Morley-Ellenbrook Line

NORANDA STATION – CIVIL – DESIGN REPORT

MEL-MLCX-CI-RPT-00009

Rev	Date	Purpose of Issue	Prepared	Reviewed	Approved
A	18/11/2021	Reference Design	Tejas Dalal	Miguel Monteiro (JAJV SRE)	Manoj Aravind (SEM)

Document Details	
Project	Morley-Ellenbrook Line
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This is to be updated with the full revision history of the document

Document revision history

Rev	Date	Purpose of Issue	Sections revised	Reason for updates
A	18/11/2021	Reference design	All	First issue

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1. Executive Summary

This document forms part of the Reference Design for the Morley-Ellenbrook Line (MEL) in relation to the Noranda Station Precinct Civil Engineering Design. The precinct design is intended for space planning purposes to allocate space for the different transport-oriented elements as per the Schedule of Accommodation noted on *SWTC Book 3: Part A- Scope of Works* and ensure there are no conflicts between the different modes of transport and pedestrians. Furthermore, it highlights constraints, risks and opportunities which will inform the IDDR phase of design.

The purpose of this document is to provide a description on the design development of the Civil Engineering elements in response to the proposed station precinct masterplan. This includes precinct geometry, stormwater drainage and earthworks including the following:

- Precinct overall layout geometry, including vehicular access and circulation areas
- Pick-up & Drop-off
- Parking
- Precinct proposed levels and earthworks requirements
- Stormwater drainage strategy and storage requirements
- Primary services containment

The intent is that this Design Report is a live document and will be updated throughout the process of the civil design.

Acknowledgement of Country

MELconnx acknowledges the Whadjuk People of the Noongar Nation as the Traditional Custodians of the land and waters on which the Morley-Ellenbrook Line Project is located. We pay our respect to their Elders, both past and present and thank them for their continuing connection to the country, culture and community.

2. Project overview

2.1 METRONET Vision and Objectives

As Perth's single largest investment in public transport, METRONET will transform the way people 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 Morley-Ellenbrook Line overview

As Perth grows, so does the need for rail infrastructure and METRONET is a critical element of the State Government's infrastructure agenda. The Morley-Ellenbrook Line (MEL) Project will improve connectivity between the north east metropolitan area and the rest of the city and unlock economic development in these local community areas.

Figure 1: Morley-Ellenbrook Line © METRONET

The Public Transport Authority (PTA) is the lead agency delivering the MEL Project, with Main Roads WA (MRWA) undertaking some enabling works.

2.2.1 Project features

Transport infrastructure works for the Project include:

- A 21km rail line spurring from the Midland Line east of Bayswater Station, travelling north in the Tonkin Highway median, east through land north of Marshall Road and north on the western side of New Lord Street into Ellenbrook
- Stations at Morley, Noranda, Malaga, Whiteman Park and Ellenbrook with future-proofing for a station at Bennett Springs East
- Parking and bus interchanges/facilities at stations
- Significant grade separations at key road crossings
- Underpasses to allow the rail line to enter and exit the Tonkin Highway median
- Principal shared paths for walking and cycling access along the rail line
- Track and associated infrastructure to connect to the existing Midland Line
- Road and bridge reconfiguration works
- Integration across the packages of works and other nearby projects.

2.2.2 General scope of works

The Project's general scope of works includes the design and delivery of rail infrastructure and ancillary works to support operational passenger rail between Bayswater and Ellenbrook, including stations with inter-modal bus and rail with parking and associated road works at Bayswater, Morley, Noranda, Malaga, Whiteman Park and Ellenbrook stations.

The Project activities include all investigation, design, approvals, construction, testing and commissioning, Entry Into Service (EIS), training and operational readiness required to incorporate the new railway to Ellenbrook, and tie into the existing 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 design and delivery of the main works package for the Project is broken into three distinct stages:

- Alliance Development Stage
- Project Alliance Reference Design Stage
- Project Alliance Delivery Stage (Detailed Design through to Project close-out).

Figure 2: Architect's Impression of Ellenbrook Station © MELconnx

2.2.3 Key Project Objectives, Key Compliance Objectives and Critical Success Factors

The PTA and MELconnx's single Non-Owner Participant (NOP) Laing O'Rourke Construction Australia Pty Ltd, have formed an integrated, collaborative Project Alliance to successfully deliver rail infrastructure that reflects our absolute commitment to achieving the Project Objectives and delivering positive outcomes for the State.

The following image demonstrates how we have mapped each Key Project Objective in the Project Alliance Agreement (PAA) against the Critical Success Factors to achieve best-for-project outcomes, underpinned by the Key Compliance Objectives.

Key Project Objectives	Critical Success Factors for Successful Project Delivery (abbreviated)
Implementation of a robust, cooperative team culture.	• Development of a culture that results in all Participants developing behavioural values and driving principles to achieve Alliance goals and project objectives • Longevity and stability of key Alliance personnel i.e. Alliance Manager, ALT and AMT.
Timely delivery of Works to achieve project milestones in accordance with agreed program.	• Development of a final proposal with a sufficiently developed design and accurate TOC • Subsequent cash flow management and financial forecasting, scheduling and value-earned calculation and determination • Implementation of PTA mandated systems i.e. TeamBinder, Primavera P6, TILOS and a finance system accepting the PTA's cost breakdown structure • Timely completion of design, construction and commissioning through to practical completion • Timely progress towards construction milestones and completion of close-out to achieve final asset acceptance compliance.
Inclusion of processes that embrace/promote open tendering and promotion of work package development that encourages/ enables second and third tier tendering. **Compliance with WAIPs.**	• For professional service providers, implement a proven and mature supply-chain engagement process, including tender review, contract award and project integration. Ensure that it offers opportunity and security of payment relative to services delivered in an effort to achieve best-for-project outcomes • For material suppliers and other subcontract service providers, implement a proven and mature supply-chain engagement process, including tender review, contract award and project integration that offers opportunity and security of payment relative to service delivered • Proven and mature supply-chain engagement process for labour hire services, compliant with industrial and safety laws, maintained employee standards/conditions and security of employee payments • Ability to develop contracts and terms and conditions in the spirit of the Alliance values and principles , appropriate and commensurate with the size, complexity and value of packages in accordance with industry best practice.
Optimisation of operational and whole of life costs.	• Sustainability considerations and outcomes for the whole of life of the works.
Ensuring appropriate consultation/integration with stakeholders and community.	• Constant and effective engagement with relevant stakeholders, particularly utilities/services, Main Roads, third party asset owners and relevant unions • Effective management of PTA interfaces and PTA contractors • Constant/effective engagement with the PTA in design reviews, work planning and possessions/shutdowns.
Providing passengers with safe and secure services and facilities.	• Compliance with ONSR requirements • Completed rail line, stations and bus transfer infrastructure are able to deal successfully with the movement of people, including the disabled.
Minimising disruption to current and anticipated rail operations.	• Minimise impact on public transport services disruption • Liaison and interaction with PTA rail operations personnel tasked with determining network closures, to confirm available network shutdowns and implement contingency plans • Effective management of interfaces with others in heavily constrained areas • Effective management/staging of works to reflect staged/constrained site access • Effective management of existing rail infrastructure asset protection.
Recognising the State's desired industrial relations objectives.	• Develop a project-specific Industrial Relations Management Plan based on a proven and successful industrial relations approach that delivers a collaborative worksite, genuine collective agreement, making good faith in negotiations and dispute resolution, and respect for trade union rights of entry.

Key Compliance Objectives (abbreviated)				
Compliance with all Statutory requirements and State Government policy requirements for construction work.	Compliance with the SWTC.	Protecting and minimising disruption to all existing facilities, infrastructure, properties or public utility services.	Meeting all obligations to impacted stakeholders and demonstrating genuine sensitivity.	Compliance with all environmental conditions and minimise adverse environmental impact.

Figure 3: Key Project Objectives, Critical Success Factors and Key Compliance Objectives

2.3 Alliance vision and delivery approach

The MEL Project will be delivered under an alliance contract to support the management of project and stakeholder interfaces and to mitigate project risks. A collaborative alliance approach will see the Works carried out in a cooperative, coordinated and efficient manner in compliance with the Alliance Principles.

MELconnx understands that the successful delivery of the Project is critically linked to meeting the PTA's Key Project Objectives. These objectives have shaped our vision for the Project that is around delivering a high-quality product and creating exceptional value-for-money. We are committed to a no-blame culture and to the prompt and mutual resolution of any issues that may arise.

During the AD Stage, representatives from both the PTA and MELconnx participated in an interactive workshop to begin the process of developing a suitable Alliance Vision for the Project (refer Figure 4 below for workshop outcomes).

Figure 4: AD Stage Alliance Vision Development Outcomes (developed with the PTA)

The Alliance Foundation workshop was held on 11/11/2020 and the results of this workshop generated the basis for the Vision, Purpose, Values and Behaviours Commitment Statements represented here.

Figure 5: MELconnx Alliance Vision, Purpose and Values

2.4 Purpose of the Report

The Design Report identifies any interdependencies between each Design Package and how those dependencies have been accommodated within the document. The Design Report describes the relationship between each of the Package(s) engineering lifecycle and the assurance gates throughout the Project.

2.5 Changes Since Previous Design Submission

2.5.1 Alliance Development Stage to Reference Design Stage

The following design changes have occurred during the Reference Design development:

- Revised station precinct layout in response to:
  - Revised landscape architecture masterplan.
  - Revised location of Pick-up and Drop-off bays and access arrangements.
- Revised location of ancillary buildings and access arrangement.
- Further development of FSLs with the view of reducing the volume of imported fill.
- Further development of Stormwater Drainage strategy in light of TGA IFC report and design documentation.
- Development of precinct primary services (utilities) routes.
- Incorporation of Landscape Architecture masterplan requirements.

2.5.2 Reference Design to Interim Detailed Design

The following design changes have occurred during the Interim Detailed Design development.

Not applicable at Reference Design Stage.

2.5.3 Interim Detailed Design to Final Detailed Design

The following design changes have occurred during the Final Detailed Design development.

Not applicable at Reference Design Stage.

2.5.4 IFC Design Finalisation

The following design changes have occurred during the IFC Design finalisation.

Not applicable at Reference Design Stage.

3. Design Description

3.1 Scope of this Design Package

In accordance with the SWTC, *Book 3: Part A – Scope of Works, Section 3.3 Noranda Station Surrounds*, the scope of this Design Package is outlined as follows.

3.1.1 General

The scope requirements within the Noranda Station Precinct encompass the confirmation and detail design of the civil engineering elements as follows.

- Precinct layout and geometry.
- Stormwater drainage.
- Bulk earthworks
- Pavement design.
- Precinct services.

The above have been undertaken for the following:

- Car Parking areas and associated access roads.
- Station forecourt and public realm areas.
- SER compound.
- Ancillary buildings and associated access and egress.

3.1.2 Civil Engineering Scope of Works

The civil engineering scope of works include the following:

- An at grade PTA Station car park to the east of the Station and north of Benara Road with Kiss and Ride areas and access for carpark patrons to the station from the carpark to and Station Entry building. The pick-up and drop-off bays must be located adjacent to main station entrance facility. The capacity of bays as described in the Schedule of Accommodation (Book 3 - Part A, Station, Station Surrounds and Station Precinct Design).
- Vehicle access road from Benara Road to the Noranda Station precinct carpark with a priority-controlled intersection and turning pockets as required by traffic studies. Minimum requirements must include a left in, left out and right in.
- Shared path connection to proposed underpass to Benara Road.
- Modification to existing shared path and provision of priority crossing on the north side of Benara Road where the new vehicle station car park access road severs the existing shared path to maintain shared path continuity.
- Access road and associate civil works including secure fencing and gates as required for a Western Power Point of Connection, fire tank, pump room and booster, Signalling and Communications Equipment Room (SER) and Radio Mast located within the station precinct.
- MRWA access and gate to be provided via Acacia Court.
- A dedicated point of access for MRWA is to be provided to Tonkin Highway median via station precinct for MRWA to maintain lighting and communication assets.
- The pad level of the Western Power point of connection at Noranda Station must be 300mm above the 1% AEP storm event flood level.
- Provision of stormwater drainage system for station precinct to incorporate infiltration basins or underground stormwater storage system structures where open basins cannot be accommodated.
    - To accommodate the car parking runoff and existing MRWA open drainage basin (Basin 2) storage using StormTrap units or similar approved stormwater storage infrastructure. Stormwater drainage strategy is subject to approval by PTA and MRWA, and endorsement by METRONET and DWER.
- Separation between LGA, MRWA and PTA drainage to be achieved.
- Provide new utility connections and supplies to the new Noranda Station including sewer and water.

3.2 Design Description

The basis of the design and the specific design methodology adopted is described below.

3.2.1 General

This section outlines the design considerations associated with the Reference design phase of the Noranda Station including carpark, bus interchange and associated precinct.

The design is documented on the following: Drawings:

- 25-A-286-CI0001 Cover Sheet and Drawing Index
- 25-A-286-CI0002 Bulk Earthworks - Plan
- 25-A-286-CI0011 Drainage and Finished Surface - Plan
- 25-A-286-CI0012 Drainage and Finished Surface - Plan - Sheet 1

- 25-A-286-CI0013 Drainage and Finished Surface - Plan - Sheet 2
- 25-A-286-CI0039 General Arrangement - Plan
- 25-A-286-CI0046 Combined Proposed Utilities - Plan
- 25-A-286-CI0073 Pavement and Kerbing - Plan
- 25-A-286-CI0078 Pavement and Kerbing - Detail - Sheet 1
- 25-A-286-CI0086 Minor Structures - Plan
- 25-A-286-CI0093 Vehicle Tracking Plan

Models:

- 25-B-286-CI0001 (Earthworks)
- 25-B-286-CI0002 (Drainage)
- 25-B-287-CI5004 (Car Parking)
- 25-B-286-CI5005 (Utilities)

3.2.2 Precinct Layout

The precinct design has been progressed based on AD Phase Noranda Precinct Design 1, and further precinct amendments agreed during Reference Design development..

In summary the revised layout has been developed to a higher level of detail and includes:

- Revised carpark located east of the station and Tonkin Highway and north of the Kiss and Ride.
- Revised pick-up and drop-off south of the car park.
- Precinct access road from Benara Road.

Refer to the table below for a summary of proposed parking facilities. A total of 400 car parking bays are achieved for the station precinct.

Table 1: Noranda Station Total Car Parking Numbers

Location	Description	No.	Notes
Car Park	Standard All Day Car Parking Bays	357	
	Tenant All Day Parking Bays	0	
	Electric All Day Car Bays	2	
	Short Term Bays	21	Within main car park
	Short Term Bay	1	Accessible
	Accessible Car Bays	7	
	Taxi Bays	1	
	Service Bays (co located loading bay)	2	
	Staff Parking Bays	4	
Pick-Up & Drop-Off	-	5	Short Term Bays (within Pick-Up &Drop-Off)
	Sub-total	**400**	

Bicycle storage facilities have been proposed adjacent to the west of the station building.

3.2.2.1 Car Park

The carpark has been designed to maximise the number of car parking bays whilst allowing for all vehicle movements and providing safe pedestrian access to Noranda Station.

The carpark layout has been designed to be compliant with Australian Standards 2890.1 Off-street Car Parking and 2890.6 Off-street parking for people with disabilities, and include:

- Parking Bay Dimensions: 2.4m x 5.4m (assuming no overhang)
- ACROD bay dimensions: 2.4m x 5.4m perpendicular bays (one shared access bay for every two ACROD bays)
- Aisle width: 6.2m (bays at 90 degrees)

3.2.2.2 Pick-up and Drop-off

The pick-up and drop-off layout has been designed to be compliant with Australian Standards 2890.1 Off-street Car Parking and 2890.6 Off-street parking for people with disabilities, and include:

- Parking Bay Dimensions: 3.0m x 8.0m parallel parking
- Circulation access road width: 3.5m (one-way)
- Turning facilities

3.2.2.3 Precinct Access Roads

The carpark access road has been designed to interface with the proposed Benara Road intersection design (refer to JAJV Highways drawings).

3.2.2.4 Vehicle Tracking

Vehicle tracking movements have been assessed for the following Austroads 2013 design vehicles:

- 5.2m passenger vehicle (for internal carpark movements)
- 9.9m service vehicle (bin store related internal carpark movements)
    - Includes swept path movement requirements for a refuse vehicle
- 12.2m pumper fire truck (emergency vehicle access to the station concourse area and fire pumps and tanks compound)

3.2.3 Earthworks

The design surface has been modelled using 12D software design package, with the resulting bulk earthworks cut/fill volumes shown on drawings 25-A-286-CI0002.

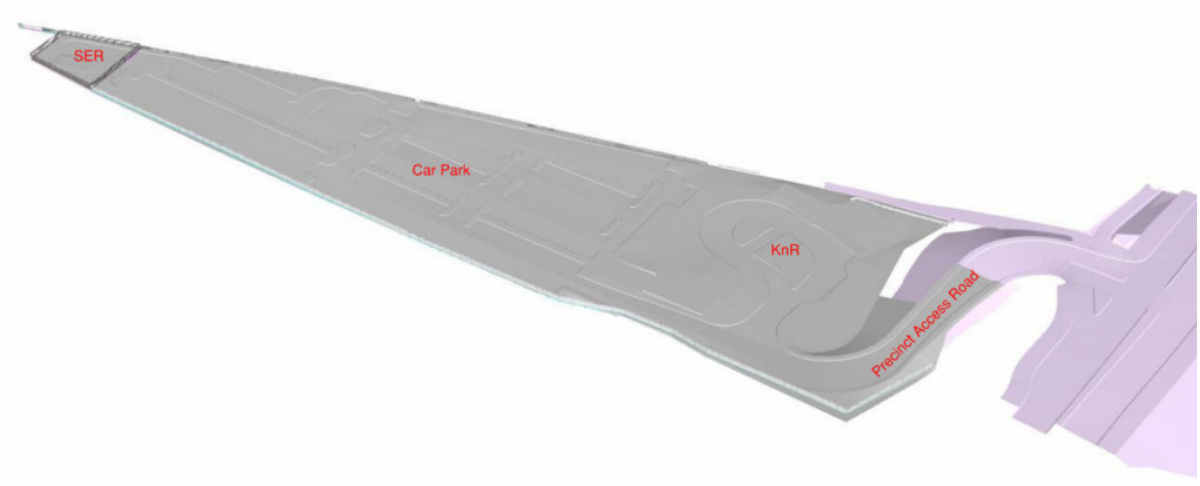

Figure 6: Perspective view indicating proposed Noranda Station Precinct design

The site has been modelled to minimise cut and fill volumes, using the level of the top of Main Roads WA basin as the design level for the station car park.

Two retaining walls are required as part of the design:

- A 110m long wall with a max retained height of 2.0m between the Benara Bridge wing wall and the station entry building.
- A 200m long wall with a max retained height of 1.3m along the western edge of the car park.

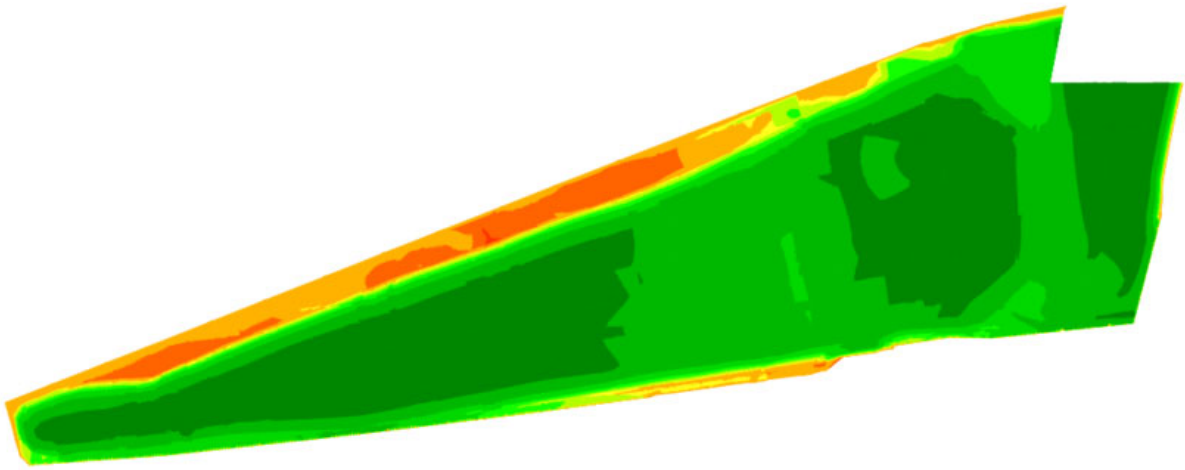

Figure 7: Noranda station precinct earthworks depth range (cut/fill requirements)

Bulk earthworks volumes have been calculated based on the bulk earthworks design surface (design surface minus 300mm depth to allow for pavement build-up and landscaping) and the existing surface model (minus 100mm for topsoil stripping).

Bulk Earthworks volumes are as below:

- Cut: 570 m^3
- Fill: 35,720 m^3

The existing surface model is based on model no. MEL-MLCX-SV-MDL-00001.

3.2.3.1 Car Park

Carpark design levels grade in a south-north direction for major flood routing, nevertheless contained within the car parking area due to the level difference with the surrounding areas. Interface with proposed levels at the precinct access road and Benara Road and Tonkin Highway have been taken into consideration. Falls are introduced to the carpark surface between rows of car bays and towards road gullies.

Carpark, pick-up and drop-off facilities, are designed to be at grade facilities.

3.2.3.2 Station Forecourt

The station forecourt and public open space east of the proposed station entry building are proposed to tie-in with the station forecourt. Levels range from +29.85m AHD to +29.25m AHD to support the step in the entry building. The design surface grades towards the pick-up and drop-off for stormwater drainage purposes.

3.2.3.3 SER Compound

The SER compound drainage has been designed with a one way fall from east to west.

3.2.3.4 Pick-up and Drop-Off

The road design surface falls towards the internal kerb line for stormwater drainage collection purposes with a typical crossfall of 2%. Allowance for footpath and landscaping works have been included. A central soft landscaped area segregates traffic flows in opposite directions.

3.2.4 Pavements

In coordination with landscape architecture, eight (8no.) pavement types have been specified for the station, as follows:

- Pavement Type 1: Asphalt Pavement (Light-Duty)
- Pavement Type 2: Asphalt Pavement (Heavy Duty)
- Pavement Type 3A: Block Paving, not subject to vehicular loading
- Pavement Type 7: Concrete Pavement (motorcycle parking shelter)
- Pavement Type 8A: Pedestrian areas (concrete), not subject to vehicular loading

Pavements subject to vehicular traffic have been designed to MRWA Engineering Road Note 9. Pavement design thicknesses have been rationalised based on a 40-year design life and following design traffic assumptions:

- Carpark and circulation areas: 4 million ESA
- Pedestrian areas subject to occasional vehicular loading: 3 million ESA

The pavement extents and details and are documented on drawings 25-A-287-CI0088, 25-A-287-CI0089 and 25-A-287-CI0097 respectively.

In line with Advisian geotechnical investigation interpretive report, document number MEL-ADV-GE-RPT-0010 dated 15/12/2020, a design CBR value of 12% has been assumed – given the sand geology of the site.

3.2.5 Drainage

3.2.5.1 Existing Drainage

The Noranda Precinct development impacts existing Main Roads stormwater drainage infrastructure (Basin 2). The site accommodates a 1% AEP stormwater drainage basin serving a total catchment of approximately 6.64 hectares (Source: AD Stage Design Report MELconnx 2020).

3.2.5.2 General design strategy

An increase in the impermeability through precinct areas carparks and station buildings will increase the stormwater runoff. The general design strategies for the precinct are as follows:

- Capture and treat the 1EY 1hour runoff.
- Minor Storm: 10% AEP. The drainage system shall be capable of carrying and controlling flow from the minor storm event. The flood level to be kept below the pavement level.
- Major Storm: 1% AEP. Safe, well-defined overland flow paths will be incorporated in the surface design. Above ground storage will be kept away from critical infrastructure (i.e., buildings, major roads) with a minimum of 300mm freeboard. All drainage infrastructure will be approved by the relevant local council. A maximum flood depth of 200mm to be maintained.
- Major Storm: 1% AEP. Station building and platform runoff to be captured and dissipated on site.

Furthermore, where management of superficial groundwater is required as part of the project work, groundwater to be managed consistent with the DWER's publication "Water resource considerations when controlling groundwater levels in urban development, DoW, April 2013", and the requirements specified in the SWTC Book 3: Part A: Scope of Works.

3.2.5.3 General design input

The key drainage design inputs for the station precincts are noted as:

- Design Intensity-Frequency-Duration (IFD) Rainfall – BOM 2016 IFD (climate change factor is applied)
- 2% AEP Ground Water Levels
- Geotechnical investigation and report
- Climate change factor applied to the IFD
- An Infiltration rate for the site has been adopted as 10 m/day for the minor and major analysis (as per MELconnx Geotechnical Interpretive Report MEL-MLCX-GE-RPT-00010)
- Infiltration rate for the design of soakwells has been reduced to 3 m/day to account for the clogging factor.

3.2.5.4 Drainage Design

The stormwater strategy for the site is documented on drawings 25-B-286-CI0012 and 25-B-286-CI0013 and is separated into five components as follows:

- SER
- Pick up and drop off
- Car Park
- Access Road
- Station Building and Eastern Overpass

The station platform is discussed further in the hydraulics section.

The design was completed using 12D. The pipe network was modelled in 12D and pipe sizes were checked using ILSAX method. The underground storages and soakwells were modelled using PCSump V6.1.

Figure 6 below shows the design contours and proposed stormwater drainage networks which indicate the proposed stormwater drainage management strategy.

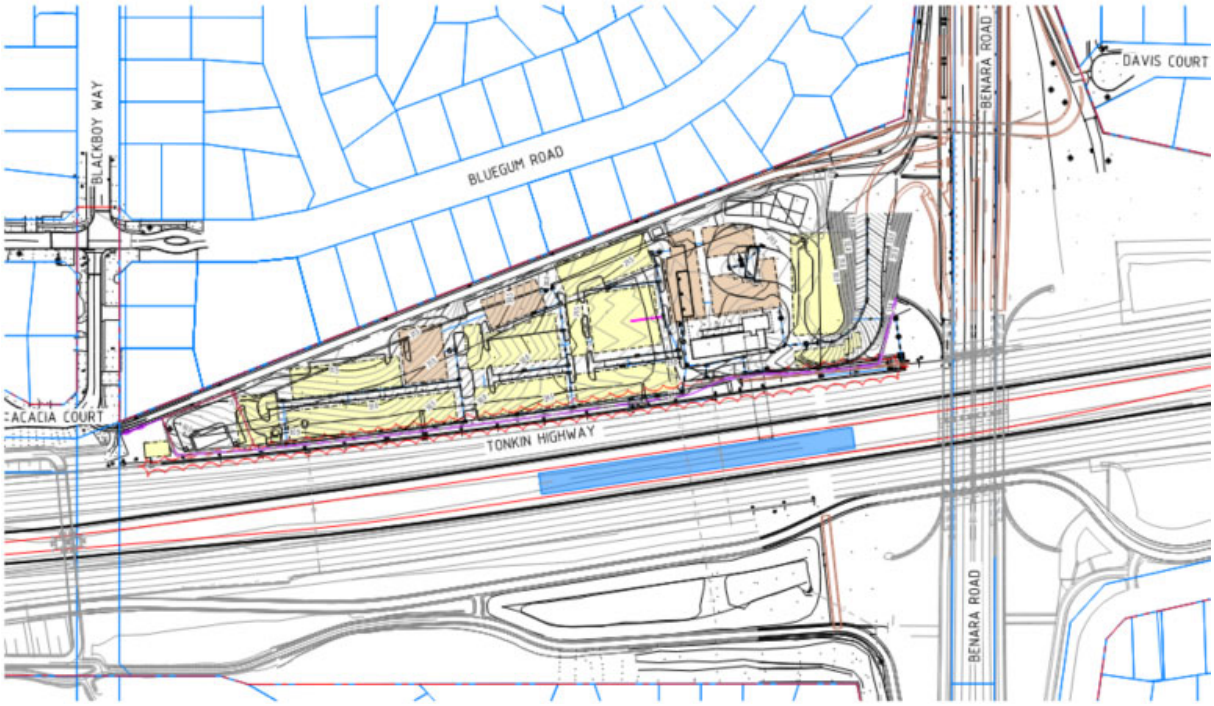

Figure 6 Noranda Station main precinct stormwater drainage and proposed contour

3.2.5.5 SER

The SER is located at the northern end of the car park, with the compound graded to the west. Kerbing along the perimeter of the trafficable compound area will convey 10% AEP runoff to soakwells. Runoff from the 1% AEP flood event will be conveyed within a swale to the northern end of the site to a depression. The flood depth within the SER compound does not exceed the maximum allowance of 200 mm.

3.2.5.6 Pick-up and Drop-off

The pick-up/drop off loop is located to the east of the station access building at the southern end of the car park. The loop is graded towards the central island to be collected and conveyed by a pit and pipe network into underground storage. Major rainfall events will overtop and pond within the central island, with ponding depth over the pavement not exceeding the maximum allowance of 200 mm.

GPT prior to the underground storage inlet will provide treatment for the 1EY 1 hour event.

3.2.5.7 Carpark

The car park is generally crowned in the centre of each vehicular aisle to direct runoff towards the parking bay medians. A pit and pipe network collects and conveys runoff into underground storage beneath the car park and pedestrian thoroughfares. Major rainfall events will pond over the pavement not exceeding the maximum allowance of 200 mm. Events greater than the 1% AEP will exit the site onto the Tonkin Highway.

The current car park layout does not provide suitable area for bioretention areas to treat runoff. In-line proprietary SQIDs are proposed prior to underground infiltration storages to treat car park runoff.

3.2.5.8 Access Road

The precinct access road has a one-way crossfall towards the outbound lane. A pit and pipe system on the low side will collect and convey runoff to the underground storage located to the east of the station access building.

In the 1% AEP flood event ponding over the pavement will not exceed the maximum allowance of 200 mm.

3.2.5.9 Station building and Entry Building

The train station and platform drainage are discussed further in the hydraulics section. The existing MRWA pipes under the Tonkin Highway will be retained to convey flows from the track and platform areas.

The Station building and eastern overpass drainage systems will be conveyed into the car park drainage system. There will be three points of discharge/ connection.

Roof drainage is directed to the ground level via downpipes, connecting to the access road and car park pit and pipe networks along the northern and western facades of the building. The downpipe discharge locations are highlighted in the Hydraulic design package.

3.2.5.10 Existing Geology

The existing geology is characterized by Bassendean Sands underlain by coffee rock for some portion of the area. The exact extent and nature of this coffee rock is unclear based on historical geotechnical investigation undertaken at the site. However, based on the available investigation previously completed by Advisian (2020) (MELADV-GE-RPT-00002 rev 0), Coffee rock (or Ferricrete) was encountered in some of the investigation points, which is summarized as follows:

- 6 Hand augers (HA) tests were completed at Basin 2 and surrounding area; NOR-HA01, NOR-HA04, NOR-HA05, NOR-HA06, NOR-HA07 (RSR) and NOR-HA08(K). Coffee rock was encountered in 5 of the 6 tests at a depth between 26.3m-26.5m AHD and 0.1-0.2m thick. Groundwater levels were generally encountered below the coffee rock at 25.8m AHD and 26.0m AHD.
- CPT tests: NOR-CPT01 and NOR-CPT02 terminated at 25.9m AHD and 26.3m AHD due to early refusal, potentially due to the presence of coffee rock. This is consistent with the depth of coffee rock present in the HA tests above.
    - Boreholes: NOR-BH05 and NOR-BH06. Coffee rock was encountered was encountered in both tests at a depth of 26m AHD and 26.5m AHD and 0.3m thick. Groundwater levels were generally encountered below the coffee rock at 25.7m AHD and 26.0m AHD.
    - One infiltration rate was undertaken at hand auger NOR HA08(K) at 2.0 m depth, which is within the
- Bassendean Sand but did not include Coffee rock. Advisian Interpretive Report, 2020 (MEL-ADV-GERPT-
- 00007 rev 0) noted NOR-HA08 (k) coefficient K20 = 4.5m/day.

Based on the assessment above it is likely that Noranda Station Precinct (existing MRWA 'Basin 2') is underlain by Coffee Rock at a depth 26.3m AHD to 26.5m AHD and between 0.1-0.3m thick.

Where coffee rock is encountered within the precinct, options for penetration through the rock or removal are recommended to be developed to improve infiltration and take full advantage of the underlaying aquifer.

In light of the above, a Technical Memo note (doc. Ref MEL-MLCX-CI-NTE-81003 was developed describing the investigations into the presence of coffee rock at the Noranda Station Precinct, in that it impacts on the sizing of detention storage replacing the current MRWA infiltration basin draining Tonkin Highway and other parts of the surrounding suburbs.

In summary, three options can be considered to remove the impact of the presence of the Coffee Rock Layer:

- Option 1: Excavate Coffee Rock layer and replace with granular imported fill.

- Option 2: Excavate and reuse the Coffee Rock layer as granular fill
- Option 3: Puncturing the Coffee Rock layer

Furthermore, as part of the assessment of eliminating the effects of coffee rock on infiltration, a review of available information has been undertaken, together with limited modelling, to determine a suitable regime of penetrations through the coffee rock to enable full engagement with the underlying aquifer.

This work was based on finite element modelling, to calculate the size and spacing of penetrations through the coffee rock that will allow full utilization of the aquifer that lies beneath. The results of the modelling are critically dependent on the assessed permeability of the coffee rock. No testing of this has been done, so a site-wide investigation is required to confirm design assumptions made in the modelling.

Sensitivity testing of the coffee rock permeability has been made though, which can be seen to have a significant effect on the time taken for the storage to empty. In making recommendation of the size and spacing of penetrations through the coffee rock, a value of 0.001 m/day has been adopted, but this needs to be confirmed by further testing.

In summary, the assessment work suggests that 450 mm dia holes at a 5 m spacing through the coffee rock will lead to a satisfactory emptying time for the StormTrap units. An investigation program is required to confirm the design assumptions relating to permeability of the coffee rock. If a permeability greater than 0.001 m/day is shown to be applicable, then the spacing of 450 mm dia holes could be increased. Conversely, a lower value would reduce the spacing.

3.2.5.11 Underground Storage

The existing site accommodates a MRWA 1% AEP drainage basin (Basin 2) for the Tonkin Highway and various adjoining main roads. In developing this site, storage of on-site (Precinct) and off-site (Roads) runoff is to be accommodated separately within the Noranda Precinct and car park. The full development of the site for the proposed Noranda Precinct and car park results in limited area to accommodate separate surface storages for the MRWA (off-site) and Precinct (on-site) 1% AEP flows.

Reporting by TGA suggested the required storage volume to contain and infiltration the 1%AEP event from the Tonkin Highway catchment is approximately 7,360 m^3. This volume is accommodated across 10 underground storage chambers within the precinct car park. Refer to drawing 25-B-286-CI0011.

Pre-treatment via a GPT has not been provided upstream of the MRWA underground storages due to limited space available for the placement and provision of safe access for maintenance. The proposal to provide a TL5 barrier along the edge of the Tonkin Highway and a retaining wall on the western side of the car park and access road limits placement of devices within the road corridor.

As the site is proposed to be filled up to 2.5 m above the existing surface level it was deemed practical in the AD phase to provide underground storage within the site. As there is a large volume of flow from an external catchment contributing to the precinct catchment it is proposed to separate the Station Precinct and off-site MRWA runoff flows into a series of underground storages to be managed and maintained by PTA and MRWA. The proposed drainage units have been located to account for the precinct buildings, amenities, facilities, site and utility services. Due to its efficient storage capacity and suitability for use in spatially constrained sites, the proposed solution is StormTrap system.

The units are sized for 1% AEP with infiltration through the base based on an infiltration rate of 10 m/day as per MELconnx Geotechnical Interpretive Report (MEL-MLCX-GE-RPT-00010).

3.2.5.12 PTA Noranda Precinct

Five underground storages (of varying size) are provided to retain and infiltrate the 1% AEP event flow from the proposed PTA infrastructure (precinct and car park). For the PTA drainage storage, the base is kept at 200mm above the 2% groundwater level. The storage volume that can be achieved within the site is approximately 1,560 m^3.

Each inlet into the StormTrap chambers will include a treatment device to provide treatment for the 1EY 1 hour event. Due to area constraints within the site, utilisation of bioretention areas within the carpark and drop off / pick-up area is not feasible.

3.2.6 Utilities

3.2.6.1 Existing Utility Impacts

Existing services within the vicinity of the Noranda Station and associated precinct are documented on drawing 25-A-286-CI0046.

Several services are likely to be impacted by the proposed works. These include:

- Existing Main Roads WA Tonkin Highway lighting infrastructure. The Noranda Precinct access road has been designed in close proximity to the existing concrete barrier on Tonkin Highway. An existing Main Roads lighting pole and lighting pit are located immediately east of the existing barrier. It is envisaged that the existing lighting pit may need to be relocated. Furthermore, the location of lighting pole will need to be surveyed to assess the impact of the access road. The impact to the lighting infrastructure in the vicinity of the proposed access road will need to be coordinated with MRWA during detailed design stage.
- Existing City of Bayswater lighting on Benara Road due to the required reconfiguration of the existing island to facilitate the turning pockets for access and egress to the proposed station precinct.
- Not in use 600mm Water Corporation Water Main. The proposed station platform and precinct car park have been designed over a mapped existing 600mm Water Corporation Water Main which has been confirmed by the Water Corporation as not being in use. It is envisioned that this main may no longer be required and may not require any protection measures, however, this will need to be confirmed with Water Corporation at detailed design phase.

Temporary utility supplies, utility protection measures considering construction activities and utility relocations and modifications are not included as part of this scope of works.

3.2.6.2 Proposed Utilities

3.2.6.3 Overall Strategy

The general strategy for the Noranda Precinct is to provide dedicated services corridors with connections to:

- Existing Western Power services in Acacia Court.
- There is no existing water corporation water or sewer network at the boundary of Noranda station. existing water corporation networks to be extended to this point to facilitate proposed connections. Water pipe outside lot boundary will be owned by water corporation. refer to water corporation network extension drawing MEL-MLCX-UT-SKT-81020.

The width of the services corridors has been kept as narrow as possible to minimise impact on the adjacent landscaping and proposed underground stormwater storage units.

Consideration has been given to the future precinct lighting and CCTV provision in the positioning of primary chambers.

3.2.6.4 HV Electricity

The HV power connection to the station will be taken from the Western Power 22kV distribution line within Acacia Court.

Two Western Power Assets are proposed. A Western Power Ring Main Unit (RMU) is proposed to be just north of the SER compound, and a Western Power substation proposed east of the Station forecourt area.

- 6no. 100mm Ø ducts are proposed between the assets stated above.

3.2.6.5 LV Electricity

A precinct wide primary network has been developed from the main site switchboard located adjacent to the Western Power Substation to the south facade of the station entry building.

Typical connectivity has been provided as follows:

- 6no. 100mm Ø LV ducts between Station Isolation Transformer and the station intake point located along the southern façade of the entry building
- 2 x 2no 100mm Ø LV ducts running along the Pick-Up and Drop-off eastern edge and along the western precinct boundary on a north south direction serving the parking area.
    - 1no.100mm Ø LV ducts will feed the car park in an east west direction

3.2.6.6 *Precinct Telecommunications*

The telecommunications connection will be taken from the existing Telstra cable within the Benara Road (Note: This existing Telstra cable will be modified as part of the Benara Road realignment).

3.2.6.7 *Potable Water*

There is no existing water corporation water network at the boundary of Noranda station. existing water corporation networks to be extended to this point to facilitate proposed connections.

Water Corporation has confirmed that a 50mm connection to the existing 100mm RC water main located on the south side of Acacia Court is acceptable.

A water meter is proposed to be located at the entrance to the station precinct boundary.

3.2.6.8 *Fire Water*

Water Corporation has confirmed that a 50mm connection to the existing 100mm RC water main located on the south side of Acacia Court is acceptable.

Similarly, to potable water a meter will be required at the entrance to the station precinct.

3.2.6.9 *Sewer*

Water Corporation has confirmed that a 150mm connection to the existing sewer MH: T7500, IL26.79 extension of 150 PVC-U at 1:200, IL at property connection = 27.39, is acceptable.

In light of the existing sewer connection, a private pump station is proposed to be located to the north of the proposed station building to enable discharge from the precinct area to the future Water Corporation 150mm diameter pipe.

3.3 Relationship with other Design Packages

The relationship and/or reliance of this design package on other MEL design packages is outlined in the Design Interface Matrix included in Appendix X of this report.

3.4 External Interfaces

The relationship and/or reliance of this design package on external interfaces and details of integration strategies are outlined in the Table below.

Item	External Party	Interface Elements	Integration Strategy
1	Main Roads WA	Storm Water Drainage	LOR to facilitate liaison with MRWA
2	Main Roads WA	Extent and design of TL5 Barriers along Tonkin Highway	LOR to facilitate liaison with MRWA
3	Water Corporation	Water Supply	LOR to facilitate liaison with Water Corporation.
4	Water Corporation	Sewer Connection	LOR to facilitate liaison with Water Corporation.
5	Water Corporation	Interface with existing 900mm diam. Gravity sewer	LOR to facilitate liaison with Water Corporation.
6	Western Power	Power Supply	LOR to facilitate liaison with Western Power.

7	Western Power	Interface with existing 22kV distribution cables	LOR to facilitate liaison with Western Power.
8	Western Power	Proposed Western Power RMU	LOR to facilitate liaison with Western Power.
9	NBN/ Telstra	Fibre connection	LOR to facilitate liaison with Telstra/ NBN.
10	DFES	Access and Egress	Ensure that access and egress for fire and emergency vehicles in agreed.

4. Design Inputs

4.1 Project Design Requirements

The following design inputs have been used in preparation of this report.

4.1.1 SWTC Requirements

The following sections of the SWTC are applicable to the Permanent Way Design and have been considered:

- MEL-PTAWA-PM-RPT-00001.0.IFU_Ver1 - Book 1: Part A - General Scope of the Alliance Works.
- MEL-PTAWA-PM-RPT-00002.0.IFU_Ver1 - Book 1: Part B - Limit of Works.
- MEL-PTAWA-PM-RPT-00004.0.IFU_Ver1 - Book 3: Part A - Scope of Works.
- MEL-PTAWA-PM-RPT-00006_Ver2 - Book 4: Technical Criteria.
- MEL-PTAWA-PM-RPT-00007_Ver1 - Book 5: Appendices to the SWTC.

4.2 Design software used for this package

The following design software has been used in preparation of the design.

- AutoCAD
- 12D
- DRAINS

4.3 Applicable Codes and Standards

The applicable standards, codes and guidelines are in accordance with SWTC Appendix 3. Standards and codes listed in the Table below are those in addition or amended revisions applied to the design.

Reference	Description/Title	Compliance (Specific Provisions, Criteria and Classifications)
Australian and Other Standards and Guidelines		
-	Main Roads WA Supplements to Austroads Guide to Road Design	
AS3798 -2007	Guidelines on earthworks for commercial and residential developments	

AS2890.1	Part 1: Off-Street car parking	
AS2890.6	Part 6: Off-street parking for people with disabilities	
-	Utility Providers Code of Practice for Western Australia	
-	Water Corporation Design Standard No. DS 50 Wastewater Gravity Sewers	
-	Water Corporation Design Standard No. DS 51 Wastewater Pump Stations and Pressure Mains	
-	Water Corporation Design Standard No. DS 60 Distribution pipelines other than reticulation	
-	Water Corporation Design Standard No. DS 63 Water reticulation pipelines	
-	Western Power Underground Cable Installation Manual and other design guidelines	
-	ATCO Gas Additional Information for Working around Gas Infrastructure	
-	APA Group Information for Planners and Developers	
-	Department of Lands – Land Use Guidelines, Dampier to Bunbury Natural Gas Pipeline Corridor.	
-	DWER's guidelines 'Decision Process for Stormwater Management in WA November 2017' & 'Stormwater Management Manual for WA"	
-	Local council engineering standards for drainage (City of Swan, City of Bayswater) – including: • City of Swan Handbook of Storm Water Drainage Design. • City of Swan Development Design Specification – Storm Water Drainage Design.	
-	MRWA Supplement to Austroads Guide to Road Design Part 5, Part 5A and Part 5B	
-	Water Corporation Design Standard No. DS66 Urban Main Drainage Standard	

-	Department of Water and Environmental Regulation - Stormwater Management Manual for Western Australia	
-	Department of Water and Environmental Regulation – Decision Process for Stormwater Management	
-	Australian Rainfall and Runoff: A Guide to Flood Estimation. Commonwealth of Australia (2016)	
-	Australian runoff quality - a guide to water sensitive urban design (2006)' published by Engineers Australia	

4.4 Reference Information

The project specific reference information and reports that have been used as inputs into the development of the detailed design are included in the table below.

Document Reference	Description/Title
25-B-00-CI001	Rail Model
25-B-286-LA0001	Landscape Masterplan
25-B-286-AR0001	Architectural Model
MEL-ADV-GE-RPT-00008 & MEL-MLCX-GE-RPT-00010	Geo reports
TIN_Grndwater_Full_Align_AEP002	Groundwater Models
MEL-MLCX-SV-MDL-00001	Topographical Survey
MEL-MLCX-CI-RPT-00001	Flooding Modelling Report
TGA-02-GE-0250-MEM-0001	TGA Infiltration Basin Parameters for PCSump (V6.1) – Associated Works - 100% Stage Geotechnical Design Report
TGA-02-CI-0180-REP-0001	TGA IFC Design Report

4.5 Design Criteria

The design criteria utilised in the development of this design package are outlined below.

4.5.1 Earthworks

Earthworks modelling was undertaken to provide cut and fill volumes for all design surfaces, including:

- Station forecourts
- Station carparks
- Station Pick-up Drop-off areas
- Precinct minor roads

The following key criteria shown in Table 7 and PTA Standard Drawing 00-C-04-0085 Cut and Fill Surface Railway, behave been used when developing batter slopes for the earthworks model for these various aspects of the design listed above.

	Precincts	Minor Roads
Max batter slope - cut	1:4	1:3
Max batter slope - fill	1:4	1:4

All imported material and excavated material for re-use will need to comply with Main Roads WA Specification 302 – Earthworks, and PTA Specification 8880-450-067 - Specification: Roads, Busways and Paths.

4.5.2 Utilities

All works associated with the MEL project will aim to avoid impacting existing utilities where possible and reasonable.

Where impacts to existing utilities are unavoidable, these will be identified. Diversions/realignments will be developed by MELConnx in accordance with the above standards in conjunction with the associated authorities, PTA and METRONET.

Clearances to existing utilities will be maintained (as applicable) as summarised below.

	Precincts / Road Reserves (Code of Practice)	Rail Reserve (not under tracks) AS4799	Rail Reserve (under tracks) (PTA: 8110-400-030)
Power	750mm	600mm	2500mm
Telecommunications	450mm/ 600mm	600mm/ 900mm	2500mm
MCR (Power)	1000mm	1000mm	2500mm
MCR (Telecomms)	1000mm	1000mm	2500mm
Water	600mm	600mm	2500mm
Sewer	600mm	600mm	2500mm
Trunk Services/ Major Pipelines	750mm	1200mm	2500mm

Cover to proposed services crossing the transit corridor will be assessed and discussed in detail with PTA on a case-by-case basis. Any non-conformances will be discussed and agreed with PTA, prior to progressing to Detailed Design.

4.5.3 Drainage Design Criteria

The drainage philosophy for the Noranda Precinct can be summarised as follows:

- Capture all runoff from the site for water quality treatment.
- Discharge runoff at a rate equivalent to the existing condition to ensure no increased flood risk to the downstream environment.
- Protect the environment and infrastructure.

Specific criteria and requirements are in the SWTC. Some criteria from ADA are highlighted below:

- Treatment of 1EY 1 hour runoff within bioretention areas in the carpark.

- 10% AEP flood level to be kept below the pavement level.
- Depth of the 1% AEP flood on the pavement does not exceed 200mm on the pavement surface.

As a minimum, the design for the station precinct has considered the following:

- An assessment of surface water hydrology and groundwater hydrology.
- Modifications to existing LGA drainage systems has been undertaken to the design standard for the relevant authority.
- Drainage must be designed and constructed in accordance with the PTA relevant specifications, and project specific requirements.
- The invert level for swales and basins must be minimum of 300mm above the maximum groundwater (1%, 2%% AEP) level (MGL). MGL to be determined by groundwater monitoring and historical data
- Limited use of pit and pipe drainage solutions may be used in locations where there is insufficient room for swale drains
- Drainage features wherever possible will be integrated into the built form and proposed landscaping design
- Maintenance vehicular access to basins to be incorporated into overall design
- WSUD principles will be incorporated into the storm water strategy
- LGA Water Management requirements will be included in Design requirements.

4.6 Design Life

The design life requirements related to this design package are outlined in the Table below.

Item	Asset Element of the Works	Design Life (Years)
1	All civil and structural elements of tunnels, underground stations, dive structures and other associated underground structures, inclusive of other load bearing elements, internal support structures, foundations, retaining structures, track slab structures, transition slab structures, drainage structures and waterproofing elements.	120
2	All civil and structural elements of on or above-ground structures and buildings, inclusive of any other load bearing elements, internal support structures, steel trusses, purlins and associated roof structural elements, foundations, retaining structures, drainage structures and waterproofing elements.	120
3	All civil and structural elements of rail bridges or bridge overpasses, including pedestrian bridges associated with the stations or spanning the railway inclusive any other load bearing elements, foundations, retaining structures, transition slab structures, drainage structures and waterproofing elements.	120
4	Storm water surface drainage structures, tanks and inaccessible pipe systems including all pits	50
5	Water treatment systems excluding structural elements.	7
6	Noise barriers, noise attenuation devices and acoustic panels and support systems excluding structural elements.	30
7	Artwork, signage and way finding excluding foundations and supporting structures.	20
8	External pedestrian paving (including substrate and paving finish).	25

9	External furniture and fittings, fences and security/fire gates or doors excluding structural elements.	20
10	Internal non-structural elements - fit out, fixtures and finishes	20
11	Protective galvanised coatings to steelwork (excluding structural elements)	25
12	Associated support, gantries and other equipment associated with ticketing systems not otherwise supplied by PTA	30
13	Road sign support structures and other roadside furniture	25
14	Flexible (asphalt) road pavements, car park surfaces, external paving, footpaths, shared paths and hard landscaping features	25
15	External pedestrian paving (including substrate and paving finish)	25
16	Existing drainage structures underneath new pavement	50 years residual
17	Street lighting and light fittings excluding structural elements	20
18	Road surfacing of dense graded asphalt	25
19	Road surfacing of open graded asphalt	20
20	Road and pedestrian bridges (including foundations) and all road drainage structures	120
21	All other Assets not described above must be agreed with the PTA's Representative to meet with Design Life in the above category	

4.7 Durability Requirements

Details of durability issues and risks, and measure to comply with the durability requirements are outlined in Appendix U of this report.

4.8 Specialist Technical Inputs

The following specialist technical design documents have provided inputs to this design package:

- Geotechnical Interpretive Reports
- Groundwater Models
- Flooding Models.
- Topographical Survey

4.9 Constructability Requirements

Details of constructability issues and measures, including traffic management during construction of the Works and the Temporary Works, where this influences design.

- Works will be carried out in the vicinity of live services.
- Dewatering activities are likely to be required considering the high ground water table.
- Sewer and water main extensions from the junction of Beechboro Road North and Marshall Road.

4.10 Environmental & Sustainability Design Criteria

The following key environmental and sustainability initiatives have been developed as part of this design package.

- Optimisation of earthworks requirements minimising the requirement for imported fill.
- Utilisation of Crushed Recycled Concrete (CRC) subbase in accordance with MRWA Specification Series 500, Clause 501.92
- Integration of Water Sensitive Urban Design (WSUD) initiatives in close collaboration with Landscape Architecture to form the basis of the proposed Stormwater Strategy for the Station precinct. WSUD initiatives have been considered and implemented in the design. The main storm-water discharge principles rely on infiltration which will reduce the peak discharge to the main storm-water line (as applicable). Furthermore, planted swales have been incorporated which will aid the removal of first flush pollutants. During IDDR JAJV will work closely with the Landscape Architect for the choice of the planted species to best suit the WSUD strategy.

For further details refer to Sustainability Management Plan (MELAD-MLCX-EN-PLN-00002).

4.10.1 Risk and Opportunities Assessment

In the development of the design the following opportunities have been identified:

- Water Sensitive Urban Design (WSUD);
- Use of Crushed Recycled Concrete (CRC) for pavement sub-base material

4.11 Future Proofing

In the development of the design the climate change factor of RCP 4.5 has been considered. This has been adopted as a reasonable allowance based on the process that was outlined by PTA. The proposed factor will be revised after the risk analysis for the entire project is complete. A Project wide climate Change Risk Assessment workshop will be undertaken in June 2021 and any high risks identified will be mitigated through design, wherever possible.

Future proofed for the future overall wider precinct masterplan by aligning the proposed Pick-up and Drop off and associated roundabout with the proposed masterplan roundabout location. Furthermore, the proposed car park aisle positions have taken into consideration the proposed future lot boundaries.

4.12 Value Engineering

A Value Engineering Optimisation workshop has been completed. The outcomes of this workshop are summarised as follows:

- Significant reduction of earthworks fill requirements.
- Reduction in the requirements for precinct retaining structures.

4.13 Third Party Operational Stakeholders

The following key Third Party Operational Stakeholders requirements have been developed as part of this design package.

Not applicable to this design package.

For further information on third party requirements, refer to the RATM extract for this design package contained in Appendix O.

4.14 Design Input from Stakeholders and Community Involvement Process

The design inputs from Stakeholders and local Community are detailed in the following sub-sections:

4.14.1 Stakeholder Requirements Register

To be confirmed at the next Design state.

4.14.2 Community Involvement Process Input

4.15 Design Assumptions, Dependencies, and Constraints (ADC's)

Details of design assumptions, dependencies, and constraints are outlined in the following sub-section.

4.15.1 Design Assumptions

Design assumptions related to this design package are detailed in the Table below.

ID	Description	Status	Evidence of Validation
	No design assumptions have been made at this stage of design.		

4.15.2 Design Dependencies

Design dependencies related to this design package are detailed in the Table below.

ID	Description	Status	Evidence of Validation
1	Station Architecture Model	Closed	Precinct design has considered proposed architectural model. Model Ref. 25-B-286-LA0001
2	Landscape Architecture Masterplan	Closed	Precinct design has responded to the landscape masterplan. Drawing Ref. 25-B-286-AR0001
3	Benara Road Highways Model	Closed	Precinct design has considered proposed Benara Road highways model. Model Re.25-B-00-CI2006
4	Rail Transit Corridor Model	Closed	Precinct design has considered proposed transit corridor model. Model Ref. 25-B-00-CI002

4.15.3 Design Constraints

Design constraints related to this design package are detailed in the Table below.

ID	Description	Status	Evidence of Validation
1	High ground water table	Closed	Drainage design has considered revised ground water model. Model Ref. TIN_Grndwater_Full_Align_AEP002

2	Existing Main Roads WA Tonkin Highway lighting infrastructure. The Noranda Precinct access road has been designed in close proximity to the existing concrete barrier on Tonkin Highway. An existing Main Roads lighting pole and lighting pit are located immediately east of the existing barrier. It is envisaged that the existing lighting pit may need to be relocated. Furthermore, the location of lighting pole will need to be surveyed to assess the impact of the access road. The impact to the lighting infrastructure in the vicinity of the proposed access road will need to be coordinated with MRWA during detailed design stage.	Open	Further liaison with MRWA required during Detailed Design phase.
3	Not in use 600mm Water Corporation Water Main. The proposed station platform and precinct car park have been designed over a mapped existing 600mm Water Corporation Water Main which has been confirmed by the Water Corporation as not being in use. It is envisioned that this main may no longer be required and may not require any protection measures, however this will need to be confirmed with Water Corporation at detailed design phase.	Open	Further liaison with Water Corporation required during Detailed Design phase.

4.16 Requests for Information (RFI)

Requests for information submitted in relation to this design package are outlined in the Table below. Copies of the RFIs are provided in Appendix W of this report.

RFI REFERENCE	Description/Title	Status
MELD-MLCX-RFI-00239	RFI - Noranda Station Precinct Infiltration Rate (JAJV RFI-00181/RFIC128)	Closed
MELD-MLCX-RFI-00187	RFI - Northern dive, Southern dive and Gnangara Tunnel Change in SWTC (RFIC086)	Closed
MELD-MLCX-RFI-00168	RFI - Amended Scope for Independent Verification	Closed
MELD-MLCX-RFI-00154	RFI - Noranda On-Tracking Tonkin Highway (JAJV RFI-00150/RFIC048)	Closed
MELD-MLCX-RFI-00137	RFI - Settlement Requirements for Shallow Foundations	Closed
MELD-MLCX-RFI-00127	RFI - Blast Loading Tech Memo	Closed
MELD-MLCX-RFI-00125	RFI - Retaining Walls Specification PTA drawing (RFIC026)	Closed
MELD-MLCX-RFI-00113	RFI - Noise Walls Vertical Supports (RFIC014)	Change to SWTC Agreed with PTA

MELD-MLCX-RFI-00076	RFI - Confirmation of Parking Requirements – Station Precincts (Civil/BCA)	Closed
MELD-MLCX-RFI-00025	RFI - Aerial Imagery Updates	Closed
MELD-MLCX-RFI-00024	RFI - PTA RFI - Xref naming exemption from PTA Standard 8110-300-001	Closed
MELD-MLCX-RFI-00019	RFI - Review Requirements - Amended Scope for Independent Verification	Change to SWTC Agreed with PTA

5. Design Outputs

5.1 Deliverables List

A matrix of all document/ deliverable types required at each design stage associated with this design package are provided in the Table below.

Deliverable	Reference Design	Interim Detailed Design	Final Detailed Design	IFC
Design Report	X	X	X	X
Drawings	X	X	X	X
Specifications		X	X	X
Specialist Reports		X	X	X
Construction Methodologies		X	X	X
Third party approvals			X	X

5.2 Drawings and Models

The drawing and model list for this design package is provided in the TIDP in Appendix A of this report.

5.3 Specifications

The specification list for this design package is provided in the TIDP in Appendix A of this report.

5.4 Standard Reference Drawings

The standard drawings which form part of this design package have been summarised in the Table below.

Not applicable to this design stage.

Drawing Number	Description/Title	Revision
n/a		

5.5 System Coordination Drawings and Models

The system coordination drawings and models which form part of this design package have been summarised in the Table below (General arrangements and typical cross-sections).

Drawing Number	Description/Title
E007	Architecture drawings
E008	Landscape Architecture drawings
E018	Line Wide Track drawings
E020	MCR drawings
E025	Civil - Flooding & Hydrology Model
E026	Track, Earthworks, Drainage, Civils drawings
E089	Structures - Foundations, Platform, Concourse & Roofs and Canopies & Pedestrian Bridges and Walkways
E090	Electrical - Lighting & LV & Communications & Security
E092	Hydraulics and Wet Fire

5.6 Type Approvals

Not Applicable.

5.7 Calculations

Calculations are provided in Appendix E of this report.

Calculations are not required as part of this design stage.

5.8 Schedules

Schedules for this design package are provided in Appendix F of this report.

Schedules are not required as part of this design stage.

6. Competence for Design

The competence assessments for relevant design personnel have been undertaken and is evidenced in the PTA SRE Appointment form contained in Appendix J of this report.

7. Design Reviews and Certification

7.1 Interdisciplinary Design Coordination (IDC) Review

An Interdisciplinary Design Coordination (IDC) review has been carried out as outlined in the Table below

Reference	Design Stage	Description/Scope	Evidence
IDC-001	**Reference Design**	Noranda IDC	Refer to Appendix H & I
IDC-002	**Interim Detailed Design**	N/A	N/A
IDC-003	**Final Detailed Design**	N/A	N/A

7.2 IDC Certificate

Design checking has been carried out. An IDC Certificate is provided in Appendix I of this report.

7.3 Design Checking and Verification

Design verification has been carried out. Evidence of design checking and verification is provided in Appendix J of this report.

7.4 Independent Verification

Independent Verification has been carried out. Evidence of independent verification is provided in Appendix K of this report.

7.5 BCA

Not applicable to this design package.

7.6 DDA

Not applicable to this design package.

7.7 PTA Design Submission Reviews.

Review comments raised in the previous design stage have been responded to and closed out. The comments register is attached in Appendix N of this report.

8. Design Compliance

The demonstration of compliance with the requirements of the Project Definition Documents, including any non-conformances of concessions is summarised on the following sections.

8.1 Standards & Guidelines

The standards and guidelines relevant to this design package are outlined in Section 4.3. The design has been carried out, checked and verified by competent personnel as outlined in Section 6.

8.2 SWTC

Refer to the RATM extract in Appendix O of this report.

8.3 Planning & Environmental Approvals

Refer to the RATM extract in Appendix O of this report.

8.4 Third Party Requirements

Refer to the RATM extract in Appendix O of this report.

8.5 Engineering Change

The following categories of Engineering Change that have been considered for the design development are as follows:

- Engineering Change – A novel design solution that is subject to review and approval from PTA through Management of Engineering Process, refer to PTA Procedure 8110-100-014
- Design Departures – A design non-compliance to relevant codes and standards. Will be subject to review and approval from PTA through Management of Engineering Process, refer to PTA Procedure 8110-100-014.
- SWTC Departures – To be discussed and agreed with PTA in the first instance, technical justification required for departure and confirmation of impacts/benefits to the overall Project. Departure to be formalised through the RFI process once agreed in principle.

Engineering changes are summarised in the table below

ID	Category	Description	Status
NA	NA	No design departures are anticipated at this stage of design	

9. External Interface Work Packages

A copy of the Project Interface Management Plan will be provided at the next Design stage.

9.1 Project Interface Control Plan

A copy of the Project Interface Control Plan has been provided in Appendix X.

10. Effects of the Works

The predicted effects of the Works (EOW) in relation to this design package are outlined in the Table below.

ID	Description	Status
1	Interface with existing services that may require diversion or protection.	Open

11. Safety in Design

11.1 Overview

Safety in Design is a standard process defined as the integration of hazard identification and risk assessment methods early in the design process to eliminate or minimise the risks of injury throughout the life of the product being designed. It encompasses all design including facilities, hardware, systems, equipment, products, tooling, materials, energy controls, layout and configuration.

By this definition, the designer takes a leading role in the integration of concepts of safety into the design of a product. In brief, this is achieved through progressive development of the Project Hazard Log (PHL). The PHL included in Appendix Y has been filtered to communicate package relevant hazards and controls. Key Safety in Design considerations include the following (listed in order of precedence):

- Eliminating hazards at the source.
- If hazards cannot be eliminated, then a control will be established to reduce the level of risk associated with the hazard in order of a hierarchy of possibilities and controls:
- Substitution of a less hazardous alternative.
- Engineering controls.
- Administrative controls.
- Other control mechanisms.
- Communicate known controlled and residual risks to affected parties.

11.2 Safety in Design relevant to this Package

11.2.1 Hazard Log

A Master Hazard Log has been maintained for the project which covers the full scope of the project. The baseline set of hazards has been developed which is reflective of the current PTA suite of technical standards, as extracted from the SWTC. A PHA exercise has been conducted to build this baseline set of hazards which has included review of the PTA PHA and Tender Design SiD findings.

The hazard log will be progressively updated to incorporate outcomes from hazard analysis workshops, including those detailed in Section 11.2.2 below. An extract of the hazard log identifying hazards relevant to this design package is included in Appendix Y.

The hazard log will be progressively updated to capture and derive additional safety requirements that will be incorporated into the MELconnx requirements management system (DOORS).

Safety requirements which have been addressed by this design have been reported in the RATM (see Appendix O).

11.2.2 Safety in Design Activities and Reference Design

Safety in Design has been addressed through the engagement of appropriate SREs in a workshop discussion to examine and discuss the design details with a view to determining the safety risk and appropriate treatments in the minimisation of any identified safety risks. The SiD activity builds on the work conducted to manage the hazard log which forms and input to the SiD workshop.

At this issue of the design report a SiD workshop was conducted (MELconnx - Reference Design Safety-in-Design Workshop No. 1) on the 25th of February 2021 which covered hazard identification for:

- Package 1 – Linewide Rail Systems
- Package 2 – Gnangara / Lord Intersection
- Package 3 – Northern Dive to Whiteman Park - Linewide Civils, Roads and Structures
- Package 4 – Whiteman Park to Ellenbrook – Linewide Civils, Roads and Structures
- Package 9 – Malaga Station & Precinct
- Package 11 – Ellenbrook Station & Precinct

A record of which was captured in MEL - Safety in Design Workshop No.1 Report (MEL-MLCX-RS-MOM-70001) and the actions close-out has been captured as part of the SiD process. Any impacts on the hazard log have been managed by raising a hazard transfer form and specific hazards have been added to the hazard log.

A subsequent SiD workshop was conducted (MELconnx - IDDR Safety-in-Design Workshop No. 8 on the 1st September 2021 which covered Operating & Support Hazard Analysis (OSHA), Construction Hazard Assessment Implications Review (CHAIR) and a Sub-System Hazard Analysis (SSHA) for:

- Package 9 – Malaga Station & Precinct

A record of which was captured in MEL - Safety in Design Workshop No.8 Report (MEL-MLCX-RS-RPT-00018) and the actions close-out has been captured as part of the SiD process. Outputs including derivation of safety requirements and updates of the RATM are still under development in accordance with the requirements of the SSAMP and shall be included in subsequent design submissions.

A record of the SiD Workshop Reports detailed above have been included in Appendix Z.

11.3 Systems Safety Assurance Plan.

The Project Systems Safety Assurance Plan has been developed and will be updated during the various stages of design development. The SSAP includes Goal Structuring Notation (GSN) informing the safety arguments. The purpose of the SSAP is to define methods, activities, management of activities and deliverables required for the Alliance scope of the MEL Project (including design, construction, testing, commissioning, and handover). The intent is to demonstrate that the systems have been designed and constructed with safety hazards mitigated, meeting relevant safety standards and the completed Project can be operated and maintained with an acceptable level of safety by the Rail Operator.

The SSAP describes how the Alliance proposed to produce a design that is safe to construct, operate, maintain and decommission. It identifies:

- Those responsible for safety assurance;
- The process of capturing safety assurance arguments;
- The engineering safety and safety assurance principles to be followed;
- How the principals will be applied during the life cycle of the system;
- How a systematic approach to risk management will be adopted;
- How relevant knowledge will be imparted to designers; and
- How information about hazards and risk control measures are communicated to those who will work with the finished assets.

The scope of the SSAP includes safety assurance associated with the interfaces with the Tonkin Gap and Bayswater Station Projects design but excludes identification of safety assurance processes and deliverables associated with those two Projects.

11.4 Compliance with Safety Assurance Plan

The safety objectives of the overall project are to ensure that the design complies with statutory and design requirements, such as relevant standards and codes, and that all safety requirements are incorporated into the design, reducing the risk to "So Far As Is Reasonably Practicable (SFAIRP)".

Safety hazards are being identified and will be managed in accordance with the Alliance Systems Safety Assurance Plan.

11.5 Safety Analysis

The SSAP outlines the Hazard Analysis to be conducted during the detailed design stages MEL Project to identify hazards related to interfaces, hazards specific to each sub-system, potential operation and support issues with the proposed designs and any construction specific risks.

A number of hazard analysis workshops will be progressively conducted during the design stages broken down into relevant disciplines and analysis types (combined SHA/IHA, OSHA, Construction) to ensure hazards are effectively identified at the relevant stages as the design progresses.

11.6 Safety Argument

The Safety Argument is based on the GSN for the Project as shown in the MELconnx Systems Safety Assurance Plan and is as summarised in

11.7 Section 11.9 Hazard Analysis

Risk has been assessed against hazards in accordance with the Risk Matrix and Tolerability Criteria in the MEL System Safety Assurance Plan as outlined in the Project Hazard Log (PHL) in Appendix Y of this report.

11.8 Satisfaction of Safety Integrity Level Targets

Not applicable to this design package.

11.9 Satisfaction of GSN Requirements

The assurance activities required to fulfil all the relevant GSN to support the safety argument for elements of the following goals, sub-goals and solutions appropriate to this design package are described in the Table below.

Ref	Goal	Evidence
G2.1	Design management processes incorporating safety are defined and implemented	Safety Assurance Statement (MEL-MLCX-RS-RPT-00038)
G2.2	Appropriate technical standards have been specified	
G2.3	Hazards have been identified and risks assessed	
G2.4	Detailed Design has been developed by competent personnel applying robust design management processes	
G2.5	Risks are identified, assessed, rated and eliminated or treated to SFAIRP principles	
G2.6	Sub-Contractor Assurances are managed	

G2.7	Design confirmed as meeting system requirements and technical standards	

11.10 Management of Safety Requirements

Controls identified in the workshops are raw controls that are transferred to relevant design package owners. During hazard identification workshops controls are identified as either to Implement or to Consider. Controls identified as implement are embodied in the design at the current design stage whereas controls to consider may be implemented into the design at some point in the future pending further consideration.

After the workshops, as part of the design process, hazard controls have been assessed as either Open, Implemented or Rejected:

- **Open** signifies that implementation is not yet confirmed.
- **Rejected** signifies that the control is not implemented. reasons for rejection recorded at Safety Control Verification Reference column in the PHL.
- **Implemented** signifies that implementation in the current stage design has been confirmed with evidence recorded at Safety Control Verification Reference column in the RATM.

Controls which are Implemented shall be further developed into Derived Safety Requirements which are traced in the RATM in DOORS. These safety requirements shall follow the wording convention of other requirements in the RATM and in addition shall be specific, measurable, relevant and realistic

11.11 Safety Assurance Statement

A Safety Assurance Statement No. 07 (MEL-MLCX-RS-RPT-00027) has been produced for this design and is submitted as part of the parent package for this design.

11.12 Transfer of Residual Risks and Safety Related Operational Conditions

All hazards which do not have a hazard status of “Hazard Eliminated” refer to residual risk to be transferred either to construction or operation.

Refer to Section 15 for operational phase requirements required to maintain the design integrity of the infrastructure referred to in this Design Package.

In addition, the following Safety Related Operational Conditions identified in the PHL must be met to maintain the design safety integrity of the infrastructure referred to in this Design Package:

12. Systems Engineering

12.1 Sub-system Allocation

The sub-system (s) related to this design package are:

SBS ID	Title	Related to Package	Level	Design Packages	E075, JAJV - Noranda Precinct - Civil - Earthworks	E076, JAJV - Noranda Precinct - Civil - Drainage & Highways Roads	E077, JAJV - Noranda Precinct - Civil - Car Parking, Fencing and ites, Retaining
2	Track & Structures	Yes	0		x	x	x
2.1	Structures	Yes	1			x	x
2.2	Track	Yes	1		x	x	x
2.2.1	Access Roads	Yes	2		x		x
2.2.2	Buffer Stop	Yes	2		x		
2.2.3	Railway Crossings	Yes	2			x	x
2.2.3.1	Level Crossing Control Box	Yes	3			x	x
2.2.3.2	Level Crossing	Yes	3			x	x
2.2.3.3	Pedestrian Crossing	Yes	3			x	x
2.2.3.4	Vehicle Access Apron	Yes	3			x	x
2.2.3.5	Vehicle Access Gate	Yes	3			x	x
2.2.4	Insulated Joint	Yes	2			x	x
2.2.5	Location Case	Yes	2			x	x
2.2.6	Lubricator	Yes	2			x	x
2.2.7	Hardstand	Yes	2			x	x
2.2.8	Slab track	Yes	2			x	x
2.2.9	Sleepers / bearers	Yes	2			x	x

12.2 Requirements Management

Requirements management occurs throughout the life cycle of the project and is described in the Systems Requirements Management Plan (RMP). The Requirements Allocation and Traceability Matrix (RATM) has been established and is used to track the requirements from the identification and allocation stages through to verification for contract requirements and derived requirements, such as safety and Human Factors requirements from hazard analysis.

In Reference Design phase, these requirements were allocated to package(s) for demonstrating compliance at agreed points in the project lifecycle. For the Interim and Final Detailed Design phases, the progressive compliance of requirements allocated to this package is shown at Appendix O.

Further details of requirements management activities can be found in Engineering Assurance Summary (MEL-MLCX-EA-RPT-00008).

12.3 Engineering Assurance Summary

Prior to formal submission of the RD and FDDR for each design package, and to support PMF3 and PMF4 gate approvals, Melconnx shall provide an Engineering Assurance Summary for PTA's review. This is provided to evidence an integrated design approach has been adopted and all Engineering Assurance activities have been completed to the extent required for the specific design stage.

Engineering Assurance documentation is supported by the Safety Assurance Statement detailed in Section 11.11. The table below provides a breakdown of where each of the assurance artefacts is contained.

Item	Description	Reference	Documented in SAS (Y/N)	Documented in EAS (Y/N)	Evidence/ Traceability in SAS
1	Scope of Work summary	EAS & SAS	Y	Y	Section 2.6 & Section 4
2	Environmental Planning Approval	EAS	N	Y	N/A
3	Whole of Life Sustainability Outcomes	EAS Design Report, Appendix V	N	Y	N/A

4	SWTC & SRS Compliance	EAS & SAS	Partial	Y	Section 7.4
5	Stakeholder Consultations	EAS Design Report, Appendix N	N	Y	N/A
6	Safety Assurance Activities	SAS	Y	N	Section 6
7	Engineering Change Approvals	EAS & SAS	Partial	Y	Section 5.1.4
8	RAM Considerations	EAS & SAS	Partial	Y	Section 7.5
9	ADC	EAS & SAS	Partial	Y	Section 2.10
10	Operation and Maintenance Strategy	EAS	N	Y	N/A
11	Design Review	EAS Design Report, Appendix H and I	N	Y	N/A
12	Program / Schedule	EAS	N	Y	N/A
13	Human Factors Analysis	SAS	Y	N	Section 7.6

13. Sustainability in Design

Development and documentation of sustainability initiatives have been determined for this design package and are included in detailed in Section 4.10.

14. Testing & Commissioning Requirements

Inspection and Test Plans (ITP) summarise the requirements of the Specifications and Design Drawings by detailing the criteria for workmanship, verification activities including Witness and Hold Points, and related authorities/responsibilities for each stage of the construction/installation process.

Refer to summary below for specific ITP requirements including Hold Points and Witness Points which will be required to be undertaken as part of the construction phase support activities.

14.1 ITP's

ITP's relevant to this Design Package will be included at detail design.

14.2 Hold Points

To be provided when specifications are provided in future design stages.

14.3 Witness Points

Witness points relevant to this Design Package will be included at detail design.

15. Human Factors

As outlined in the Human Factors Integration Plan (HFIP) the Design Report will detail the strategies and initiatives to identify, manage and integrate Human Factors (HF) risks and requirements through all phases of the Project.

The purpose of applying the HF process is to ensure human interactions with the system and system elements are well designed through the application of established HF principles and knowledge so that the delivered operational system benefits the end users by:

- Minimising errors
- Improving effectiveness
- Improving user comfort
- Increasing system acceptance.

A review of HF activities and the implantation of HF controls was reviewed during Safety-in-Design Workshop No. 01 (MEL-MLCX-RS-MOM-70001) & 08 (MEL-MLCX-RS-RPT-00018).

Further details of human factors activities can be found in Design Safety Assurance Report (MEL-MLCX-RS-RPT-00038) that will be submitted at FDDR.

16. Reliability, Availability and Maintainability (RAM)

Details of Reliability, Availability and Maintainability activities undertaken for this design package are contained within Engineering Assurance Summary (MEL-MLCX-RS-RPT-00038).

17. Construction Methodology

The following construction methodology and staging has been assumed in the development of this design package.

17.1 Construction Methods

The following construction methodology and staging has been assumed in the development of this design package.

17.2 Operational Staging

The works associated with this design package will be delivered in one Operational Stage as it is a brownfield site with limited interfaces with the operational network along Benara Road.

17.3 Works in Track Occupancies

To be confirmed at the next Design stage.

18. Asset Maintenance Strategy

The following asset management strategy is required for this design package:

18.1 RTO Assets

To be confirmed at the next Design stage.

18.2 Other Assets

To be confirmed at the next Design stage.

19. Asset Operations Strategy

The following operational strategy has been assumed in this design package:

19.1 Normal Modes of Operations

To be confirmed at the next Design stage.

19.2 Degraded Modes of Operations

To be confirmed at the next Design stage.

20. Decommissioning Strategy

A decommissioning review, including a decommissioning methodology and staging review has been undertaken to identify any restrictions on the assets capability to be modified, and or decommissioned on final completion of the Works (following transfer to the final asset owner).

20.1 Capability to Modify

To be confirmed at the next Design stage.

20.2 Decommissioning Strategy

To be confirmed at the next Design stage.

21. Project Actions

A list of outstanding issues and assumptions that may affect the design are outlined in the Table below.

ID	Outstanding Issues	Potential Effect	Status
1	**Addition to VT on northern side of the station**	Revised precinct layout to the north side of the station. Additional precinct fill material and associated civil infrastructure items (pavements etc)	Open
2	**Final sizing and location of station roof drainage storage tanks**	An indicative size has been added to the Civil precinct drawings for costing purposes.	Open
3	**Fencing/ Risk assessment of swales**	Increase fencing type 2 length requirements and/ or additional soft landscaping.	Open
4	**Review of pedestrian desired lines with PTA**	Precinct layout amendments.	Open

Appendix A: Drawing and Model List

Appendix B: Specifications

Doc No.	Doc Title	Discipline	Revision	Revision Date
Example: MEL-MLCX-CI-SPC-00302	Example: MEL - MLCX - Specification 302 - Earthworks	Example: Civil	Example: A	Example: 01/10/2021

Appendix C: Standard Drawings

Appendix D: Engineering Change Approvals

Appendix E: Calculations

Appendix F: Schedules

Appendix G: ITP Strategy

Appendix H: IDC Review Schedule

Appendix I: IDC Certificates

Appendix J: Design Verification Certificates

Appendix K: Independent Verification Certificates

None.

Appendix L: BCA Certification

Appendix M: DDA Certification

Appendix N: PTA Comments Review Register

Appendix O: RATM Extract

Appendix P: Third Party Approvals

Appendix Q: Concessions

Appendix R: Non-Compliance/Deviation Report

Appendix S: Designers Certificate of Compliance

Appendix T: Contractors Certificate of Compliance

Appendix U: Durability Assessment

Appendix V: Sustainability

Appendix W: RFIs

Appendix X: Project Interfaces

Appendix Y: Project Hazard Log

Appendix Z: Safety in Design

Details of Safety in Design activities for this package is contained within the Safety in Design report: MEL- Safety in Design Workshop No. 7 Report (MEL-MLCX-RS-RPT-00017)

Appendix AA: Human Factors

Refer to Safety Assurance Statement No. 07 (MEL-MLCX-RS-RPT-00027) for HF details relating to this package.

Appendix BB: Reliability, Availability, Maintainability

Refer to Safety Assurance Statement No. 07 (MEL-MLCX-RS-RPT-00027) for RAM relating to this package.

Appendix CC: Competency Assessment Confirmation Letter