ancillary works to support an electrified operational passenger rail between Armadale and Byford Stations. Also, in the case of the Australind train service, tying into the non-electrified rail network south of Byford Station.

The Project activities include all site investigation, design, planning, scheduling, procurement, cost control, approvals, construction, OH&S management, environmental management, quality management, testing and commissioning, Entry Into Service (EIS), training and operational readiness required to tie the rail extension to Byford into the existing rail network including the associated road, utilities and other required works to interface with adjacent works and contracts. This will include bulk earthworks and retaining structures, grade separations, roads, and drainage, the demolition and removal and treatment of waste material and contaminated material resulting from construction of the Works, and temporary works constructed for the purpose of facilitating the Works.

The project scope also includes any new road works, modifications to existing roads and signalised intersections, utilities (diversion, protection, and new installation) and any other ancillary works to enable the BRE Project.

2.2.3 Future Proofing the works

As part of the Project, space must be allowed within the rail corridor for the option of a 4-track scenario for a potential high-speed regional service from Bunbury. The additional 2 tracks shall be constructed in the eastern half of the rail corridor, so that future infrastructure can be constructed without impacting on existing rail operations. The Project should also allow for the possibility of future extension of the electrified line south of Byford to Mundijong, and a future stabling yard south of Abernethy Road.

2.3 Purpose

This report presents an assessment of environmental noise emission to support development approval of Byford Station and associated facilities.

This report provides the noise emission assessment of the external noise sources associated with the station.

The extent of the station and study area is indicated in **Figure 2.**

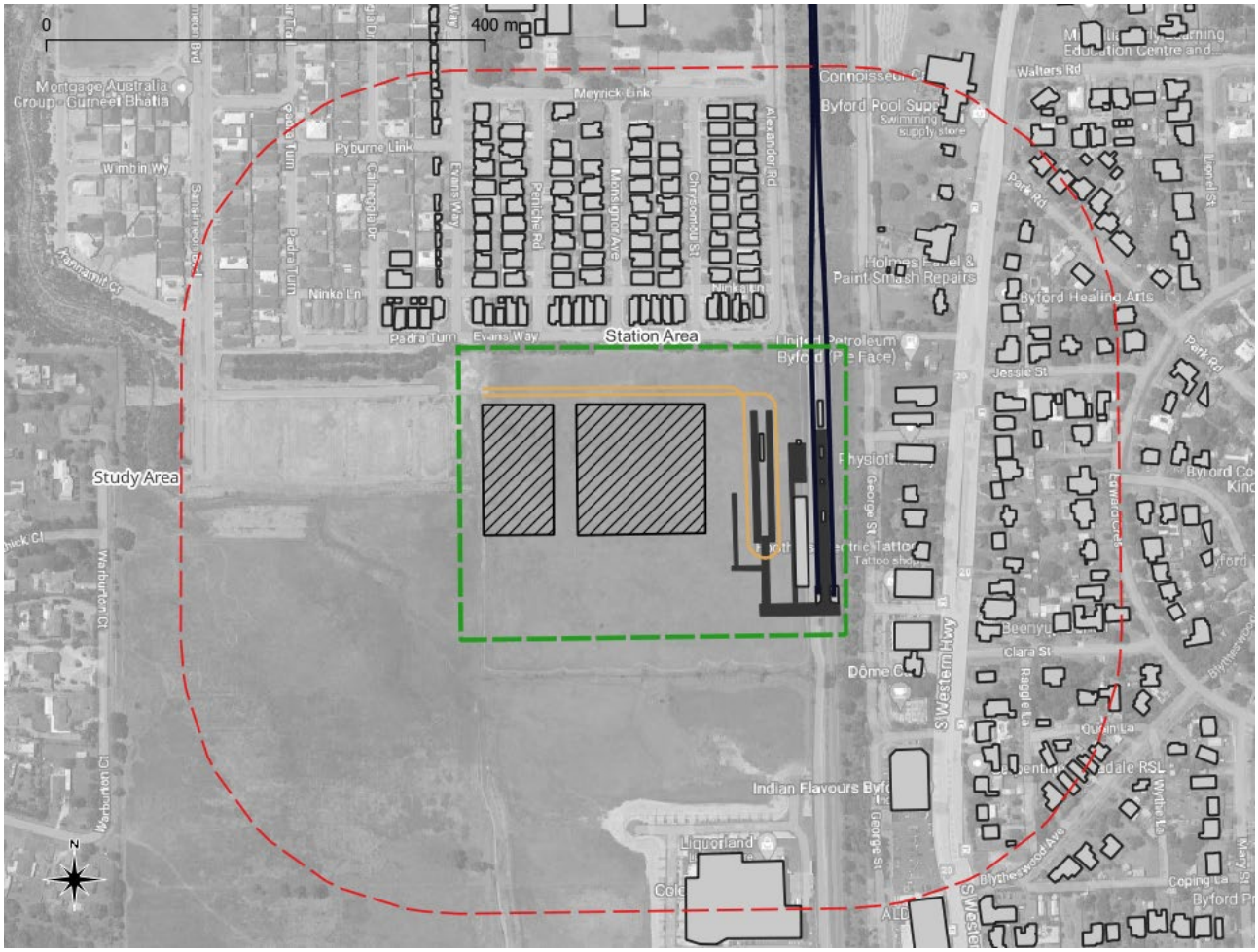

Figure 2: Annotated aerial image indicating extent of study area, Byford station

Key terms used in this assessment are provided in **Appendix A**.

2.4 Structure

Section 3 presents a summary of relevant design criteria used. **Section 4** present assessments of environmental noise from the identified noise sources associated with the Byford Station.

3.0 Design criteria

3.1 State Planning Policy 5.4

The following criteria is used to assess the noise emission from bus interchange and car parks associated with the Byford Station.

Table 1 below outlines the adopted noise objective levels in regard to airborne noise during road and rail operations. Noise mitigation is recommended where noise levels from designed rail assets are above these targets.

Table 1: Road and rail noise criteria

Metric	Application	Value(s)
Period average noise levels	New road	$L_{Aeq,day}$ 55 dB
		$L_{Aeq,night}$ 50 dB

These objectives are assessed outdoors, 1 metre from the main building on a lot associated with a noise sensitive usage. Consistent with SPP5.4, the criteria are assessed

- only at premises that are occupied or designed for occupation or use for residential purposes (including dwellings, residential buildings or short-stay accommodation), caravan parks, camping grounds, educational establishments, childcare premises, hospital, nursing home, corrective institution; or place of worship; and
- at all floor levels where identified from surveys, noting that sufficient mitigation (in the context of the targets) may not reasonable or practicable at higher floors.

Note that the criteria excludes recreational parks, commercial and industrial premises along the alignment – results will be determined for these locations, but mitigation may not be required under the SWTC.

3.2 Environmental Protection (Noise) Regulations 1997

The following criteria has been used to assess the noise emission from the station facilities, including mechanical and electrical services plant, crowd and public address system noise associated with the Byford Station.

Environmental noise emissions (excluding trains and some emissions from road vehicles) from various premises to nearby noise receiving premises are covered by legislation in the form of the *Western Australia Environmental Protection (Noise) Regulations 1997,* which operate under the *Environmental Protection Act 1986*. For this project, these regulations apply to stations and ancillary operational equipment, and specifically do not apply to trains.

To achieve compliance, received noise levels at nearby premises including noise sensitive premises (for example, residential, commercial and industrial premises) are not to exceed specified noise limits in the form of assigned noise levels.

The assigned noise levels, as shown in **Table 2**, vary for each noise sensitive receiver, as they are determined from consideration of Influencing Factors (IF) which takes into account the amount of commercial, industrial and road transport infrastructure within specific distances to the receiving noise sensitive premises.

Table 2: Table of Assigned Noise Levels, dB

Part of premises receiving noise	Time of day	LA10	LA1	LAmax
Noise Sensitive premises at locations within 15 metres of a building directly associated with a noise sensitive use	0700 to 1900 hours Monday to Saturday	45 + IF	55 + IF	65 + IF
	0900 to 1900 hours Sunday and public holidays	40 + IF	50 + IF	65 + IF
	1900 to 2200 hours all days	40 + IF	50 + IF	55 + IF
	2200 hours on any day to 0700 Monday to Saturday and 0900 hours Sunday and public holidays	35 + IF	45 + IF	55 + IF
Noise Sensitive premises at locations further than 15 metres from a building directly associated with a noise sensitive use	All hours	60	75	80
Commercial premises	All hours	60	75	80
Industrial and utility premises	All hours	65	80	90

Regulation 7 of the *Environmental Protection (Noise) Regulations 1997* requires that, if noise emitted from any premises when received at any other premises cannot reasonably be free of intrusive characteristics of tonality, modulation and impulsiveness, then a series of adjustments must be added to the emitted levels (measured or calculated) and the adjusted level must comply with the assigned level. The adjustments are detailed in **Table 3**, and are further defined in Regulation 9(1) of the *Environmental Protection (Noise) Regulations 1997*.

Note that the following adjustments (**Table 3**) generally apply to fixed plant and infrastructure only.

Table 3: Table of adjustments for intrusive characteristics

Noise characteristic	Definition	Adjustment if present (Note [1])
Tones	Where the difference between the A weighted sound pressure level in any one third octave ban and the arithmetic average of the A weighted sound pressure levels in the two adjacent one third octave bands is greater than 3 dB in terms of $L_{Aeq,T}$ where the time period T is greater than 10% of the representative assessment period, or greater than 8 dB at any time when the sound pressure levels are determined as L_{ASlow} levels.	+5 dB
Modulation	A variation in the emission of noise that – • Is more than 3 dB L_{AFast} or is more than 3 dB L_{AFast} in any one third octave band; • Is present for at least 10% of the representative assessment period; and, Is regular, cyclic and audible.	+5 dB
Impulsiveness	Present where the difference between the L_{APeak} and L_{Amax} is more than 15 dB when determined for single representative event.	+10 dB

Note 1 Where noise emission is not music, these adjustments are cumulative to a maximum of 15 dB.

During the assessment process the above adjustments have been applied to relevant noise sources, taking into account specific intrusive characteristics of these noise sources based on SLR's in-house noise database. It is unlikely that modulation or impulsiveness characteristics would apply to PTA fixed assets being typically electrical power transformers or air handling plant.

4.0 Assessments and discussion

4.1 Bus interchange

Noise emissions from bus vehicle movements associated with the station are considered assessable under SPP5.4. Bus vehicles have been modelled using Nord2000 methodologies with the following parameters:

- Bus movements of up to 4 buses per stand per hour during the day (up to a maximum total of 20 buses per hour), and 0.5 bus per stand per hour during the night (up to a maximum total of 3 buses / hour) has been assumed for the assessment.
- Changes in level from arriving / idling / departure at stations (as assessed at nearest noise sensitive location) have been determined insignificant and not modelled. Publicly accessible road sections beyond the loop or its intersections are not included.
- Ground class F (compacted dense ground).
- Category 2a vehicles (up to 12.5m length and 2 axles, e.g. Volgren OC500LE), approximately L_{Amax} 75dB, L_{AE} 78dB at 7.5m and 35km/hr.
- Traffic case F (35km/hr max).
- Asphalt concrete surface, any increases in noise level due to gradients was included on the basis of the ground topography provided.

The proposed new bus interchange has large offset distance from the adjacent existing residential properties, approximately 50 meters, and therefore are not predicted to contribute to any excessive noise level at these sensitive receivers.

From figures presented in **Appendix B**, predicted levels are compliant at all existing noise sensitive locations.

4.2 Passenger car park

The proposed new Park 'N' Ride carpark will consist of 393 car bays and proposed future carpark will consist of 128 car bays.

EU Parking Area Noise 2007[1] guidelines have been used to provide an indicative level of noise emissions on surrounding areas.

- Vehicle movement rate for P&R facilities over 20km from CBD. A vehicle entering or exiting a parking bay is one movement, so the same vehicle arriving and departing on the same day completes two movements.
- 0.30 per hour per parking bay (6am to 10pm).
- 0.10 per hour per parking bay (10pm to 6am).
- Random fill across all parking lots.[2]
- Impulse correction K_I 4dB.
- L_{w0} 63dB (standardised vehicle sound power level).

The predicted noise levels from the proposed car park operation as presented in **Appendix B** are compliant at all existing noise sensitive locations.

4.3 Crowd/ Patron noise

The arrangement of the station has passenger waiting areas on the platform, busway waiting areas and pick up points at distances over 80 metres from residences and/or generously spaced open environments.

Providing this level of distance separation and low crowd densities is expected to ensure that any sustained crowd / patron noise levels (conversations, walking) as individually L_{Aeq} 60dB at 1 metre and below L_{Aeq} 30dB at 80 metres will be at a cumulative level that is inaudible at nearby residential locations against other background environmental noise.

On this basis, crowd noise levels in the context of the design criteria and other environmental noise sources are considered insignificant.

[1] Bayer, Landesamt für Umwelt 2007, Parking Area Noise - Recommendations for the Calculation of Sound Emissions of Parking Areas, Motorcar Centers and Bus Stations as well as of Multi-Storey Car Parks and Underground Car Parks, Bayerisches Landesamt für Umwelt, Parkplatzlämstudie 6, Aufl., August 2007.

[2] Random fill assumed in the absence of a specific car parking traffic analysis. Fill patterns in practice may vary due to proximity to train station, and presence of ticketed parking and/or reserved parking.

4.4 Public Address systems

The public address system will need to be designed to be sufficiently audible (involving both sound level and speech intelligibility) to meet relevant provisions of Australia Standard 1670.4*, Fire Detection, Warning, Control and Intercom Systems - System Design, Installation and Commissioning - Sound Systems and Intercom Systems for Emergency Purposes* (AS 1670.4) such that patrons can be advised in case of emergencies.

By inspection of the station arrangement and distancing to the nearest noise sensitive receivers, it can be seen that there is a range of sound levels which can meet both the minimum sound level limit requirements of AS 1670.4 and maximum noise level limits.

Consideration should be given to active PA systems which regulate speaker volumes depending on actual ambient sound level conditions to maintain intelligibility.

4.5 Mechanical plant

The supplied drawings indicate that the outdoor mechanical plant comprise condenser units. Based on rooms served, each would have capacities the order of 6 kW or less (similar to domestic residential air conditioning systems).

Refer to **Appendix B** for predicted noise levels from the mechanical plant associated with the Byford Station.

From the contour maps**,** it can be seen that predictions are between well below 35 dBA at the nearest noise sensitive receivers. Therefore, the units assessed in cumulative terms, are considered compliant with the assigned noise levels defined in **Section 3.2** at the nearest existing and future noise sensitive premises.

4.6 Electrical and hydraulic plant

From the supplied drawings, it can be seen that the electrical and hydraulic plant associated with the station are located internally within the station building and bus interchange facility services rooms, therefore are expected to be inaudible at all existing and future noise sensitive locations.

5.0 Summary

An assessment of environmental noise has been undertaken to support development approval of Byford Station and associated station facilities.

Predicted noise emissions from the station have been compared with targets derived from a review of relevant state noise policies and industry guidelines.

The predicted results indicate that external noise emissions from the proposed Byford Station and associated station facilities are compliant with applicable state noise policy at all existing anticipated future noise sensitive receptors.

Appendix A: Key terms

Terms used

The following table describes key terms used in this report.

Table 4: Terms used

Parameter	Comment
dB	Decibel, a unit of sound or vibration which is described as a ratio of the result to a fixed reference value. All sound pressure levels (LpA, LA, LAeq etc.) quoted in this report are referenced to 20 micro Pascals (dB re 20μPa).
	Vibration velocity levels (Lv) quoted in this report are referenced to 1 nanometre per second (dB re 10-9 m/s), noting that some US criteria use dB re 10-6 in/s.
Guidelines	Implementation Guidelines for State Planning Policy 5.4 Road and Rail Transport Noise
LAmax	The maximum A-weighted noise level associated with a sampling period.
LAmax,95%	The "typical maximum noise level" for a train pass-by event. For operational rail noise, LAmax refers to the maximum noise level not exceeded for 95% of rail pass-by events measured using the 'slow' (sometimes denoted by subscript 'S') response setting on a sound level meter.
LA1	The A-weighted noise level exceeded for 1% of a given measurement period. This parameter is often used to represent the typical maximum noise level in a given period.
LA10	The A-weighted noise level exceeded for 10% of a given measurement period and is utilised normally to characterise average maximum noise levels.
LAeq	The A-weighted average noise level. It is defined as the steady noise level that contains the same amount of acoustical energy as a given time-varying noise over the same measurement period.
LA90	The A-weighted noise level exceeded for 90% of a given measurement period and is representative of the average minimum background noise level (in the absence of the source under consideration), or simply the "background" level.
Lv	Unweighted vibration velocity level, see dB.
Lv,RMS,1s	Maximum unweighted RMS vibration velocity level over a 1 second period.
Policy	State Planning Policy 5.4 – Road and Rail Transport Noise (2019)
RMS	Root Mean Square, a parameter used to estimate the average energy level of a continuous signal.

Noise

The terms "sound" and "noise" are almost interchangeable, except that in common usage "noise" is often used to refer to unwanted sound. Sound (or noise) consists of minute fluctuations in atmospheric pressure capable of evoking the sense of hearing. The human ear responds to changes in sound pressure over a very wide range. The following table presents examples of typical noise levels.

The loudest sound pressure to which the human ear responds is ten million times greater than the softest. The decibel (abbreviated as dB) scale reduces this ratio to a more manageable size by the use of logarithms. The symbol 'A' represents A-weighted sound pressure level (SPL): the weighting is designed to better represent the hearing ability of the average listener at each frequency.

L_{Aeq} values represent an energy average of sound over time and are basic indicators of loudness. However there other ways to statistically represent sound and common noise level descriptors that may be used are illustrated in the following figure and are described below.

Table 5: Guide to sound pressure level ranges for selected environments (dB re 20µPa)

Subjective Evaluation	L_{Aeq}	Comments / Examples
Intolerable. Onset of pain. Exceeds daily exposure limit in under a second.	140	Military jet engine at 30 metres
	130	2kW disaster warning siren at 1 metre
Very loud. Risk of exceeding daily noise exposure limit in under a minute.	120	Jet aircraft take-off at runway edge
	110	Rock concert; freight train main horn at 25 metres
Loud. Onset of risk to exceeding daily recommended noise exposure limit.	100	225mm angle grinder at 1 metre, car horn at 3 metres
	90	Heavy industrial factory interior
Noisy	80	Shouting at 1 metre, kerb side of busy street
	70	Freeway at 20 metres
Moderate	60	Normal conversation at 1 metre, department stores
	50	General office areas
Quiet	40	Office air conditioning background level
Very quiet	30	Bedroom in quiet suburban area
Almost silent	20	Whisper, rural bedroom at night
	10	Human breathing at 3 metres
	0	Threshold of typical hearing

For example, the L_{Amax} parameter is used to describe the highest noise level over a relatively short period (typically 1 second), and the L_{A90} (90^{th} percentile A-weighted result) indicates ambient or background noise levels.

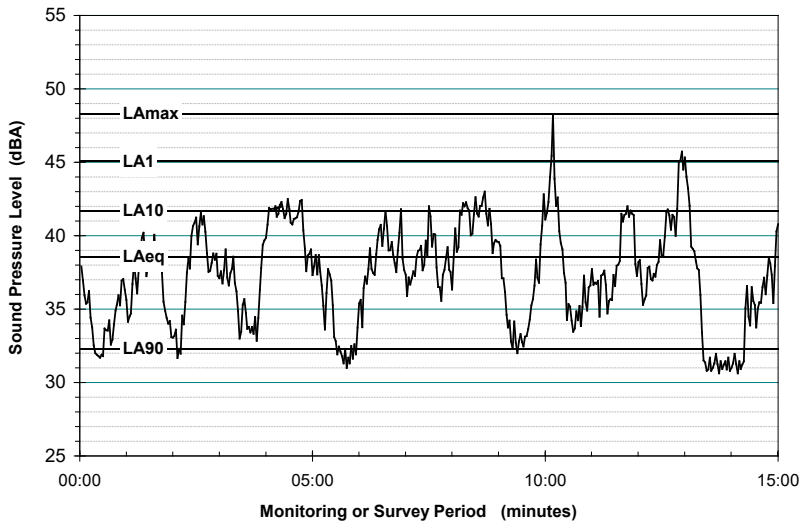

Figure 3: Example of typical noise indices (1 second logging)

The ability to discern a change in noise level varies between individual listeners, however it is reasonable to suggest that a change of up to 3 dB in the level of a sound is difficult for most people to detect, and a 3 dB to 5 dB change corresponds to a small but noticeable change in loudness. A 10 dB change corresponds to an approximate doubling or halving in loudness and is readily noticeable.

Vibration

Vibration is the term used to describe the oscillating or transient motions in physical bodies. Reference is here in terms of velocity, however this motion can also be described in terms of displacement or acceleration. Most ground borne vibration (GBV) assessments are of human response / comfort first, as the risk of cosmetic and structural damage to buildings occurs at vibration levels that are orders of magnitude higher.

Vibration and sound are intimately related. Vibrating objects can generate (radiate) sound and, conversely, sound waves (particularly at lower frequencies) can also cause objects to vibrate. Noise that propagates through a structure as vibration and is radiated by vibrating wall, ceiling and floor surfaces is termed “ground-borne noise” (GBN), “regenerated noise”, or sometimes “structure borne noise”.

The primary noise metrics used to describe railway induced GBN emissions in the modelling and assessments are:

- LvSmax: The “typical maximum vibration level” for a train passby event, being the highest 1 second maximum root-mean square (RMS) value in dB re 1 nm/s. For operational rail GBV, this similarly refers to the 5th highest percentile of LvSmax results.

- LAsmax: The “typical maximum noise level” for a train passby event, in dB re 20 µPa. For operational rail GBN, LASmax refers to the maximum noise level not exceeded for 95% of rail passby events measured using the sound level meter ‘slow’ (1 second) response setting. Statistically this is the 5th highest percentile of LASmax results. The subscript “A” indicates that the noise levels are filtered to match normal human hearing characteristics (i.e. A-weighted).

On the basis of guidance in International Standard ISO 14837-1 2005 Mechanical vibration - Ground-borne noise and vibration arising from rail systems – Part 1: General guidance, ground-borne noise levels are evaluated over the 20 Hz to 315 Hz frequency range.

The following figure gives examples of typical vibration levels associated with surface and underground railway projects together with the approximate sensitivities of buildings, people and precision equipment. The vibration levels are expressed in terms of the vibration velocity (in mm/s and in decibels).

Table 6: Guide to one-second maximum RMS floor vibration level ranges for selected environments

Typical response	mm/s	dB re 1nm/s	Comments / Examples
Visible response in building items, structural damage risk	16	144	High impact events such as blasting or dynamic compaction in close proximity to structures.
	10	140	
	8.0	138	
Cosmetic damage to some buildings possible over extended periods	5.0	134	
	3.0	130	Impact pile driving, 15 metres.
Noticeable. Minor cosmetic damage is feasible to buildings that are in fragile condition / an existing state of disrepair	2.0	126	Freight trains at 80 km/h, ~10 metres.
	1.0	120	Rock breaking at 15 metres. Vibratory roller at 10 metres.
	0.8	118	Typical target for workshops.
	0.4	112	Freight trains at 80 km/h, ~40 metres. **Regenerated noise highly likely** in typical residential buildings.
Barely noticeable	0.3	110	
	0.2	106	Typical residential daytime target for continuous vibration.

Typical response	mm/s	dB re 1nm/s	Comments / Examples
Threshold of human perception to vibration	0.15	104	Passenger trains at 80 km/h, ~30 metres.
Not felt	0.10	100	Operating rooms, surgeries.

Appendix B: Result Figures

The following figures present results for identified properties in terms of air-borne noise (ABN).

Airborne noise contours, bus movements, Day period

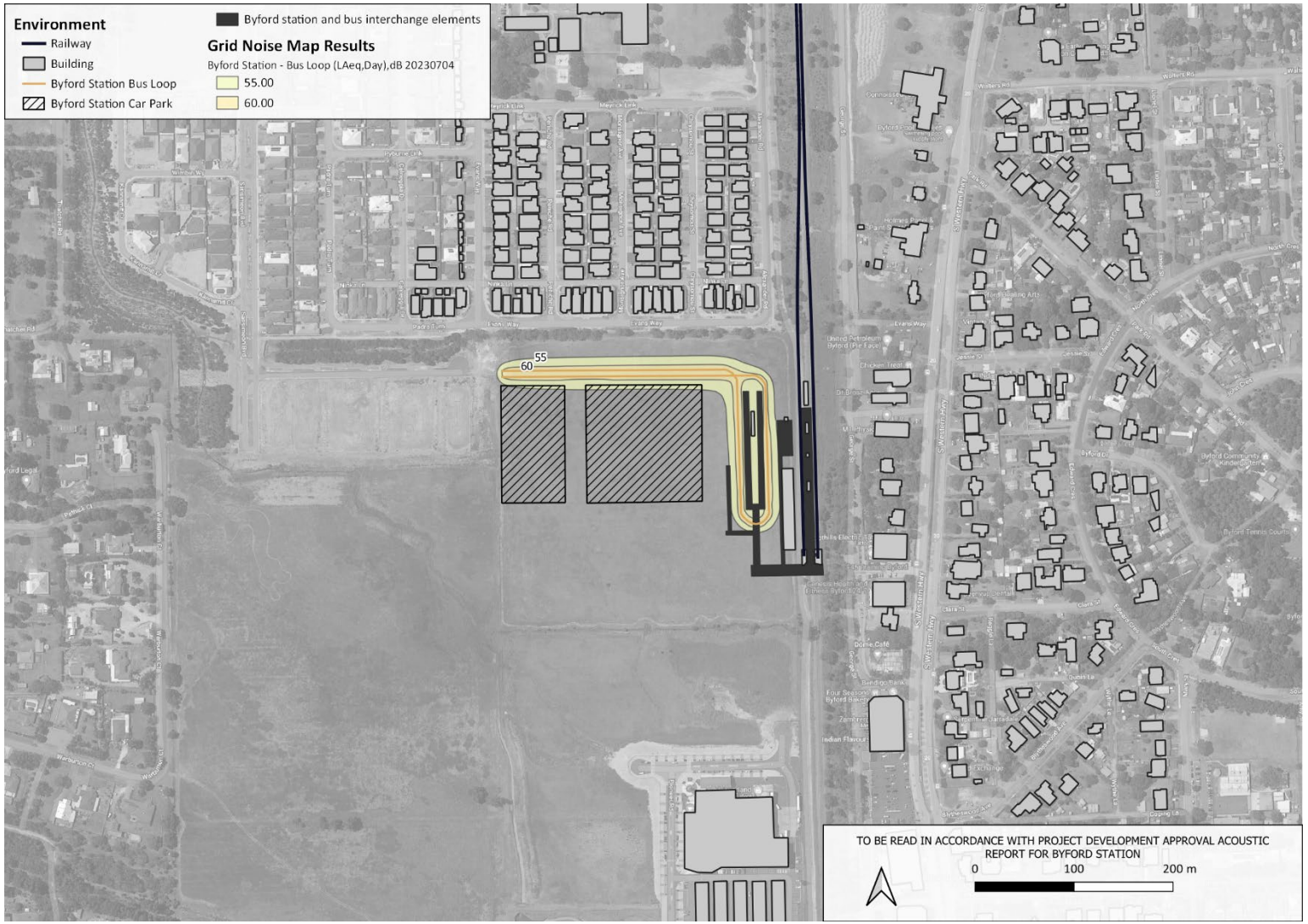

Figure 4: Predicted distribution in day period noise ($L_{Aeq,day}$) levels due to bus movements, dB.

Airborne noise contours, bus movements, Night period

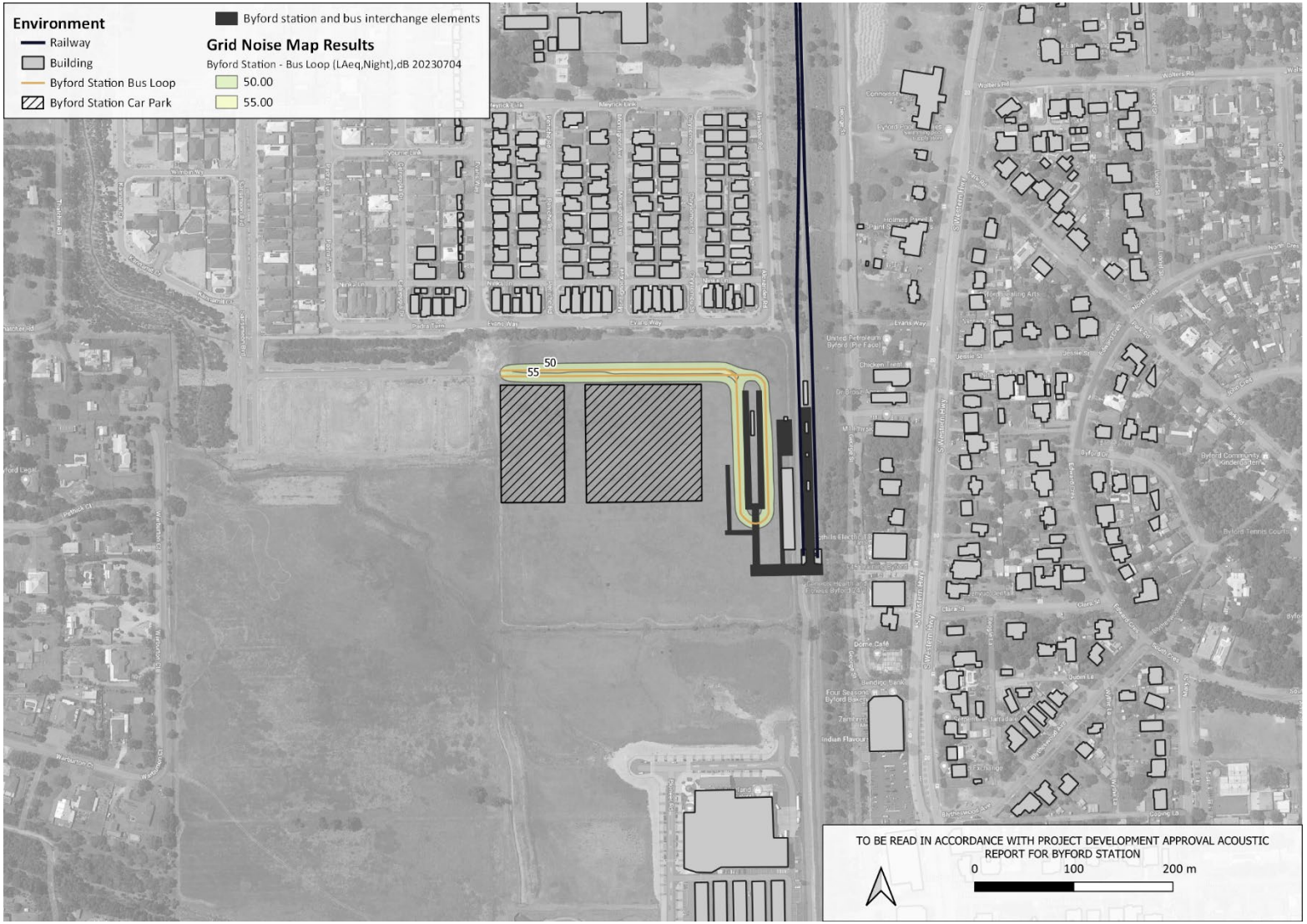

Figure 5: Predicted distribution in night period noise ($L_{Aeq,night}$) levels due to bus movements, dB.

Airborne noise contours, car parking, Day period

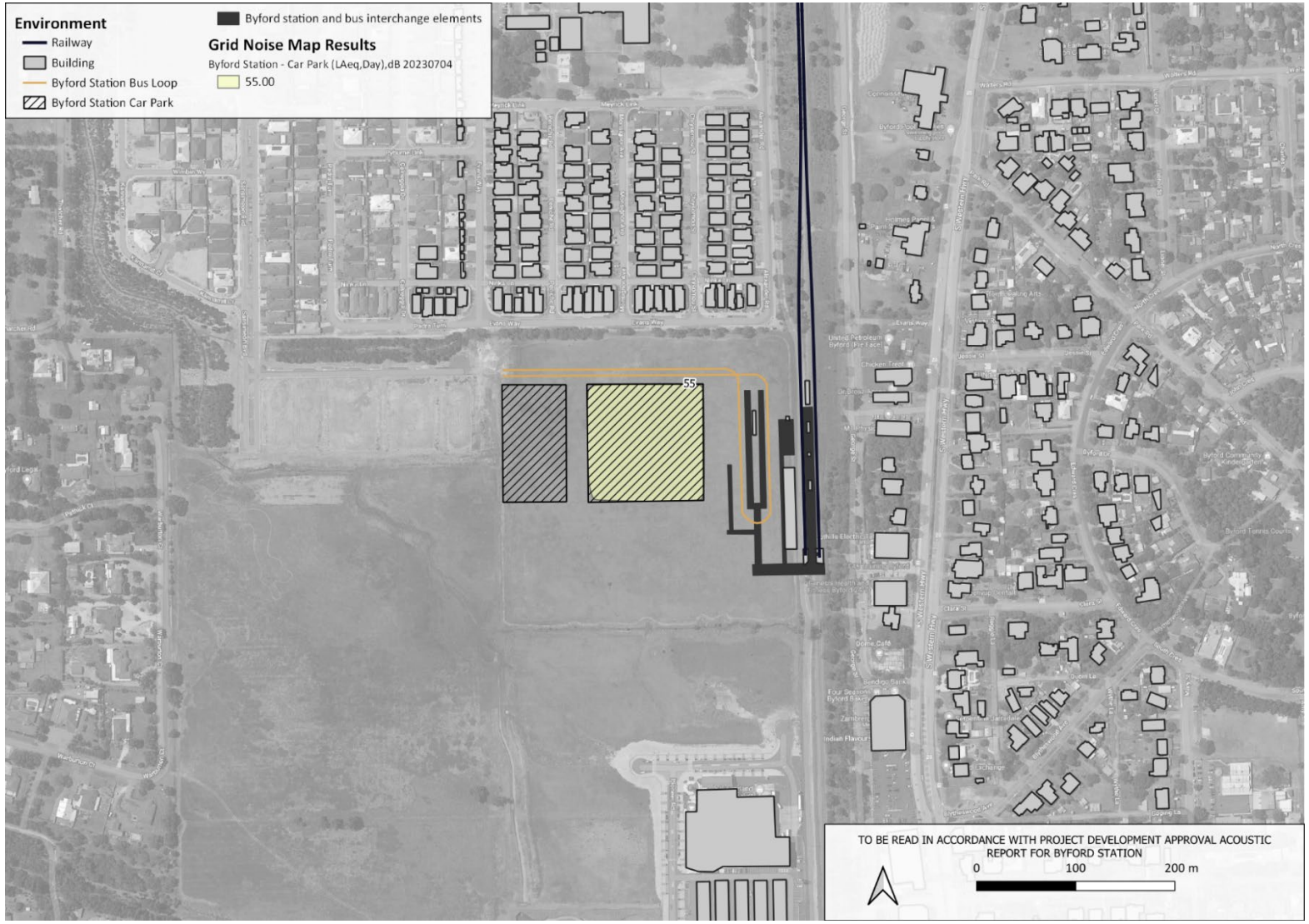

Figure 6: Predicted distribution in day period noise ($L_{Aeq,day}$) levels due to car parking movements, dB.

Airborne noise contours, car parking, Night period

Figure 7: Predicted distribution in night period noise ($L_{Aeq,night}$) levels due to car parking movements, dB.

Airborne noise contours, mechanical services, 24-hour period

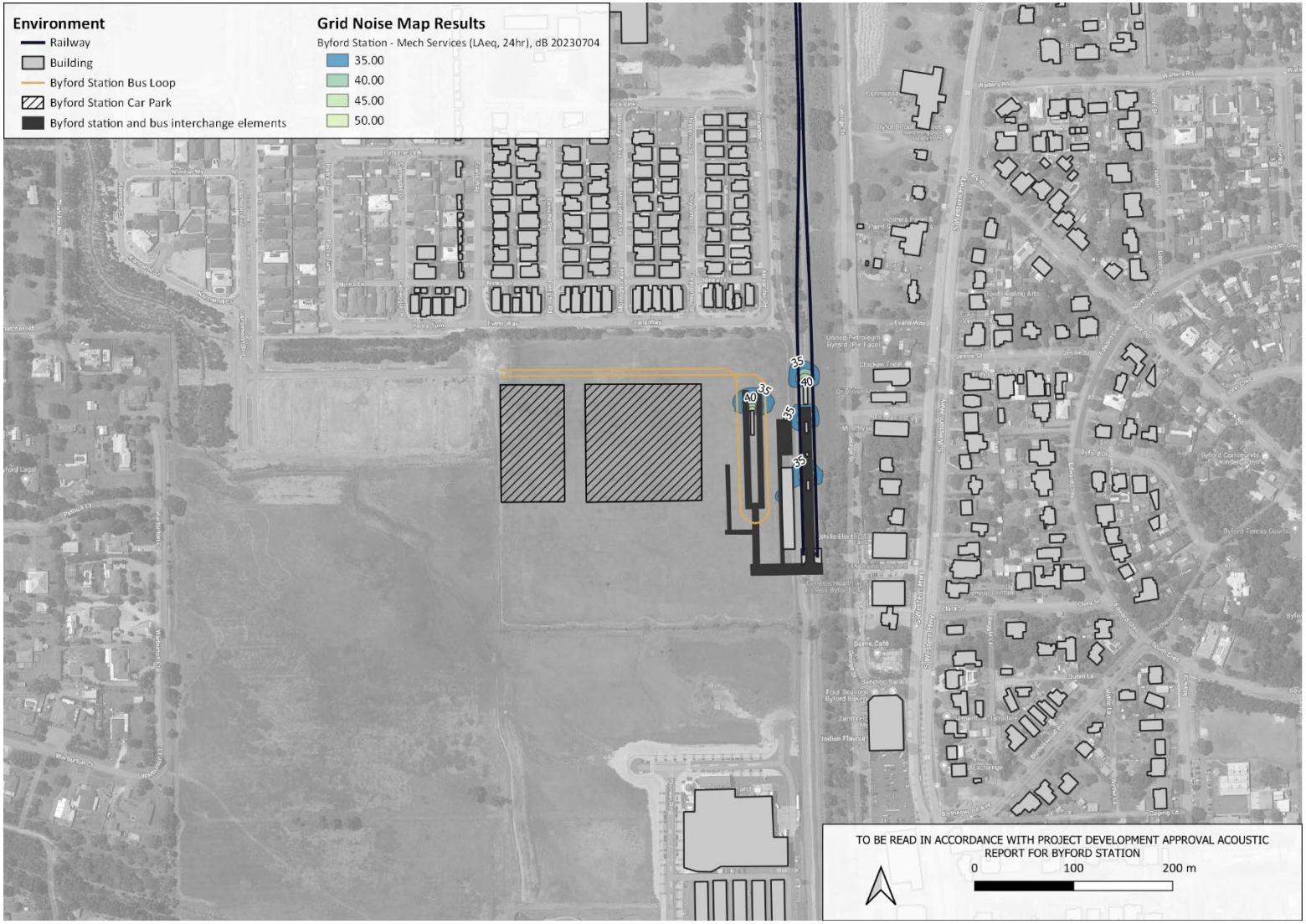

Figure 8: Predicted distribution in continuous noise (L_{Aeq}) levels due to mechanical services, dB.

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