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Design and Constructability report – Part 1

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Glossary of terms

The following glossary of terms has been used throughout the ALR Design and Constructability Report and is listed below for reference.

Term	Description
25kV AC	Alternating current (AC) at 25 kilovolts (kV) used for Railway electrification
Adit	A mined entrance or passage from a mainline underground structure
Alignment	The horizontal position and vertical grade of a railway track, described by horizontal straights and curved track of constant and varying vertical grades, transitions and vertical curves.
Automatic Train Control (ATC)	Train protection systems for railways that involves a speed control mechanism in response to external inputs
Automatic Train Operation (ATO)	Technology used to automate the operation of trains
Box (i.e. station box)	A box-shaped underground structure constructed from the surface.
Cant	The raising of the outer rail on a curve in the track with respect to the inner rail to allow higher speeds than if the two rails were level. Cant compensates for the centrifugal force generated from a train traversing a curve.
Catenary	A system of overhead wires to supply electricity to the train.
Control and Information Systems (CIS)	Methods and devices that attempt to ensure the accuracy, validity and propriety of information system activities
Communication Based Train Control (CBTC)	Railway signalling system that uses telecommunications to allow a train's position to be known more accurately than with traditional signalling systems
Concourse	The main zone in a station where passengers congregate before distributing to the platforms.
Cut and cover tunnel (or boxes)	A form of construction for a box-shaped tunnel where a trench is excavated within which the tunnel is constructed and then the trench is backfilled and the surface restored.
Diaphragm wall	A technique for forming retaining walls by constructing a reinforced concrete wall within a trench excavation of the width of the wall. The sides of the trench are generally supported by a fluid (bentonite slurry) which allows excavation through it. The fluid is then replaced with concrete through a tremie pipe (pipe that can use for pouring concrete underwater) which fills from the base of the trench upwards.

Term	Description
Dive structure	A structure that allows the rail alignment to transition from the surface to an underground tunnel.
Draught Relief Shaft	Shaft within a tunnel that reduces air velocity and improves passenger comfort on underground stations
Egress shaft	Underground structure with dedicated escape route out to surface.
Fire and Life Safety	Fire and Life Safety addresses the design and management of building infrastructure to allow safe and effective evacuation of buildings under all emergency conditions, including fires.
Emergency egress routes	Dedicated escape routes to surface in the event of an incident
Enabling works	Works carried out in advance to facilitate ease of permanent works construction.
Groundwater	Water located in pore spaces within the soil mass
Headway	Distance/time between vehicles in a transit system
In-situ reinforced concrete	Cast in place concrete structures with embedded steel reinforcing bars to give it the required strength.
Kinematic envelope	The outline of the space occupied by a rail vehicle when in motion, including the effects of tilt, sway, track cant.
Launch shaft/site	Structure/working area used for lowering in and launching the Tunnel Boring Machine (TBM).
Light Metro System	Rail transport system which uses light rail type vehicles. Typically operates on fully grade separated networks
Lining	A layer of concrete installed at the excavation face to provide ground support.
Mined Tunnel	Tunnelling method utilising a road header or similar technology to create open underground space combined with steel and concrete lining systems and rock bolting installed in a predetermined sequence.
Monotube tunnel	Single bored tunnel consisting of one large single tunnel with two tracks in a stacked arrangement one above the other.
Multi Criteria Assessment (MCA)	Analysis method used to assess multiple criteria, both quantitative and qualitative, to compare different alternatives and options
moving block system	Automated control system allowing trains to receive a “movement authority’ from the control centre

Term	Description
Modular Construction	Process involving producing standardized components of a structure in an off-site factory, then assembling them on-site
Overhead Contact System (OCS)	The physical infrastructure (structures, poles, guy-wires, portals and power distribution system) that delivers the power to the distribution system and then to the rail vehicle.
Operations control centre (OCC)	Operation base and command centre used for the managing of the metro network
Over Track Extraction (OTE)	Ducts used at underground train stations for the extraction of smoke and hot gases in the event of a fire on the track.
Over Platform Extraction (OPE)	Ducts used at underground train stations for the extraction of smoke and hot gases in the event of a fire on the platform.
Pantograph	A device that collects electric current from overhead lines for trains or trams.
Pile	A slender structural element that is driven or bored into the soil to provide vertical or lateral support.
Pipe Jacking	Trenchless construction method used to install pipelines beneath highways, railroads, runways, harbours, rivers, and environmentally sensitive areas
Platform Screen Door	A partition to separate passengers at platform from the moving trains and the platform edge with automated sliding doors to allow access to the trains.
Portal	Transition structure at the inlet and outlet of a tunnel.
Rock bolt	A form of support for broken or jointed rock in excavations. Rock bolts are usually used in conjunction with sprayed concrete lining (see „shotcrete“ below).
Rolling stock	Wheeled vehicles used on a railway, such as passenger coaches, freight wagons, multiple units, etc.
SCADA	Supervisory control and data acquisition. Computer-based system for gathering and analysing real-time data to monitor and control equipment
Secant pile wall	A retaining wall formed by constructing intersecting (secanted) reinforced concrete piles to form a continuous wall.
Segmental concrete lining	A circular ring in the form of a number of precast concrete segments. The lining of the tunnel is formed by a continuous build of rings.
Shafts	Underground structures excavated from the surface for permanent or temporary access.
Sheet piles	Steel interlocking sheets driven into the ground to form a retaining wall to resist lateral pressure of adjacent ground.

Term	Description
Shotcrete	A concrete mixture that is sprayed under pressure onto a surface.
Slab Track	Rigid railway track infrastructure made of concrete
Sleeper	Rectangular support for the rails in railroad tracks
Spoil	Excavated material
Structure gauge	The profile perpendicular to the track into which no part of any structure or fixed equipment may penetrate, taking into account all deformations and movements.
Standard gauge tracks	Railway with a track gauge of 1435mm
Top-down method	In the top-down method of construction, the structural roof is constructed first and supported by embedded walls and plunge columns and the ground surface is reinstated except for access openings. This allows early reinstatement of roadways, services and other surface features. The remainder of the excavation and construction is completed downwards constructing the floors as excavation progresses.
Track gauge	The distance between the inner faces of the rail heads (Top section of rail) of a railway track, commonly referred to as "the gauge".
Track junction	A junction where more than one rail tracks intersect.
Traction power	Electrical power used by the train to move.
Traction substation	Electrical substation supplying traction power.
Tunnel Boring Machine (TBM)	A machine used to excavate a tunnel with a circular cross section.
Tunnel Extraction Fans (TEF)	Large reversible and fire-rated axial fans connected to diffusers, dampers, and sound attenuators (aka silencers) on either side to achieve acceptable velocities and noise levels
Tunnel Ventilation System (TVS)	A system to provide an acceptable environment in the tunnel in terms of both temperature and air quality and also to remove smoke in the event of a fire.
Viaduct	Type of bridge that consists of a series of arches, piers or columns supporting a long elevated railway.
Water table	The level below which the ground is saturated with water.
Walers Beam	Waler beams are horizontal beams that are bolted to a larger upright structure in order to help support it. Waler beams distribute weight ensuring that the pressure is dispersed along the entire length of the structure

1. Introduction

1.1 Report Purpose

This Design and Constructability Report (DCR) has been prepared to support Notices of Requirement (NoR) to designate the Auckland Light Rail (ALR). This report provides a summary of the design to demonstrate construction feasibility of ALR. This includes the proposed infrastructure, including alignment, stations and tunnel to enable an understanding of the effects of construction and operation, sufficient to inform the NoR and supporting Assessment of Environmental Effects (AEE). The ALR design establishes engineering and architectural design parameters which will be refined (within the envelope established) during Reference Design of the project.

1.2 Overview of ALR

1.2.1 General

ALR is a 24km passenger railway with stations between Te Waihorotiu Station in Auckland City and Auckland Airport to the south, including tunnel and surface running. It compromises two tracks, six underground stations, eleven surface stations, one depot and a bridge crossing of the Manukau Harbour. Figure 1-1 provides an overview of the alignment and details which stations are included within this lodgement and those to be subsequentially lodged.

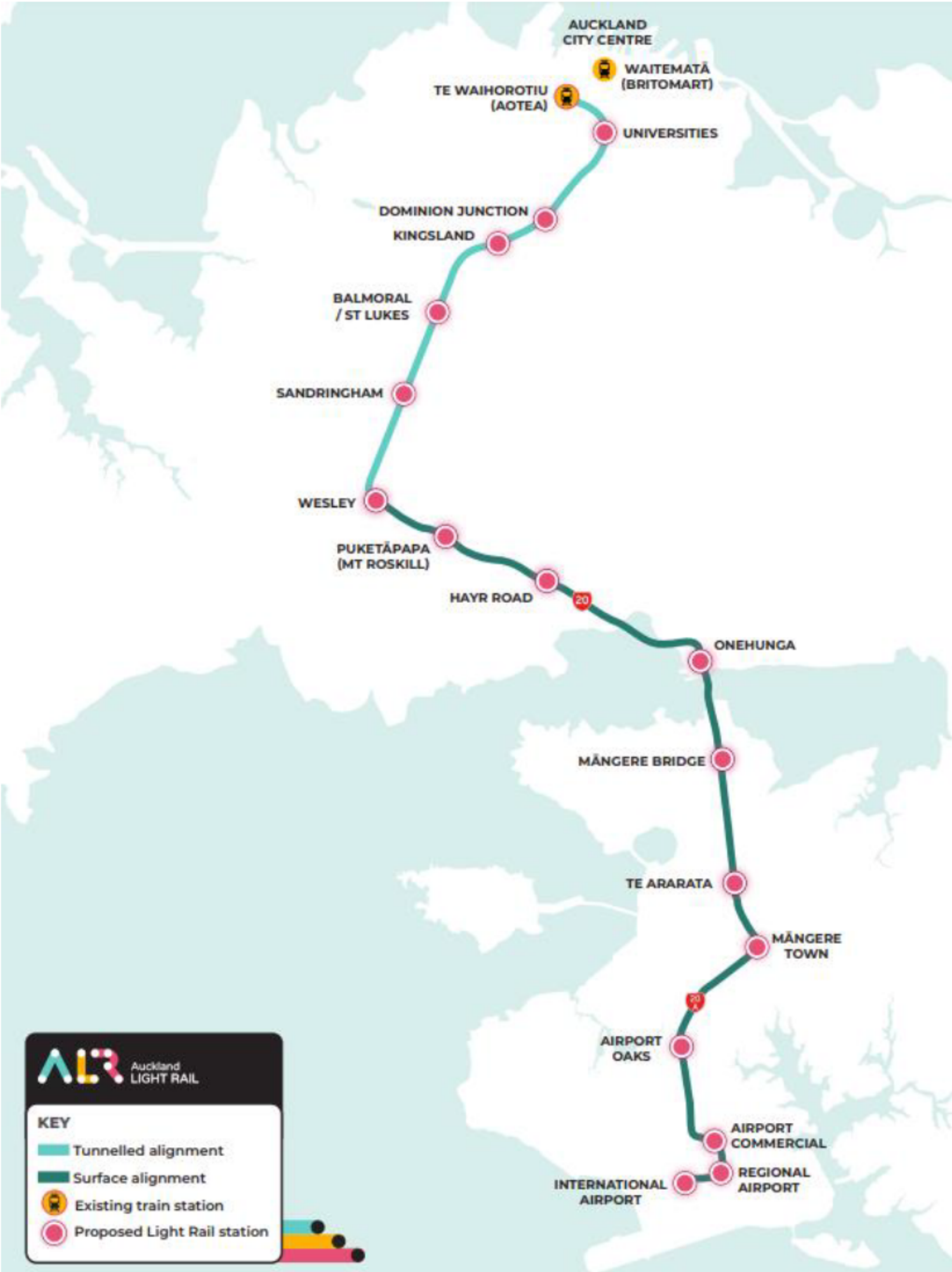


Figure 1-1 ALR Station Map

1.2.2 Notice of Requirement Footprint

The concept design identifies the temporary and permanent spatial requirements needed to support construction and operation of the proposed railway and stations along the alignment. A range of construction methods have been considered for the concept designs, based on preliminary site analysis, investigations, topography, identified risks and constraints.

1.2.3 Rolling Stock, Power Systems and Railway Geometry

The railway will be powered by 25kV AC overhead catenary lines with rolling stock running on standard gauge tracks. The alignment design must overcome the Auckland topography challenges, with vertical level difference greater than 50m between Te Waihorotiu and the Tunnel Boring Machine (TBM) launch site north of Wesley Station. The maximum gradient has been set at 6% maximum in the tunnels and 5% for the surface running sections.

1.2.4 Tunnels

The running tunnel for ALR will comprise a single bore twin track tunnel (monotube tunnel) with the up and down tracks stacked on top of each other, separated by internal pre-cast concrete structures. TBMs are proposed for construction. Turnback and passing loops will be constructed within the tunnel to allow for train operation and service requirements.

The site for the southern TBM launch shaft is near the corner of Mount Albert and Sandringham Road. The southern portal will include a cut and cover structure and dive structure.

Dominion Junction Station will serve as both the TBM reception from Wesley and the launch for the northern drive towards Te Waihorotiu. The cut and cover box for the TBM site will be transformed into a station. To facilitate the station, the removal of Dominion Road flyover ramps and level intersection upgrade at New North Road and Dominion Road is necessary.

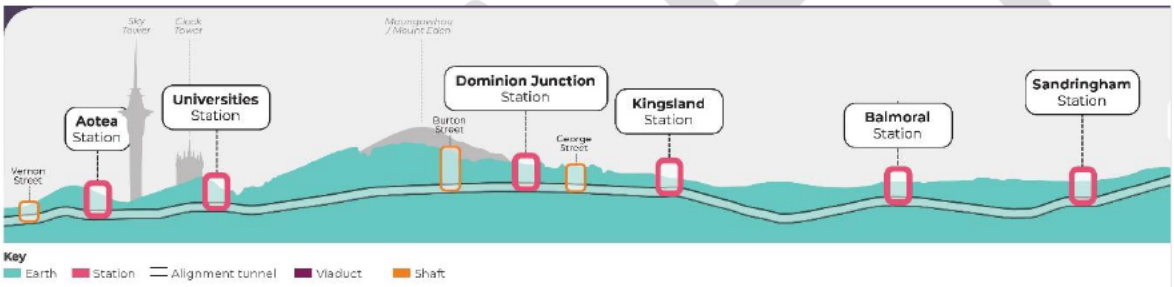


Figure 1-2 Tunnel alignment section

1.2.5 Viaducts

Viaducts are required in Onehunga and Wesley to overcome topographic challenges, adverse basalt ground conditions, groundwater, flooding and other spatial constraints. Viaduct height varies along the alignment, with piers typically located at 30 to 35m spacing; coordinated with access roads, bus lanes, and avoiding streams and other spaces of natural importance and value. Rolling stock running transitions from tunnel top and bottom to parallel run on the viaduct and along the surface route section. The tracks will split vertically within the Mount Albert dive site to be side-by-side at the viaduct in Wesley.

A new viaduct will be run along the Te Tauranga lagoon and Onehunga Bay Reserve towards the new elevated station in Onehunga. Beyond the station, the alignment turns southeast towards Māngere Harbour Crossing and to a new depot utilising a disused rail corridor. A new box girder bridge will be constructed adjacent to the existing bridge with matching design features, to take the rolling stock to Māngere Bridge. The alignment continues to the airport on a mixture of surface, trench and viaduct running.

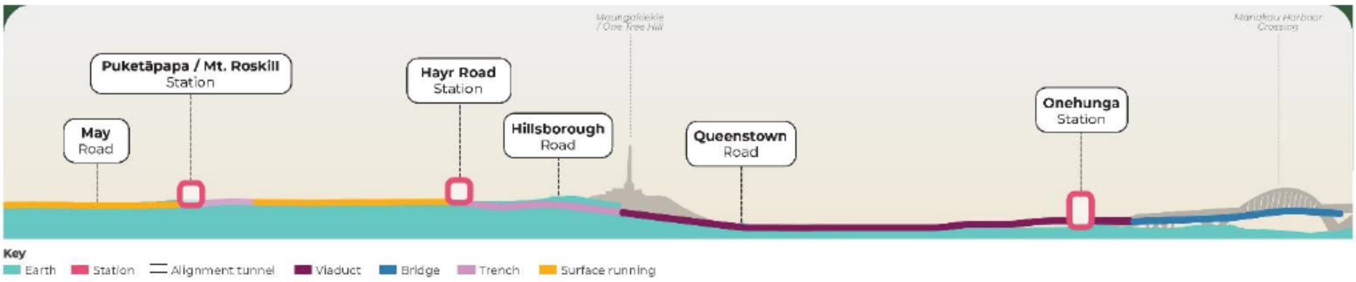


Figure 1-3 Viaduct and Bridge section

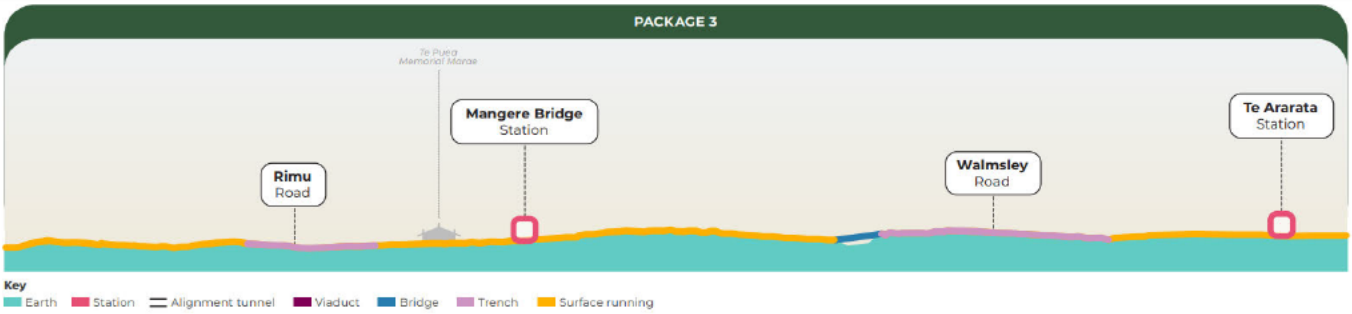
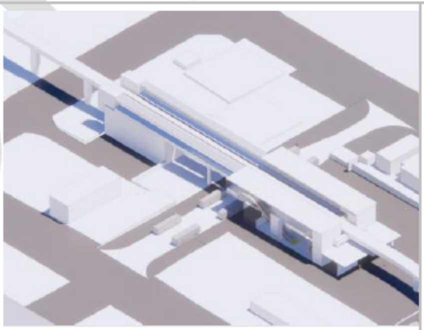
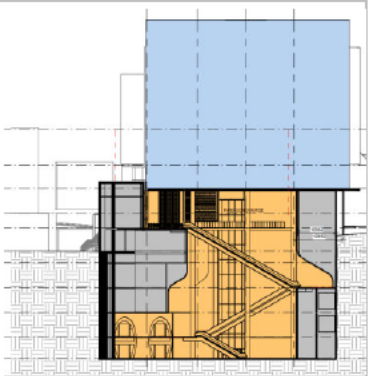


Figure 1-4 Surface Running section

1.2.6 Stations

The station design philosophy has been developed to group stations into three types and develop a modular approach to each (refer to Table 1 for at-grade, elevated and underground Station types. Constraints, including but not limited to; environmental, built heritage, archaeology, construction noise and vibration, landscape and stormwater have required certain bespoke stations to be developed; as outlined in Section 5. Construction of the underground stations will be by a variety of methods, including diaphragm walls, secant piles, cut and cover shafts with mined adits to the tunnel platforms.

Table 1-1 ALR Station Types

		
At-Grade Station	Elevated Station	Underground Station

1.2.7 Fire and Life Safety Principles

The design provisions for fire and life safety have been developed using principles from similar international underground railway systems and with reference to industry guidelines, further detail on this is contained within the Basis of Design report, Appendix B. It is possible that Fire and Life safety requirements from New Zealand fire authorities may require additional station and tunnel services and/or passenger escape facilities beyond that identified in the concept design. The design team will continue discussions with Fire Authorities to agree upon provisions.

1.3 Background – Indicative Business Case

The ALR Indicative Business Case (IBC) (submitted October 2021) was developed to investigate a rapid transit solution along the City Centre to Māngere (CC2M) corridor.

The IBC explored a wide range of options, including various modes of public transport, namely light rail, light metro, heavy rail, and bus rapid transit. Several route options were identified and assessed using multi-criteria assessment (MCA), which found that the Tunnelled Light Rail option offered the best balance of costs and benefits. Endorsing the IBC in December 2021, Cabinet confirmed that further investigations should take place, with an increased focus on the integration of transport and urban development outcomes.

The design that has been developed which determines the NoR boundaries for the project has identified an alignment route, assessed impacts on land acquisition, the approximate extents of underground and surface structures and the potential location of stations and their approximate sizes.

1.4 Relevant Related Projects

ALR will form an integral part of Auckland's rail and transport network and therefore has significant interaction with existing rail infrastructure and regional projects currently being developed. Where applicable, information from these projects has been considered so as not to preclude any future integration.

Table 1-2 Relevant Related Projects

Project	Principal	Project Status
Waitematā Harbour Connections (AWC)	Waka Kotahi NZ Transport Agency	Study and investigation
North West: Rapid Transit Network (NWRTN)	Waka Kotahi NZ Transport Agency	Study and investigation
20 Connect	Waka Kotahi NZ Transport Agency	Investigation
City Rail Link	City Rail Link Limited	Construction

The Reference Case of an integrated network of rapid transit for Auckland is based upon staged delivery of the ALR, Northwest (NWRTN) and North Shore (AWC) corridors as a single integrated network with interleaved service patterns and fully interoperable operations and infrastructure specifications.

2. Approach to Design

2.1 Overview

In developing a Basis of Design for the project, relevant codes, standards and design manuals have been referred to ensure that the design is based on existing good practice. From this research, a robust set of requirements with moderately conservative parameters to inform the design of the project has been developed. A separate report outlining the Basis of Design is included in Appendix B.

Design has been split geographically between three packages: City Centre and Isthmus, Onehunga and Manukau to Airport. The packages have been defined to match the underground section, surface running section and south Auckland section. Design teams undertook option selection and progressed conceptual scheme designs for both stations and rail alignments. They collected and reviewed useful technical data on potential interfaces along the route, such as archaeology, heritage, settlement principles and environmental information. Further details of the constraint mapping are outlined in Section 5 for each station. The package framework has allowed the multi-disciplinary design team and planners to develop conceptual scheme designs through to a single Preferred Selected Location (PSL) for each individual NoR.

2.2 System Overview

Assumptions, constraints and parameters (Basis of Design, Appendix B) have influenced the development of the design to provide an operational line that meets industry standards and provides compatibility with the Auckland rapid transit network. Table 2 provides an overview of the ALR system.

Table 2-1 ALR System Overview

Design Parameter	Value
General	
Overall route length	24km approx.
Stations	• 17 stations total: o 6 underground o 11 At grade/elevated o 6 excluded from this NoR lodgement (Wesley, Māngere Town Centre Station, Landing Drive, Airport Commercial, Regional Airport, International Airport)
Service pattern	30 trains per hour per direction (2-minute headway)
Tunnel diameter	13.0m Internal
Track Alignment and Geometry	
Design Speed	90km/h
Maximum vertical grade	6% (tunnels), 5% (above ground)
Stations vertical grade	0%
Rolling Stock	
Type	Light Metro

Design Parameter	Value
Configurations	5 units (Mc-T-S-T-Mc)
Passenger Capacity (per vehicle)	Approx 800
Acceleration/Deceleration	1.4m/s
Access for mobility impaired	Level access to coach
Stations	
Platform Length	100m
Revenue Control	Electronic gate lines between station entrance and platform access
Platform Screen Doors height	2.7m
Ticket purchase facilities	Ticket vending machines and customer service desks in ticket halls/concourses at each station
Wayfinding	Provided at all levels at all stations
Traction Power	
System type	25kV Overhead System
Incoming Power	110kV source either Transpower or Vector
Sub Stations	2no. located at: • Onehunga Depot • New North Road, Kingsland

2.3 Alignment

2.3.1 Rolling Stock and Track

2.3.1.1 General

The operating concept for ALR is that of a fully segregated light metro system operating with autonomous train control (selection of the rolling stock has yet to be finalised). Light metro is the best option for the passenger and headway demands anticipated on the project, operating at 30 trains per hour at its peak.

2.3.1.2 Alignment

The vertical alignment is limited to a maximum of 6% within the tunnel and 5% within surface running. All station platforms have been designed to have zero vertical grade to provide a flat platform. Horizontal curve radii has an absolute minimum of 120m on the mainline except within the TBM tunnel which has a minimum of 350m due to the tunnel diameter. The alignment will operate with parallel running in surface areas and a stacked arrangement within the tunnel. Train envelope clearances have been defined for both situations.

2.3.1.3 Track Slab

It is expected that the trackform will be entirely Slab Track for the mainlines. This allows for easier and less frequent maintenance. In the depot, since the construction is on a slab, it is also anticipated that the slab track will be used. Slab Track geometry is easy to control, and installation is more consistent than with ballast track. The fixing of the point machine will be in the slab next to the turnout, making the interface with signalling and turnout simpler rather than mounting on the sleeper in ballast tracks.

2.3.2 Traction Power Elements and Overhead Contact System (OCS)

Traction power will be delivered by a 25kV system comprising Traction Power Substations and an Overhead Contact System (OCS). A Traction Power SCADA (Supervisory Control and Data Acquisition) system will provide for remote monitoring and control of the traction power equipment at the operations control centre (OCC).

The OCS transmits the electrical power to the rolling stock safely and efficiently, using a series of supported cables and/or conductors. In surface areas, the OCS is formed by contact wire and catenary wire. Furthermore, it is auto tensioned, which generally allows spans of up to 60-65m, similar to that used in the existing Auckland Electrification rail system.

An area is designated in the top or crown of each of the tunnels to provide adequate physical and electrical clearance for locating the OCS. The OCS is designed to fit within the tunnel and be compliant with the physical and electrical clearances. A fixed conductor bar is used for traction power distribution to the train pantograph inside the tunnel. Conductor bar systems are better suited for tunnel environments as they offer spatial reductions and are more robust compared with catenary wires. A further advantage of the conductor bar system is that in the case of an incident or accident, the equipment can be managed locally rather than whole or half tension lengths.

2.3.3 Signalling

The signalling system will facilitate the operation of 30 trains per hour per direction at morning and evening peaks.

Rail signalling will utilise the principals of a moving block system underpinned by a Communication Based Train Control (CBTC) system. The CBTC provides continuous communications between the wayside and train, thereby enabling continuous Automatic Train Control (ATC). ATC will be deployed to provide operational efficiency, whilst including Automatic Train Protection to automatically regulate train movements and maintain safe distances between trains. Automatic Train Operation (ATO) functionality will provide as a minimum, speed regulation, programmed stopping, and door control. Automatic Train Supervision will also be implemented to:

- Monitor train performance.
- Adjust the performance of individual trains to maintain schedules.
- Provide data to adjust service to minimise disruption caused by service irregularities,
- Regulate the number of trains permitted in a ventilation section to ensure smoke control strategies can move smoke away from passengers.

2.3.4 Communications

Control and Information Systems (CIS) and Information and communications technology (ICT) systems are pertinent to railway operations and encompass a range of assets, including the fibre network, data communications network, internal telephone system, wayside to train communication system and Operational Radio System. The network will include the following:

- Video surveillance
- Passenger information systems

- Customer Help point
- Public Address system
- Central Recording & Storage System
- Passenger information displays
- Emergency Services radio coverage
- Electronic security
- Frequency modulation (FM) radio re-broadcast, public wireless fidelity (Wi-Fi)/mobile phone coverage
- Fibre cable systems
- SCADA systems
- Operation and Maintenance Telephone system
- Systems integration
- Staff radio
- Fare collection system

All underground areas (tunnel and stations) require specialist ICT tunnel infrastructure. The CIS and ICT systems pertinent to the tunnel are as follows:

- Video surveillance
- Emergency call points
- Train Control radio
- SCADA systems
- Traction SCADA

2.4 Sub-stations

The Traction Power system is to be powered by two HV bulk feed intake stations. These stations intake from the electrical network to feed the Traction Substation and the Overhead Contact System. They are to provide the necessary redundancy (N-1) and reliability of the overall ALR system. At this stage there are two potential locations (New North Road, Kingsland and Depot, Onehunga). Each traction substation will be equipped with two outdoor 110 or 220/25kV 50Hz two phase traction transformers of 15MVA. The traction substation will generally have a layout as per Figure 2-1.

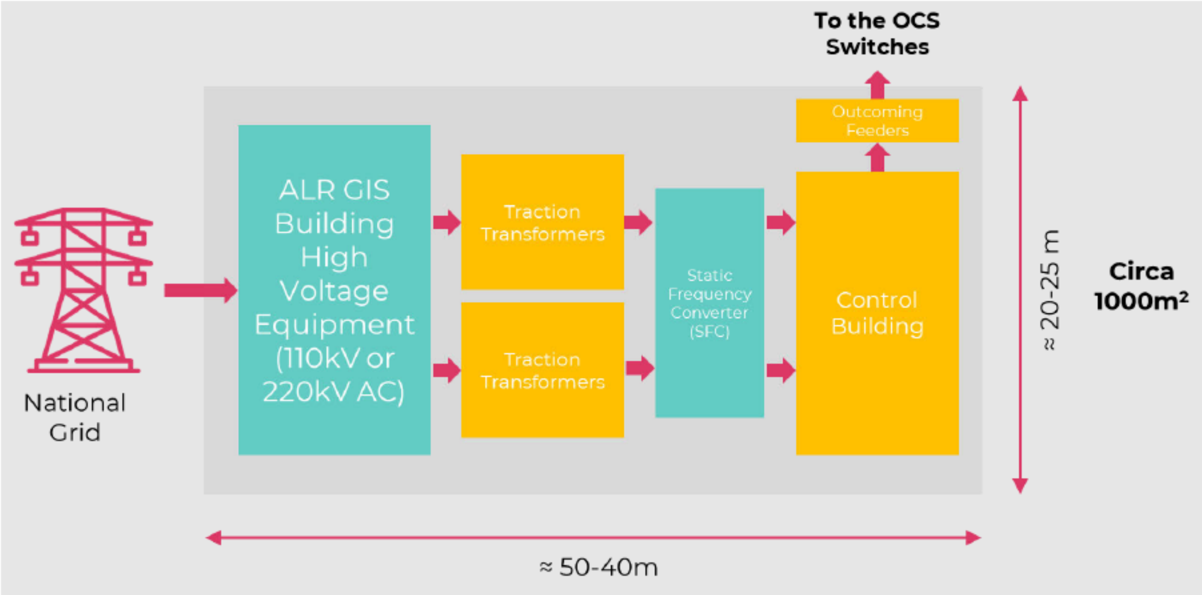


Figure 2-1 Substation Arrangement

2.5 Tunnelling

The tunnel consists of one 13.9m diameter tunnel lined with concrete precast segments. The two rail tracks are in a stacked arrangement one above the other. This requires a structural precast slab in the middle of the tunnel, as illustrated in Figure 2-2.

The internal diameter allows both upper and lower station platforms to be provided within the tunnel. This enables flexibility for the location of the station entrances connecting to the platforms at tunnel level using shorter mined tunnels or adits.

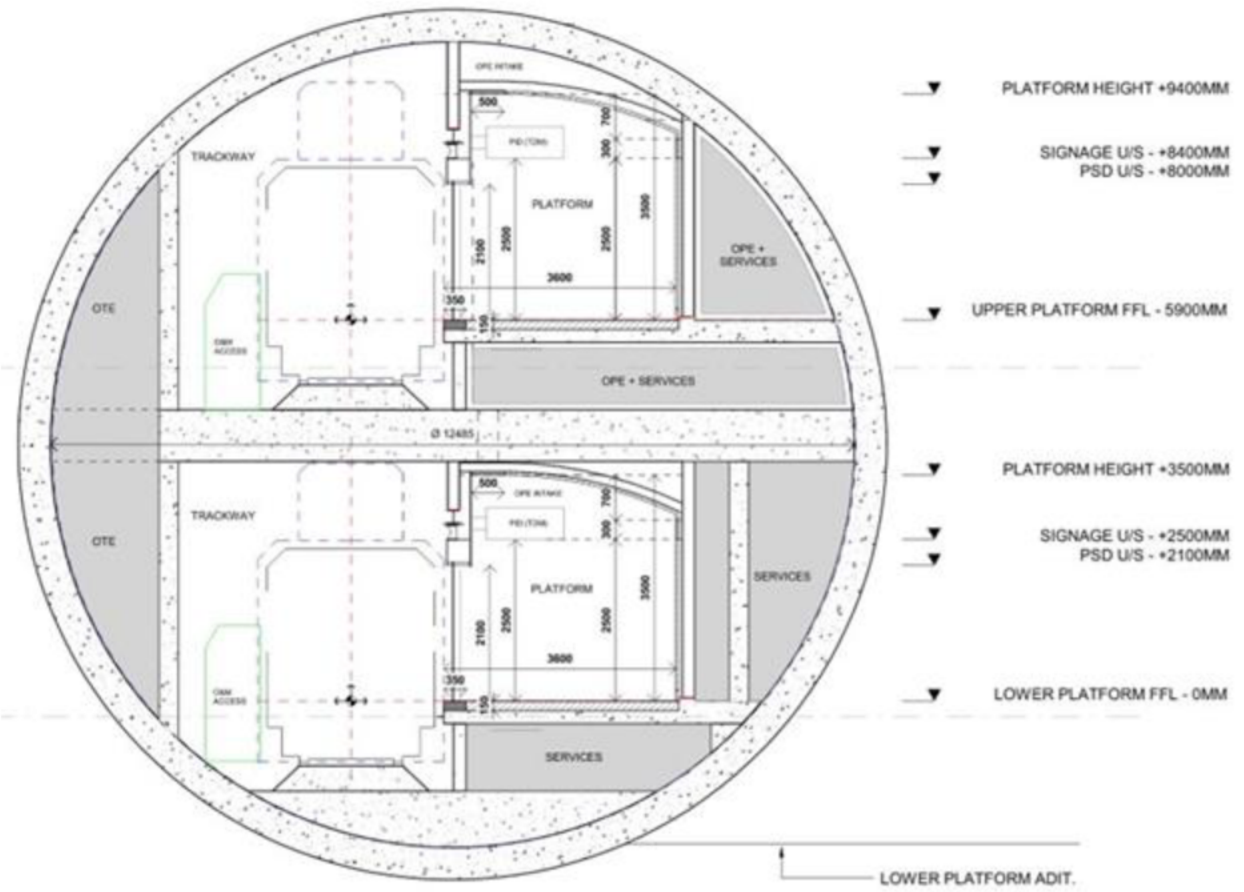


Figure 2-2 Typical Tunnel Cross Section at Station

The tunnel cross section is required to accommodate the kinematic envelope and structure gauge for the two track corridor, while providing space for other systems outlined in the following sections.

2.5.1 Egress and Emergency Access

An emergency evacuation walkway is located on the side of the rail tunnels (see Figure 2-3). The width of the walkway is proposed to be 850mm (identical to City Rail Link [CRL]), subject to confirmation with FENZ (Fire and Emergency New Zealand). Vertical cross passages with a ramp to connect between the upper and lower decks are to be provided. The spacing of vertical cross passages is being developed in consultation with FENZ and other stakeholders, with the spacing proposed to be between 240m and 400m, as there is no parallel 'non-incident' escape tunnel as compared to CRL. Ramp gradients are to meet NZBC D1/AS1 accessibility requirements. Emergency lighting, exit signs, and active directional signs are to be provided at suitable locations in tunnels.

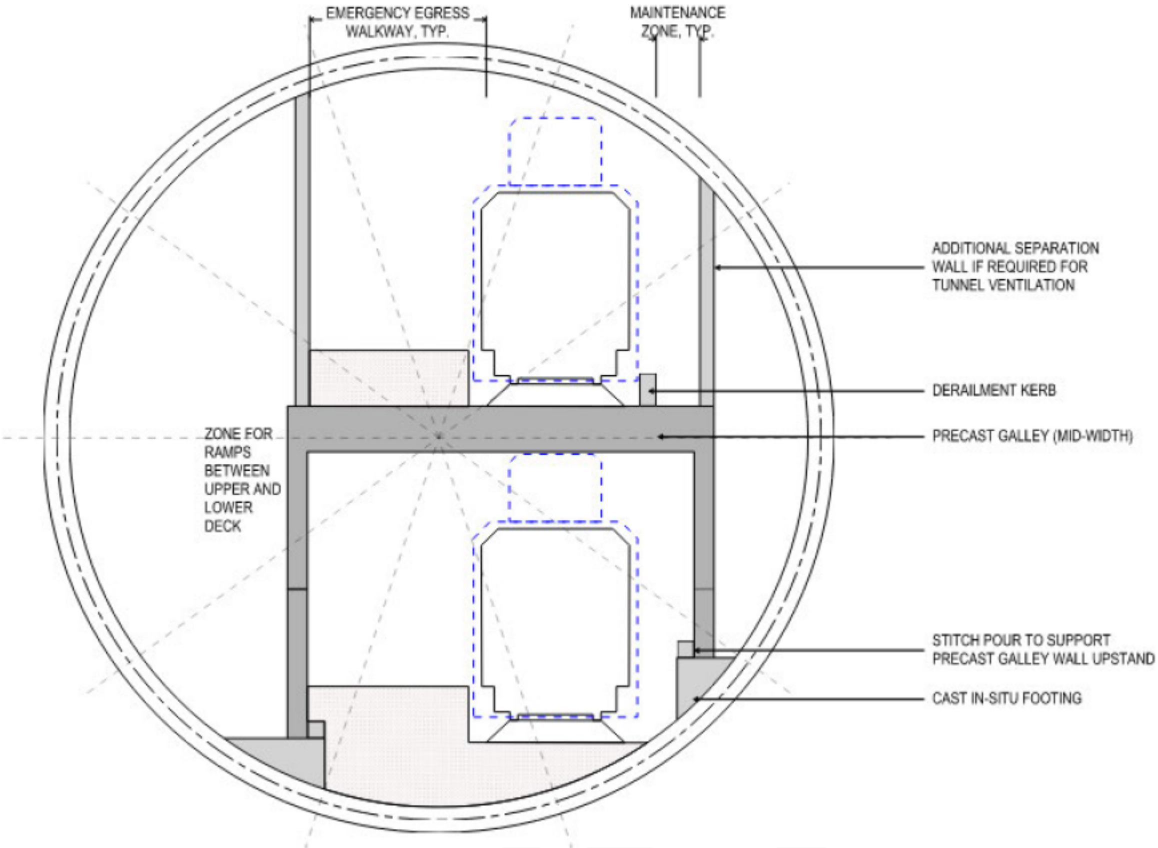


Figure 2-3 Tunnel Cross Section between stations

2.5.2 Tunnel Ventilation

2.5.2.1 General

The Tunnel Ventilation System (TVS) will need to ensure passenger and staff comfort and safety during normal, congested, emergency and maintenance operations. The TVS has a large spatial impact on station architecture and configuration of Back of House (BoH) areas.

For ALR, it is assumed that fully independent operation of the up and down services is not required (i.e. an emergency in one service will stop the other service from operating). In the fully interdependent and interconnected railway system, station and ventilation shafts share air paths between the two tracks. A single fire emergency anywhere in the network could result in the whole network being stopped to avoid cross-contamination and to maintain the effectiveness of the smoke extraction system. If congestion occurs in one tunnel which results in the ventilation system operating in that tunnel, operational limitations might be required on the other tunnels, such as a speed reduction. During normal operations, the ventilation design will have to carefully consider all possible train operations in the tunnels, to avoid unsafe pressure variation in trains and stations. The assumed TVS at the stations comprises of the systems outlined below.

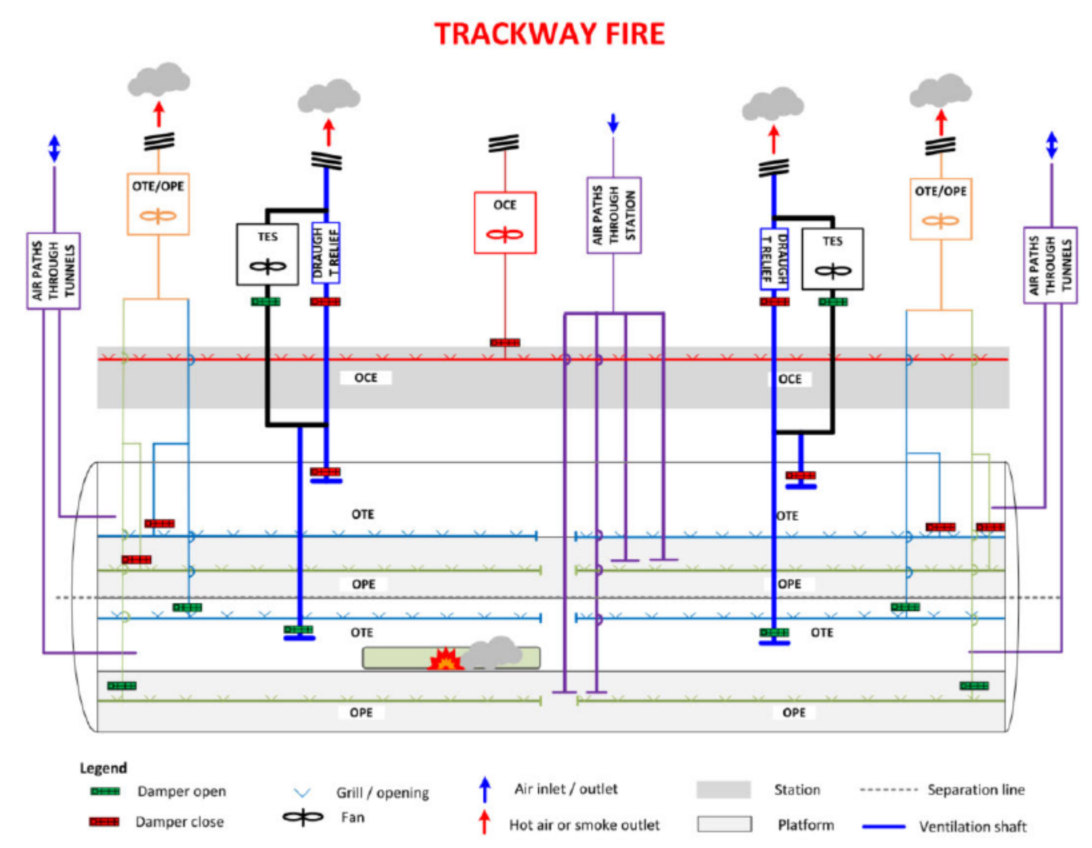


Figure 2-4 Typical Station Tunnel Ventilation System

2.5.2.2 Tunnel Extraction System (TES)

The TES provides ventilation within the tunnel to clear smoke during a fire. It comprises of two fan rooms with two or three fans connected to the ends of the platforms to serve both the adjacent tunnel and the stations. Each TES and OTE/OPE shaft shall maintain a minimum discharge height of 3m above local pedestrian level. In areas with nearby high-rise buildings, the shaft could be required to extend at a higher level to avoid dispersion and contamination issues.

2.5.2.3 Draught Relief

Draught Relief shafts serve three purposes:

- Protect passengers from piston wind effects as a train approaches/departs the station.
- Exchange heat and air between tunnels and external ambient climate, which will freely cool the tunnels and deep soil in summer months.
- Reduce aerodynamic drag and traction power consumption of trains, as they provide a relief of the air slug in front of the train.

2.5.2.4 Over Track Extraction (OTE) and Over Platform Extraction (OPE) systems

The primary smoke control mechanism for a train fire shall be the OTE. The OTE system is used to remove heat from trains waiting at the stations or smoke from train fires whilst positioned at the stations. The OTE consists of a set of smoke extract ducts and smoke reservoirs. These are located directly above the track and platform edge at the stations, and run the entire length of the station platform. The OTE may also be used in normal or congested operations to keep air temperatures at acceptable levels.

A fire on the platform will be controlled by a station platform exhaust system (OPE). A fire on the concourse will be controlled by the station smoke exhaust. The OPE will also control any additional smoke spill from the track.

The OTE/OPE systems include two fan rooms with two fans connected to ducts at each end of each platform. The ducts run over the platforms and serve both the adjacent tunnel and the stations.

OTE/OPE fans are generally large unidirectional and fire-rated axial fans connected to diffusers, dampers, and sound attenuators on either side to achieve acceptable velocities and noise levels.

2.5.2.5 **Tunnel Extraction Fans (TEF)**

Generally large reversible and fire-rated axial fans are connected to diffusers, dampers, and sound attenuators (aka silencers) on either side to achieve acceptable velocities and noise levels. TEFs can be positioned horizontally (e.g. shallow stations) or vertically (e.g. shallow and deep stations) to minimise station footprint where possible.

2.5.3 Tunnel Services

Tunnel services consist of fire protection and LV (Low voltage) systems which service tunnels, cross-passages, and access and emergency escape routes.

Tunnel fire protection systems include a linear heat detection system to be provided within the tunnel and hydrant outlets. The hydrant system shall be installed in the tunnels, with outlets at nominal 60m centres. Fire pump room and booster connections are provided at each station. Alongside the tunnel walkway, the hydrant system is to have facilities for boosting system pressures located at the station fire service access points. There will be no fire extinguishers or hose reels in the tunnels.

Tunnel LV systems include:

- LV power distribution
- Lighting
- Emergency lighting
- Exit lighting
- Cross-passage lighting
- General power
- Cabling
- Lightning and Surge Protection

Power supplies, especially those feeding signalling systems will be reliable and have high availability. The impact of low voltage power supply failure will be mitigated by having diverse feeds to equipment and systems critical to operations.

Uninterruptible power supplies (UPS) will be provided for systems such as lighting, signalling, communications, and public address. This may be by use of a common UPS or alternatively UPS provided on a system-by-system basis. The UPS serving the emergency signage and exit lighting shall be an independent system.

2.5.4 Auxiliary Shafts

To support the tunnel ventilation, emergency intervention and maintenance access, auxiliary shafts are required across the tunnel route. These are provided at:

- Vernon Street, Victoria Park
- Burton Street, Grafton
- New North Road shaft and Auxiliary Building, Kingsland

Shafts are located in built up urban areas, thus the design has to respond to this to limit the impact on the environment. Shafts are circular, formed of either sheet piles with reinforced ring beams, secant piles or diaphragm walls. Design is dependent on groundwater and ground conditions at each location. Shafts will be constructed offline from the tunnel, with a mined access adit connecting the two.

The Vernon Street shaft will serve both construction and operational purposes. During the construction period, the facility will have a shaft and mined adit for removal of the TBM and for mining the stub end. Upon completion of construction, the facility will be used for train turnback which requires the site to accommodate ventilation plant and emergency egress. This will include a building above ground with basement levels below ground.

2.5.5 Mt Albert Road Box and Dive Structure

North of Wesley station will be the first TBM launch locations, a site specifically designed for the excavation and launching of the TBM. The site will consist of a viaduct track transition area, dive structure and a cut and cover portal entrance (see Figure 2-5). The transition from viaduct to tunnel will consist of a single-track viaduct splitting vertically, before joining into a portal.

The support area for TBM assembly and launch will contain:

- Laydown and storage area
- Power supply and distribution housing
- Stores and workshops
- Grout batching plant
- Seepage and water treatment plant
- Segment storage area
- Spoil treatment and storage

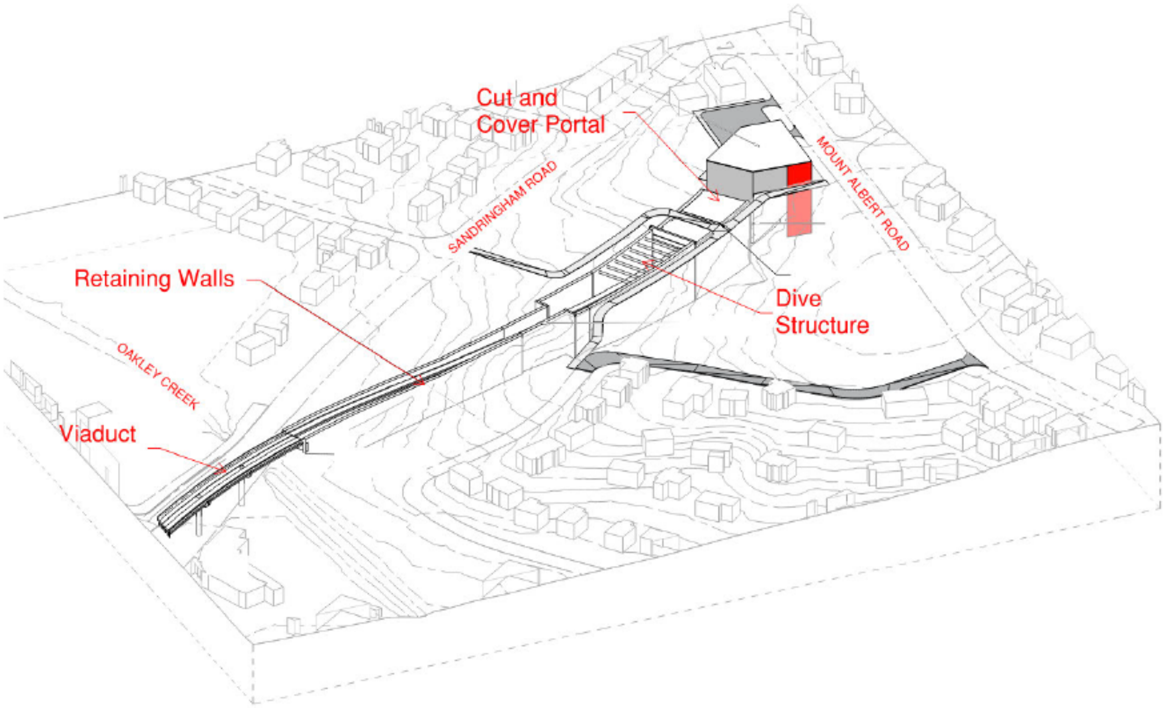


Figure 2-5 TBM Launch Site

2.6 Stations

2.6.1 Station Design

Station design has focused on function, performance and typologies. Each has been applied to provide a practical footprint for the stations, with sufficient flexibility within these footprints to allow further refinement of the station design through the next phases of design.

2.6.1.1 **Function**

The stations will provide safe, functional and clear transport solutions. A user-friendly experience is one that meets user and transport service expectations. Movement patterns will be simple, appropriate and support changing expectations and the potential for phased delivery.

2.6.1.2 **Performance**

The stations will provide a credible, sustainable design outcome that responds to climate, site and social economics. Stations must be sized with the ability to maximise patronage, enhance local communities, adapt to climate change, minimise energy consumption and be maintainable.

Each station will have an entrance with facility to purchase tickets. Space for retail provisions has been allowed for at certain stations. Universal access is provided at each station to enable all passengers to access the platform. Mode is dependent on station, options include lifts, escalators, ramps, and stairs. A secondary egress route is available on all platforms to allow for evacuation in an emergency. On the platform, communication systems such as speakers and information displays will be provided, detailing service updates. External stations will have covered platforms, the extent of coverage is not set. Back of House facilities are at each station to enable the operation, major plant replacement routes have been accounted for. External precincts will have integration with other transport modes such as buses, cycling and private car drop off. The provision and allowance of each varies at each station.

2.6.1.3 Typologies

Station design has been developed to group stations into three types; at-grade, elevated and underground (shaft and cut and cover). For each type, a kit-of-parts philosophy has been adopted to have a modular approach, which will provide economies of scale and possible opportunities for off-site manufacturing and pre-fabrication. Maximising modularisation of station components will result in a consistent identity across stations and enhance legibility and user experience. The introduction of distinct recognisable features, inherent to each station, contributes to the individual station identity. The volumetric and spatial character of the stations considers sustainability concepts and engineering optimisation.

2.6.2 Station type

Table 2-2 provides an overview of each station and its type. The following section provides a description of each type.

Table 2-2 ALR Stations

Underground	At Grade	Elevated
Te Waihorotiu University Dominion Junction* Kingsland Balmoral/St Lukes Sandringham	Puketāpapa/Mt. Roskill Station Hayr Road Māngere Bridge Te Ararata Station Māngere Town Centre** Airport Industrial**	Wesley** Onehunga Airport Commercial** Regional Airport** International Airport**
*Cut and cover station **Excluded from this NoR lodgement		

2.6.2.1 Monotube tunnel and shaft

Underground station vertical retention will be constructed offline from the TBM tunnel. This allows the shafts to be positioned around property constraints and outside of major transport corridors, thus minimising the surface impacts associated with large-scale open excavation. Methods may include those commonly adopted in Auckland, such as bored pile, diaphragm walls and benching. All underground stations inside the monotube tunnel are developed as "kit of part stations" using precast concrete elements in polygonal shapes, with the side station platforms formed within the tunnel bore on two levels. Stations are between 25-40m deep. Platforms are connected via adits to the main station entry and circulation shafts. Circulation within the shaft utilises escalators and lifts connecting the street level with the two platform levels below.

The proposed alignment and stations are deeper in most cases than CRL, due to the topography, ground conditions, tunnel diameter and existing infrastructure and building constraints.

The shaft footprint is based on the area required for all station functions, including passenger circulation; mechanical, electrical and hydraulic services; rail systems; fire and life safety ventilation, emergency evacuation and intervention; maintenance routes and access; customer amenities; gating and ticketing; and station control.

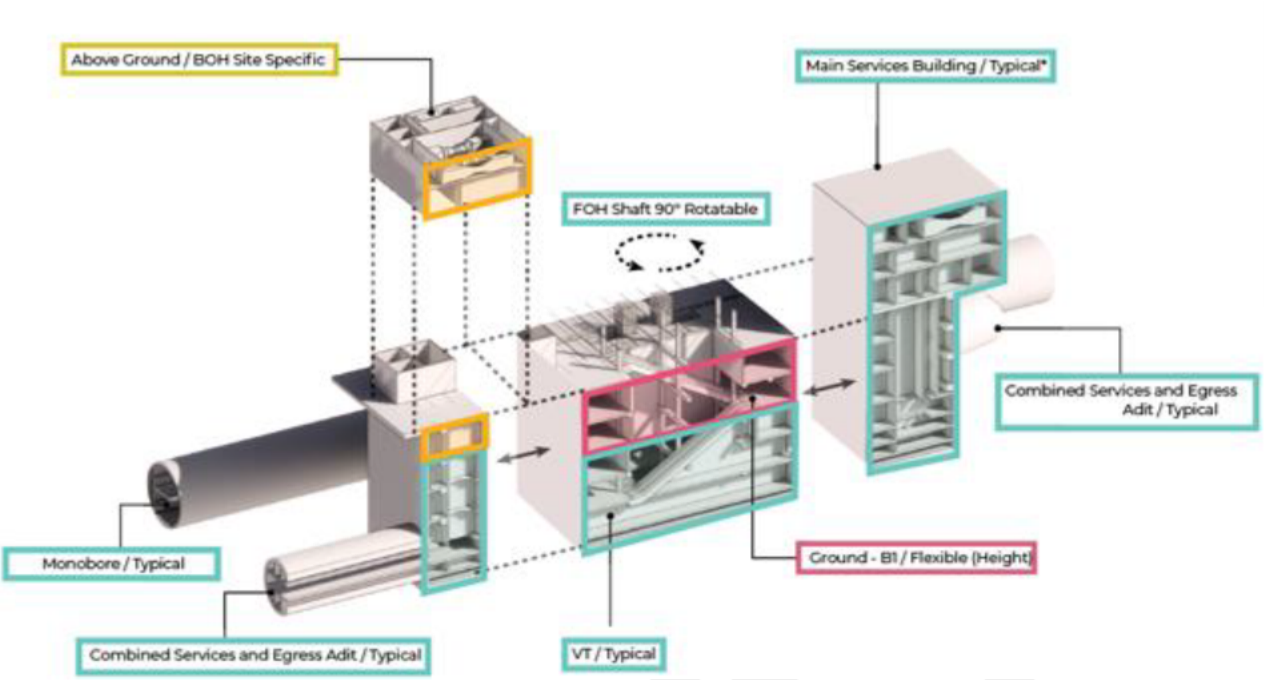


Figure 2-6 Kit of Parts Station

2.6.2.2 Cut and Cover

Dominion Junction is a cut and cover station with a central deep box, with the platforms and tracks stacked at the lowest level. Dominion Junction station configuration is driven by the alignment and achieving the required rail functionality between it and Kingsland Station, in additional to the station box servicing as the TBM launch site for the northern TBM drive. Cut and cover station boxes are excavated from surface level down to rail level in a single volume, matching the overall footprint of the station.

Due to the large volume of back of house accommodation within the station box, this typology can enable minimised service areas placed above ground level. Cut and cover stations create opportunities for oversite developments built above and/or adjacent.

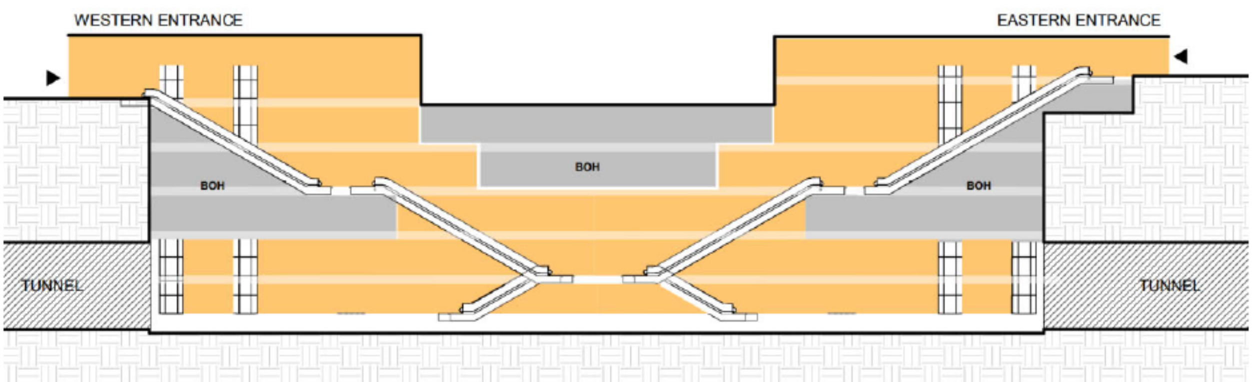


Figure 2-7 Dominion Junction Cut and Cover Station

2.6.2.3 **Viaduct Station**

Onehunga and Wesley are elevated stations with side platforms and a viaduct running through the middle. Viaduct structures are widened to accommodate station platforms either side of the tracks. Viaduct and station platforms can be supported by the same foundation. Vertical transport from street level to platform level will be via lifts and escalators on each platform.

The superstructure has an RC deck slab supported by precast prestressed concrete beams. Foundation structure is likely to encounter layers of basalt, and includes a pile cap and a number of bored piles.

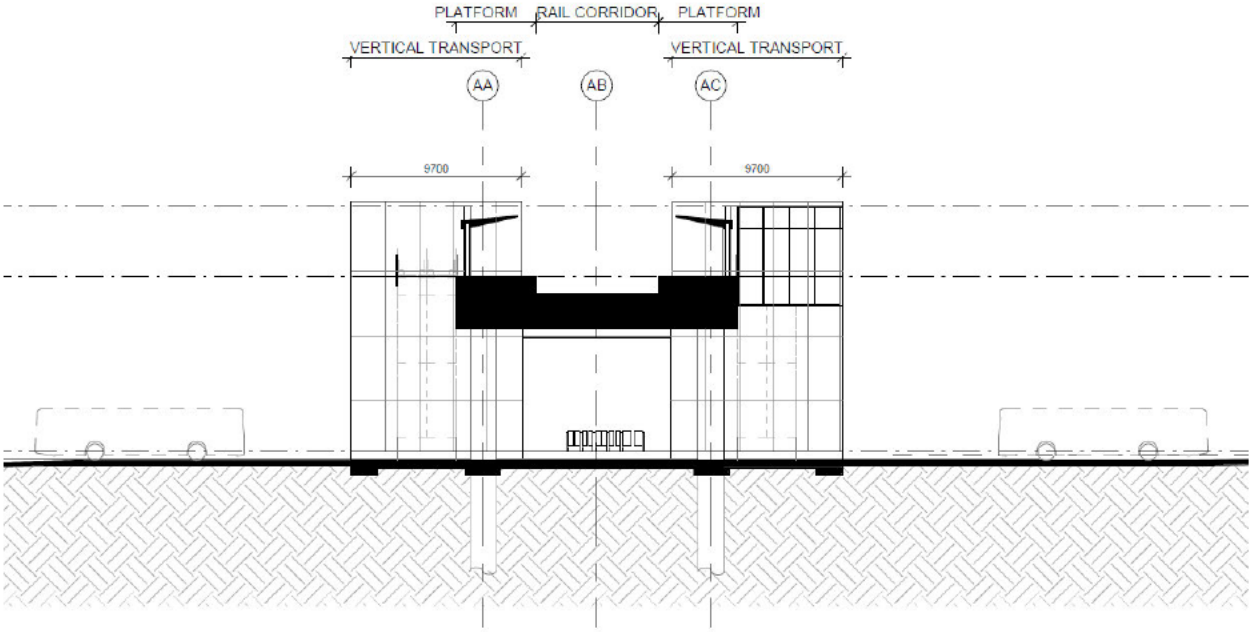


Figure 2-8 Typical Elevated Station

2.6.2.4 **At-Grade**

At Grade stations are the simplest of the proposed station types, stations are fully segregated with either an island or side platform arrangement. The rolling stock operates on ground level tracks. Station entrances are located at ground level and depending on the station there is direct station building to platform access, access via underpass or access via overpass. Alternative egress routes are provided at the ends of platforms and provide egress routes segregated from the trackway.

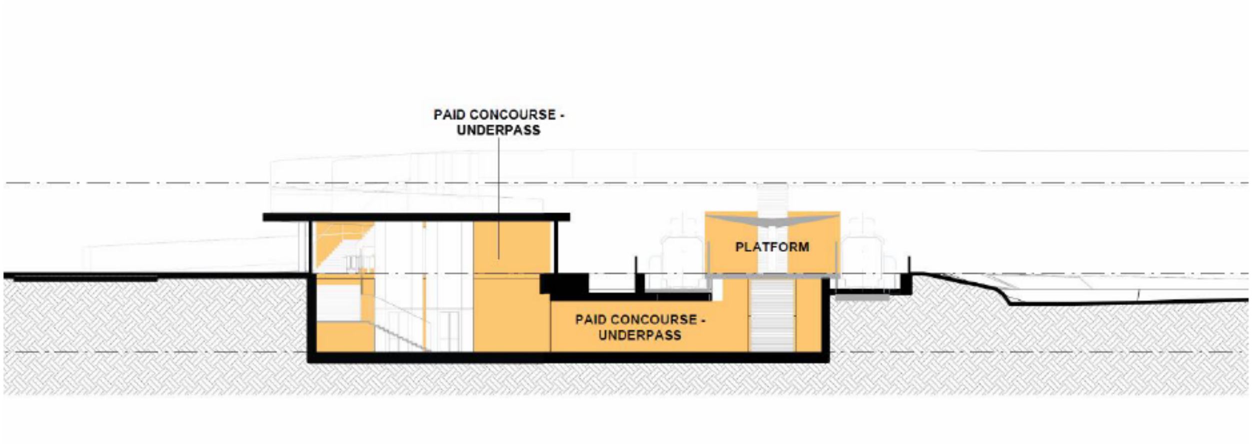


Figure 2-9 Typical At-Grade Station

2.6.3 Mechanical, Electrical and Public Health

Rail stations require areas dedicated to housing and operating the essential systems that ensure the station's functionality. Underground stations also require significant space for mechanical ventilation within underground stations to service the tunnels and station.

2.6.3.1 Vertical Transportation

Banks of escalators will provide ease of access between station levels. Escalators provide an efficient means of vertical transportation, allowing passengers to move quickly through the station. They can handle a large number of people at once, making them ideal for handling high passenger demand. Escalators that are running in the direction of egress will continue to run in that direction, i.e., in the up direction for underground stations. Escalators that are not running in the direction of egress will be brought to stop and used as a stair. Access is provided to a fire exit stair at each landing level. Lifts are also provided to offer quick access between entrance concourse and platforms. Firefighting lifts are contained in the firefighting shafts for use for evacuation of people with reduced mobility, fire service personnel and maintenance personnel.

2.6.3.2 Electrical Power Supply

High Voltage (HV) power shall be reticulated to the stations by relevant electricity distribution company. The station HV power supply will be independent of the traction HV power supply system. A minimum of two fire-segregated transformer substation locations must be provided at each station, to provide an 'A' and 'B' HV power supply arrangement. This is to ensure that in an event and loss of one HV supply, the whole station and applicable tunnel sections will continue to operate and be supplied from the alternative HV supply. HV switch rooms will be located in the BoH and sized to facilitate transformer and HV equipment replacement and for permitted personnel access. An alternative arrangement would be to have a single HV supply and life safety and essential loads supplied from generator sets. Generator sets are not preferred due to the cost of maintenance, difficulty in dealing with noise and smoke and heat emissions.

2.6.3.3 Small Power and Lighting

Station lighting levels will be designed to provide an acceptable illuminance in any public area, vertical transport and platform. In an emergency, sufficient lighting to enable passengers to escape will still be available, with battery backups provided for lighting and exit signage. Small power for use in staff and non-critical operational rooms will be provided for cleaning, maintenance and welfare.

2.6.3.4 **Hydraulic Services**

Station hydraulics include potable water, sprinkler and hydrant protection, storm water drainage, ground water drainage, sewer drainage, pumping, and stormwater retention. To address any ground water leakage, stormwater, and water arising from fire suppression, sump pumps will be installed at track level for each station and at the tunnel portals. Additionally, hot and cold potable water will be supplied to toilets and staff kitchenettes.

2.6.3.5 **Platform Screen Doors**

Platform screen doors will provide a physical barrier between the platform and the train as well as the track. These typically have glazed partitions with automatic doors that align with the carriage doors on opening. An architectural partition will form a complete fire rated seal between the platform and tunnel. On ALR underground stations, the door will be full height doors and half height doors on surface stations.

2.7 Depot

There will one rail depot situated in Onehunga. It will accommodate all maintenance functions for the rolling stock (passenger and infrastructure maintenance vehicles) across the entire lifecycle of the railway. It will house workshops for the repair and refurbishment of appropriate infrastructure, storage of spare parts for rolling stock and lay down areas for maintenance and renewal of trackwork. The depot will accommodate stabling facilities for the rolling stock and preferably a test track.

The depot is also envisaged as being the operation and administrative headquarters of the Operating and Maintenance (O&M) entity, thus the following facilities will need to be accommodated at the site:

- Operational Control Centre (OCC)
- Administration and Management Offices
- Training Facilities
- Staff Welfare Facilities
- Associated Vehicle Parking
- Storage building

The depot will house a power intake substation which will provide power for traction both in the depot and along the mainline as well as the load centres in the depot itself.

The main workshop will house maintenance tracks which will be defined with specific purposes. Typical maintenance track assignments considered in this notional layout and site selection are:

- Inspection Track/Light Maintenance Track
- Unscheduled Repair Track
- Heavy Maintenance/Lift Track
- Overhaul Track
- Stabling Tracks
- Handover Track/Headshunt
- Launch & Recovery Roads/Train Wash Track

2.8 Road

The road layout and geometric design philosophy ALR considers the existing roading network and proposed infrastructure for ALR. . New drop off bays, bus terminals and cycle lanes will be provided at the stations, details vary by station. Local roads will follow the Auckland Transport design manual set and modification works along State Highway 20 will be in accordance with the Waka Kotahi design. Traffic lane widths, and road and intersection geometry for the roads shall be designed to accommodate movements and swept paths of design and check vehicles. Road classification and consideration of how the roads will be used in the future influences the design criteria for barrier, signage and pavement markings.

The horizontal geometry of the roads encompassed within the project extents should provide for safe and continuous operation at a uniform travel speed.

Public transport infrastructure is to be designed, including bus lanes, stops, platforms, shelters and other bus facilities. New bus interchanges are provided at Onehunga, Puketāpapa/Mt. Roskill Station and Wesley Stations.

Cycleways and footpaths are to be proposed at each of the stations to connect pedestrians and cyclists from the existing road network to the proposed new stations. The cycle parking at each station has been designed to ensure easy access. Cycle access shall minimise the need for cyclists to mix with pedestrians as much as reasonably practical.

2.8.1 New North Road and Dominion Road Flyover Demolition

The existing New North Road/Dominion Road segregated interchange is proposed to be demolished and replaced with a new at-grade signalised intersection. This will provide an appropriate environment for active mode access to and from Dominion Junction station.

The intersection demolition and reconstruction will be staged to maintain critical movements, including buses and safe active mode routes during construction.

3. Indicative Construction Methodology

3.1 Overview

An indicative construction methodology has been developed for ALR to support this lodgement. The methodology applies across the whole route, with the intention of defining an the NoR boundaries, and to enable an understanding of the likely environmental effects generated by construction. This will inform an assessment of effects suitable for seeking a designation via the NoR process.

Location specific methodologies are described in Section 5 for each station, including an explanation of how the construction will be managed with the constraints at each station.

3.2 Site preparation [clearance and demolition]

Site preparation works will be undertaken prior to the main construction works. The scope of enabling works will vary between each site, but may include utility services protection and diversions, building demolition, tree removal and creation of temporary pedestrian and vehicle routes.

3.3 TBM tunnel

3.3.1 Methodology

Two tunnelling drives are proposed for the project. The first stage is a southern TBM drive from Sandringham South to Dominion Junction. Following breakthrough at Dominion Junction, the TBM will be removed. The second stage will be a northern TBM drive from Dominion Junction to Vernon Street Shaft, where the TBM will be extracted. The average TBM excavation rate for the monotube tunnel is assumed to be 9.5m/day (including TBM stoppage), with reference to the Waterview TBM tunnel construction.

The excavation and lining of the monotube tunnel will be by TBM, designed to manage the ground and groundwater conditions of the alignment. Behind a cutterhead at the front of the TBM, various components are located within a series of cylindrical steel sections slightly larger than the final segmental lining. The TBM progressively excavates and lines the tunnel. TBM hydraulics are driven by electricity, thus they require large and reliable power supplies.

An earth pressure balance TBM operates by utilising hydraulic rams to thrust the cutter head and cutting tools into the ground and multiple electrical drive motors to rotate the cutterhead. The hydraulic rams push against the precast reinforced concrete tunnel segments, which have been previously constructed behind the leading section of the TBM. In the driving direction, hydraulic thrust rams are longer than the length of each segment. As soon as the ground has been excavated sufficiently to install a new pre-cast ring, the rams are retracted, a new ring is assembled (and secured in place with grouting), and the process repeats.

During construction, the precast segmental lining is installed inside the tail shield of the TBM and connected using short bolts. The cutter head of the TBM excavates a larger diameter than required for the shield to pass through and for the permanent lining to be installed. The space created between the segments and the excavation is then filled with a cementitious grout. This process allows for the placement and grouting of the tunnel lining within a distance of one to two tunnel diameters from the advancing tunnel face. Joints between the precast lining segments incorporate durable compression gaskets which provide the tunnel lining with a high degree of water tightness.

High power supply is required for TBM operation and other related construction activities.

3.3.2 Precast segmental linings

The tunnel lining is assumed to consist of 10 precast segmental concrete units with a width of 2400mm and a length of approximately 4225mm in plan. The segments may be stored vertically (stacked segments). The production worksite will need to receive and store segments from the casting yard continually and deliver segments into the production cycle. The worksite area has been sized to accommodate the segment storage in view of the above requirements.

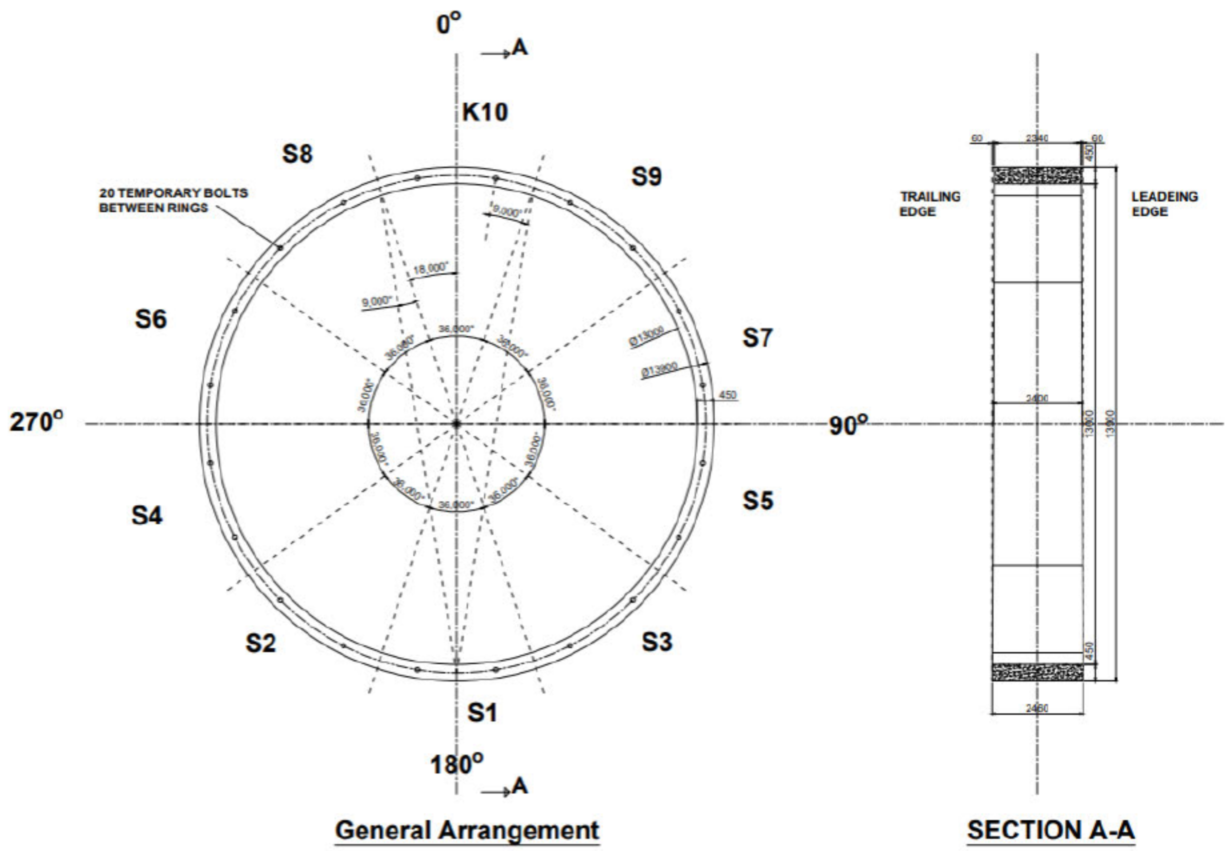


Figure 3-1 General Arrangement of TBM Precast Segmental Lining

3.3.3 Emergency Escape

The monotube tunnel has a longer horizontal distance from the TBM cutter head to an emergency evacuation point (as shafts are offline) over twin tunnel construction. To mitigate this difference, a refuge chamber is to be provided near the rear of the TBM to provide workers with an isolated safe location in the event of a fire during tunnel construction.

3.3.4 Internal Structures Slab

During tunnel construction, several trailing gantries will be used for construction of internal structures to separate the upper and lower tracks. The average construction rate of these internal structures is assumed to be similar to the TBM excavation rate.

3.3.5 Adits

The monotube tunnel typology avoids mined caverns to create the station platforms but requires smaller mined adits to provide connections from the station shafts to the tunnel.

Adits are typically proposed to be constructed by open face excavation, using either mechanical excavator or road header methods with in-line temporary support. The tunnels are sufficiently deep that they will be typically constructed in the underlying East Coast Bays Formation (ECBF) bedrock. Temporary support may comprise rock bolts and sprayed concrete, or simply shotcrete placed in sufficient thicknesses to support the ground. Permanent support may comprise of a cast in-situ plain/reinforced concrete lining with a waterproofing membrane erected before concrete placement.

There are smaller adits for OTE which could be constructed using pipe jacking methods.

3.4 Underground Station Shafts

Retaining walls are required around the perimeter of the station shafts. Generally, diaphragm walls are favoured due to the retention depth and advantages gained by single-pass construction. Secant pile walls are proposed where the station shafts encounter thick layers of water-bearing basalt.

During excavation, the shaft structure requires multiple layers of strutting to restrict the vertical span of the perimeter walls. The strutting layers align with the floor and platform levels and therefore support gravity floor loads in addition to bracing the perimeter walls. Walers and lateral strutting are likely to be constructed top-down, thereby eliminating temporary propping and/or tie-back anchors.

After completing the excavation, a structural base slab will be cast to provide a dry and durable surface. Two types of base slabs are proposed: drained and tanked, as shown in Figure 3-2.

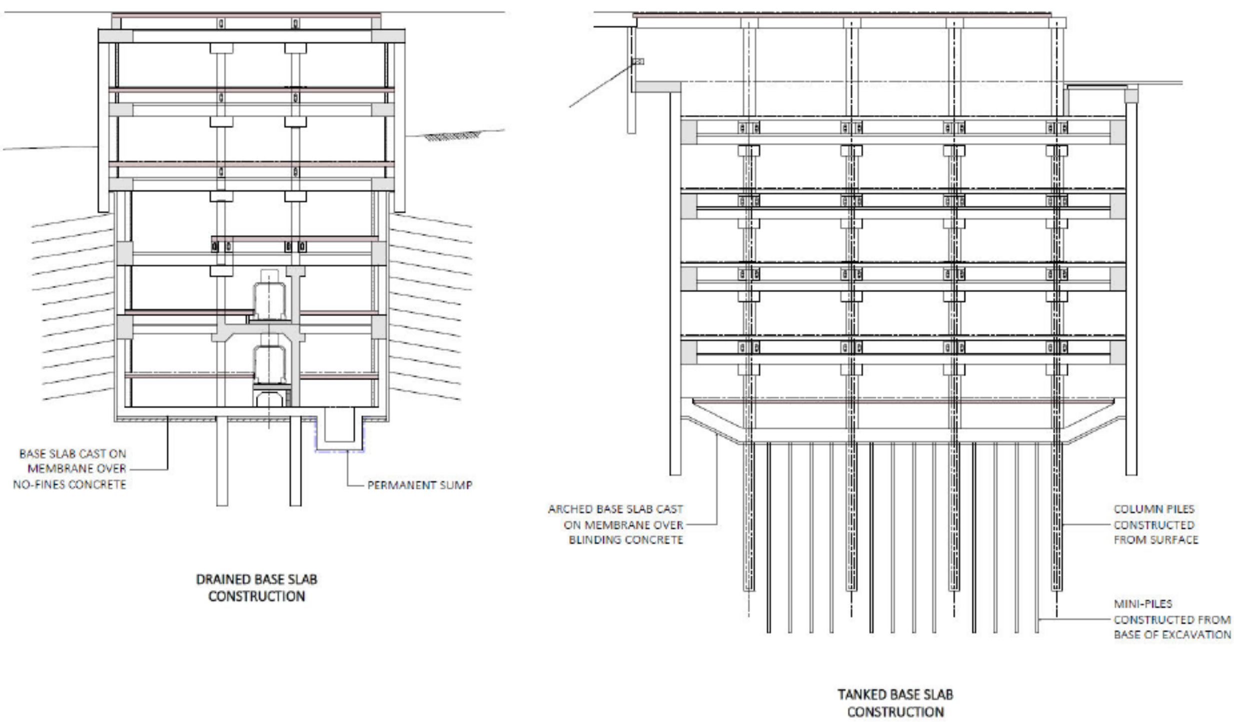


Figure 3-2 Drained and tanked base slab construction

3.4.1.1 **Drained Base Slab Construction**

Drained construction allows groundwater to enter the shaft base. This significantly reduces uplift pressures, allowing a lighter base structure without tension piles. The base slab will be cast over a layer of no-fines concrete. Strip drains (with flushing pipes) will be cast into the no-fines material and connected to a permanent sump. This system will require ongoing inspection and maintenance to ensure that blockages do not allow water pressures to escalate.

3.4.1.2 **Tanked base slab construction**

Tanked construction prevents groundwater ingress and is therefore subject to significant uplift pressure. Tension piles area are required to resist this uplift pressure. These can be either large diameter or closely spaced mini-piles.

3.4.2 Mechanical, Electrical, Fire Systems & Hydraulics (MEFH) Fitout

MEFH installation will commence after primary structural works are completed. These works include internal ducting, pipework and cabling; plant and equipment installation; cladding installation and internal finishings. Heavy duty equipment, such as escalators, lifts and transformers will require crane operation to lift from laydown areas into the stations. Fitout of the tunnel will require extended cable pulling periods with heavy cable drums. There will be opportunities to make use of works trains or driven vehicles in the tunnel to help with logistics.

3.5 Auxiliary shafts

The auxiliary shafts which support the tunnel ventilation, emergency intervention and maintenance access have different proposed construction methods, due to ground conditions.

3.5.1 Vernon Street Shaft

Vernon Street Shaft comprises rectangular secant pile walls with waler beams providing clearance to the TBM. It also has mid beams at capping beam and waler beam levels provided at the interface of shaft and adit. During excavation, the shaft extending below the secant pile walls has a lining supported by permanent ground anchors. Once the soffit of the shaft is reached, a reinforced concrete base slab with strip drain is cast over a blinding concrete layer. The permanent reinforced concrete wall is constructed from the bottom-up. The shaft is sized to allow retrieval of the TBM. Other vertical retention methods commonly adopted in Auckland, such as diaphragm walls, are also being considered. The shaft provides construction access to the cut and cover adit to allow mining of the stub end (short extent beyond TBM tunnel).

The shaft also includes a cut and cover structure across Wellesley Street, which is proposed to be staged and top-down to allow single lane traffic operations, as illustrated in Figure 3-2. Another option for traffic operation being explored is diverting the traffic through Sale and Vernon St. In the permanent case, the facility will be used for train turnback, which requires the Vernon Street site to accommodate ventilation plant, emergency egress and a low point sump and pump. This will include building an oversite development (OSD).

There are numerous utilities around the shaft location within the road corridor that will require relocation prior to excavation commencing. The shaft also includes excavating adjacent the Orakei Main Sewer, which is a circa 100yr old egg shaped brick sewer. The stub tunnel extends to just prior to the sewer alignment. It is anticipated that this section of sewer will require strengthening with a Glass Fibre Reinforced Polymer (GRP) liner. Over pumping will be required to facilitate this work.

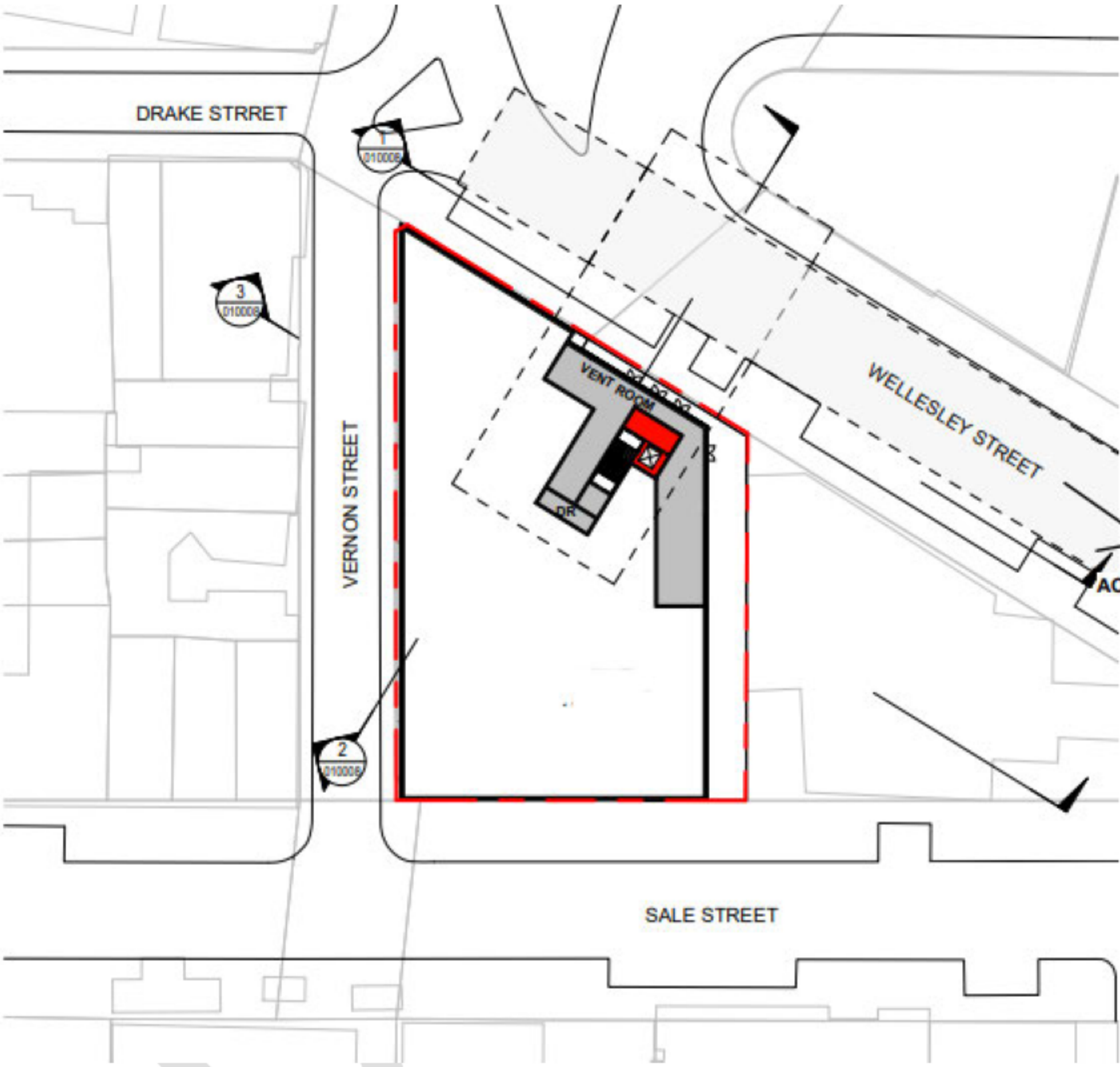


Figure 3-3 Vernon Street Shaft

3.5.2 Wellesley Street Shaft

3.5.3 Burton Street Shaft

The Burton Street Shaft is required for emergency intervention due to the distance between Universities Station and Dominion Junction Station.

The Burton Street Shaft concept comprises of permanent diaphragm walls founded into the ECBF. Ring beams are provided and at the interface between diaphragm walls and shaft lining.

During top-down excavation, the shaft extending below the diaphragm walls has a lining supported by permanent ground anchors. Once the soffit of the shaft is reached, a reinforced concrete base slab with strip drain is cast over a blinding concrete layer. A permanent reinforced concrete wall is constructed from bottom-up.

The shaft is assumed to be drained during construction and undrained in its permanent condition. The internal diameter is approximately 13m at the diaphragm wall cross-section and approximately 10m at the permanent reinforced concrete and ground anchors cross-section. The internal walls to support emergency intervention fit out (fire egress, stairs, lifts) are assumed to be cast in-situ constructed bottom-up.

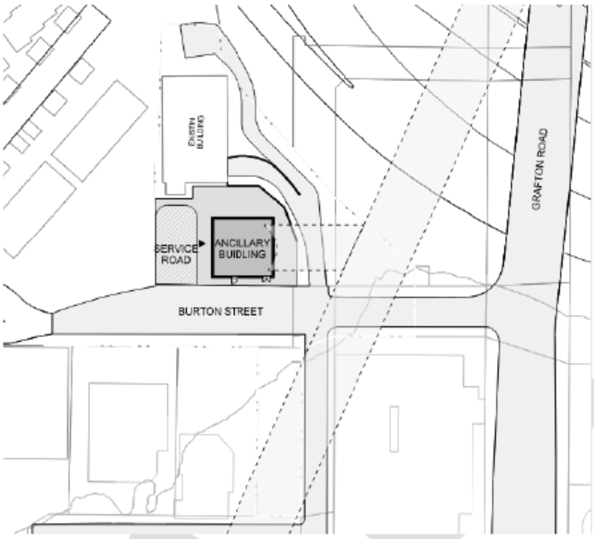


Figure 3-4 Burton Street Shaft

3.5.4 New North Road Shaft and Auxiliary Building.

The New North Road site is required to house a traction power substation, vent shaft and emergency egress. The position of the shaft is highly constrained: it must be located at mid-point of shunt tracks and passing loops between Dominion Junction and Kingsland stations to fit within the single TBM running tunnel. An offline shaft construction has been considered which requires mined adits to the running tunnel.

The shaft will be circular with secant piles installed into the soft soil. The shaft extending below the pile walls has a lining supported by permanent ground anchors and shotcrete in the mined adit. Adits connect to both sides of the TBM tunnel.

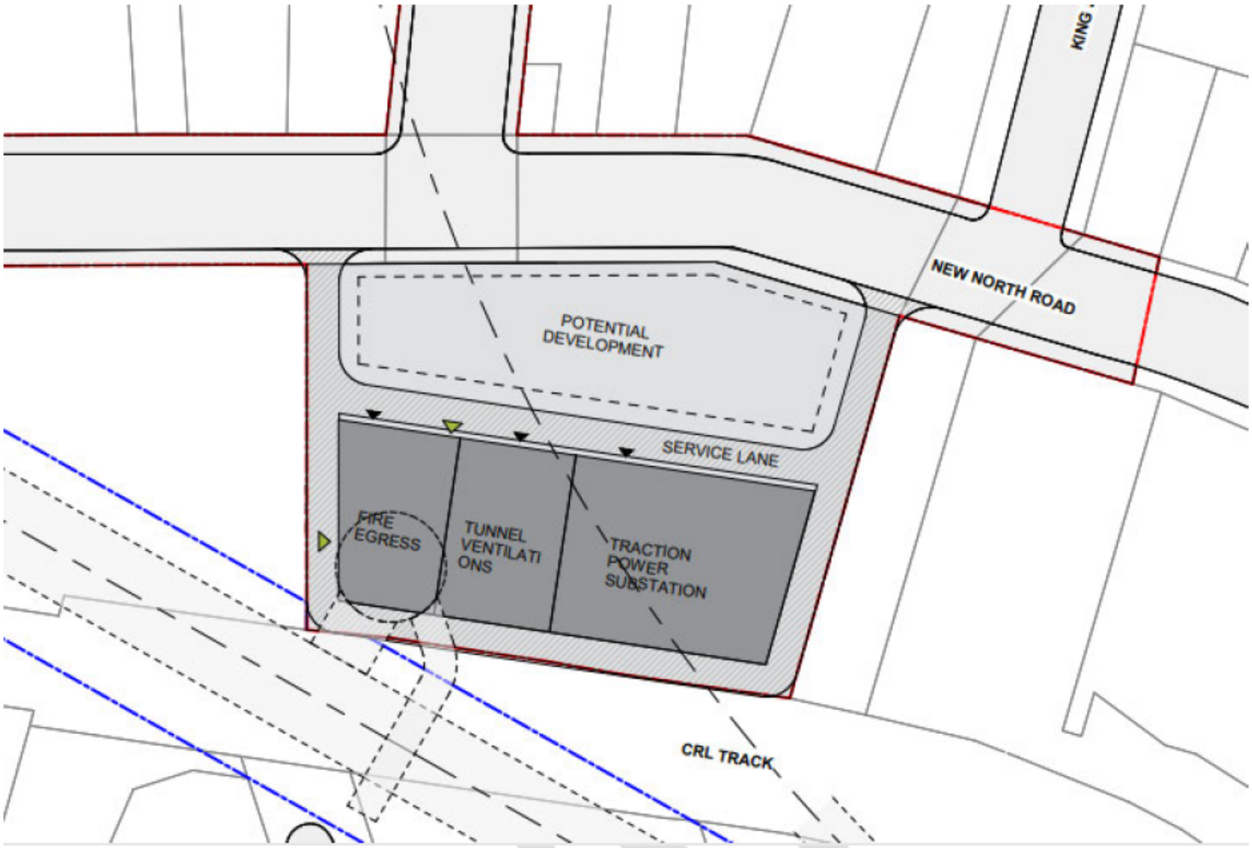


Figure 3-5 New North Road Shaft

3.5.5 Mt Albert Road Dive Structure

A trench will be dug larger in width than the TBM diameter to accommodate the launch and assembly process. The site will be approximately 140m in length and consist of a viaduct track transition area, dive structure and a cut and cover portal entrance (see Figure 2-5 above). The tracks will split vertically within the Mount Albert dive site to be side-by-side at the viaduct in Wesley.

The retaining structures that form the cut and cover and dive structures are formed with diaphragm walls, with top down propping. Due to the terrain, the slopes in the construction site may need battering supported by retaining walls.

The site also accommodates the Backup Control Centre, tunnel ventilation and emergency egress.

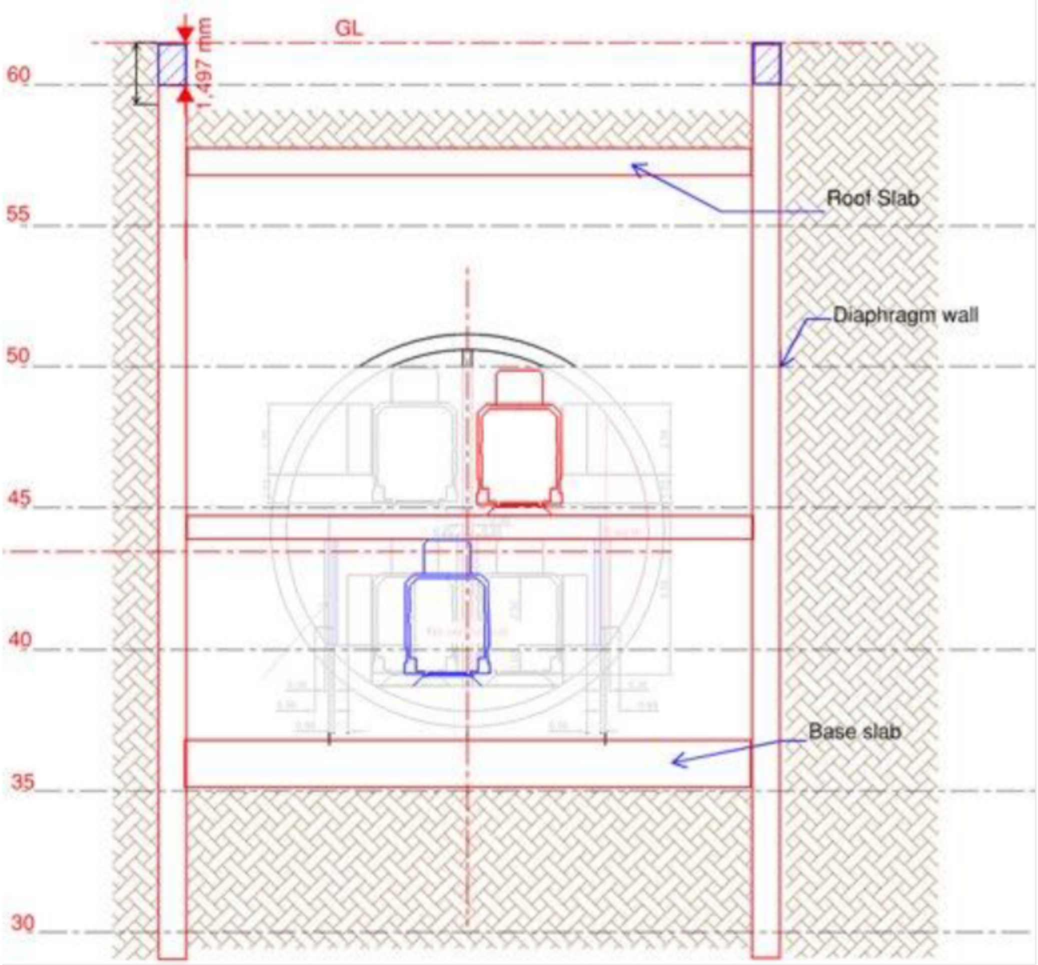


Figure 3-6 Mt Albert Road Cut and Cover

3.6 Spoil disposal

It is anticipated that TBM-excavated material will not be suitable for use as engineered fill. Therefore, it is assumed that TBM spoil will be removed and disposed off-site to a consented disposal location. This may equate to up to 330 trucks per day in each direction at each tunnelling site (refer to Section 4 for anticipated tunnelling durations). Spoil sites assumed at this stage are Puketutu Island and/or Mercer Waikato.

3.7 Construction support areas

Construction support areas (CSAs) will be required for the provision of welfare facilities, plant/materials storage and earthworks stockpiling as required. A description of each CSA and the associated activities is outlined below. It is anticipated that:

- All CSAs will be fully fenced and made secure. Site establishment activities will include site clearance, ground preparation, and establishing erosion and sediment control measures prior to any construction activities occurring. Upon completion of the works, the CSAs will be disestablished, and the areas restored to at least their previous condition prior to construction, or incorporated into the project construction works.
- All CSAs are likely to be established on compacted hard fill unless impervious areas exist.

- All CSAs are likely to be used for stockpiling of earthworks.

The CSAs are likely to require some or all the following amenities:

- Site offices, lunch rooms and amenities.
- First aid equipment.
- Staff car parking (if not provided offsite and bussed in).
- Bulk storage of materials for earthworks (topsoil, hardfill, etc.), building components (precast concrete, steelwork, timber, etc.).
- Steel shipping containers for small tools/equipment storage.
- Workshop & dangerous goods store.
- Satellite welfare facilities may also be required in addition to any welfare facilities provided within the CSAs. These will typically include the provision of temporary facilities for workers in closer proximity to their immediate working area.

Activities likely to occur within the CSAs include:

- Construction vehicle and machinery parking and maintenance.
- Storage of construction materials.
- Fabrication, reinforcement cutting and bending.
- Storage of plant and equipment and building materials.
- Construction vehicle wheel washing facilities (where necessary).
- Stormwater and groundwater treatment facilities/dewatering plant (where required).
- Shaft ventilation plant (for underground construction support areas)
- Waste storage and collection.
- Spoil and topsoil handling and storage.
- Cranage footprint.

3.8 Site establishment [clearance and demolition]

Within the project site area, the physical construction works will be undertaken in stages:

- Site preparation.
- Demolish all existing buildings and clear site.
- Close existing private access to surrounding properties.
- Establish erosion and sediment control.
- Build access road to provide site access. Maintain public use on outside roads with traffic management.

CSAs will be clearly identified on site and screened/fenced using Heras Fencing or similar. Gates on the access will be provided, utilising the fencing. These will be locked each time the area is left unattended. All areas will be made safe overnight.

Working areas will be fenced off to exclude members of the public. Pedestrian walkways (if required) will be clearly defined in accordance with the Code of Practice for Temporary Traffic Management (CoPTTM: Part 8 of the Traffic Control Devices TCD Manual).

The above is subject to further refinement and optimisation by the contractor following contract award, taking into account resources and costs, and the finalised design requirements.

3.9 Utilities

Utilities are generally located within the road reserve to service adjacent properties and avoid impacting on private property. Gravity assets (sewers and stormwater infrastructure) may however run through private property outside the road corridor. Utility assets are owned by several companies that operate and engage with third parties (like ALR) differently.

Existing services which are in direct conflict, or close to ALR infrastructure will need to be relocated or diverted. The process for utilities is:

- Assess impacts on existing utility assets and agree on a proposed solution with the utility operator.
- Protection of existing utility services where possible (in preference to diversion) to reduce disruption to the utility operator and their customers but ensuring that the asset is not compromised.
- Relocate or provide new utility services where the existing utilities cannot be protected.
- Supply new connections to the ALR infrastructure, including:
  - TBM power supplies
  - HV Power supply on the main entrance side of the stations.
  - Traction Power supplies to the depot and the New North Rd shaft.
  - Telecommunications infrastructure to tunnels to ensure high quality customer experience.
  - Water supply, including firefighting on the main entrance side of the stations.
  - Wastewater connections.

Utility data has been provided by the Network Utility Operators NUOs as geodatabase information. These data sets have been incorporated into the ALR GIS environment. ALR has additional management data fields in the GIS database to track the quality and status of asset information through the life of the project.

Utility risk is substantially reduced with the monobore tunnel typology because it negates a need for online station excavations. Instead, the tunnelled stations are generally constructed through the base of the future station building with mined adits to the main tunnel bore, which is well below almost all utility assets. Therefore, from a utility perspective these offline stations are more akin to construction of large vertical build buildings than that of traditional transport infrastructure projects. In contrast, the utility assets encountered by the monobore typology often cause a more substantive constraint to the engineering solution because they are typically larger gravity assets or assets of critical importance that are difficult and costly to relocate.

An example of this is the Vector Tunnel, which is an approximately 3m tall horseshoe shaped tunnel that houses critical Vector cables as well as 220kV Transpower cables that are part of the National Grid. The ALR tunnel runs above the Vector tunnel but below Te Waihorotiu station (CRL) in close proximity to both structures.

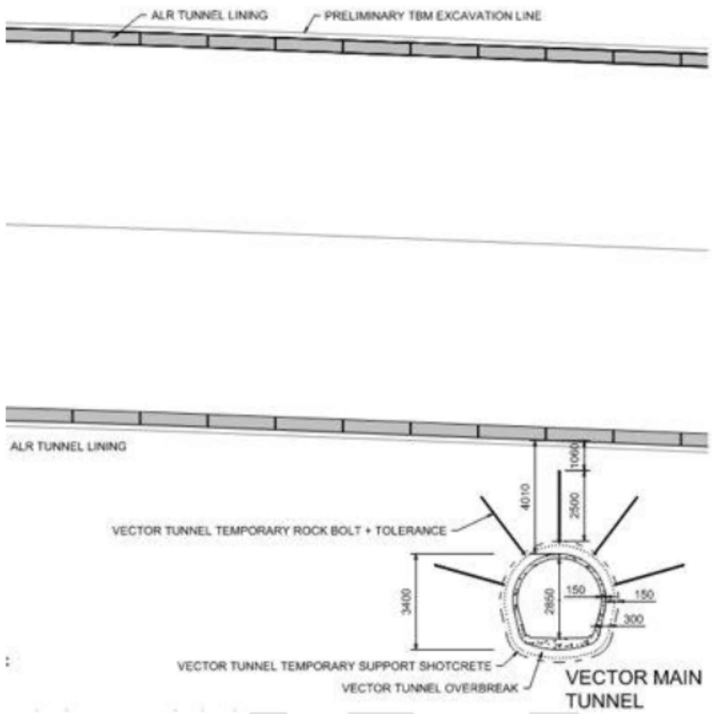


Figure 3-7 ALR Tunnel interface with Vector Tunnel

Once the tunnel daylights at Wesley, the utility risk profile changes and becomes a more traditional transport project in terms of impact. Realignment of Sandringham Road could have substantial impacts on utilities, particularly Vector due to location of both 110kV and 22kV transmission plus lower voltage power supplies. The level of impact will depend on the location of the ALR viaduct piers. ALR's alignment also crosses Watercare's Central Interceptor designation in this location, but its impact on assets adjacent to Oakley Creek is minimal.

Along SH20, there are significant utility impacts at all the bridge structures that pass over the motorway. All these structures have multiple local network assets and some larger transmission assets. At these structures it is typical that temporary solutions are required that increase cost and complexity of the build (i.e. there is generally double build cost for the temporary and then permanent solution).

Assets that will further consultation with stakeholders include:

- Adjacent to May Road bridge, there is a 1.8m diameter Vector tunnel that houses 110kV power that transitions from the tunnel into the Road corridor at ALR's proposed Puketāpapa station.
- Huia No1 watermain - 760mm diameter CLS - that bifurcates over the Dominion Road bridge and follows the motorway corridor to Winstone Road.
- At Hayr Road bridge, there are local assets as well as a Vector Distribution substation, and multiple HV cables.
- At Hillsborough Road, there is a Vector Zone substation that has multiple HV and MV cables, some of which run for a length of the motorway within the proposed NoR footprint.

- In Onehunga, there are potential impacts on Transpower's network. More work is being undertaken to determine the impact on Transpower.

3.10 Trenched alignment

Cut and cover trenches are required along the surface alignment where existing SH20 roading infrastructure needs to be avoided. Locations include under Dominion Road and Hillsborough Road. Depths of the proposed trenches range between 5-13m. Substantial earthworks are required to achieve some trenched structures, with a high likelihood of encountering basalt during excavation based on records of construction of the existing bridge over SH20; therefore, blasting may be required. Blasting the hard, volcanic rock is the most effective way to fracture it for removal and avoids prolonged and disruptive rock-breaking activities. It will be managed by a series of controlled blasts using small explosive charges.

Cut and cover construction techniques generally involve the installation of secant pile walls, after which the ground between is excavated. Depending on the depth of the excavation, propping may be required across the excavation width. Temporary Traffic Management (TTM) will be required, ideally in a staged approach to only close one side of the road at a time.

The alignment section between Puketāpapa and Onehunga generally runs within the existing KiwiRail designation corridor. ALR will be sharing KiwiRail's corridor for a large portion of this section, with future provision for two parallel KiwiRail tracks accounted for in the ALR design. The trench structure must be sized to accommodate for this.

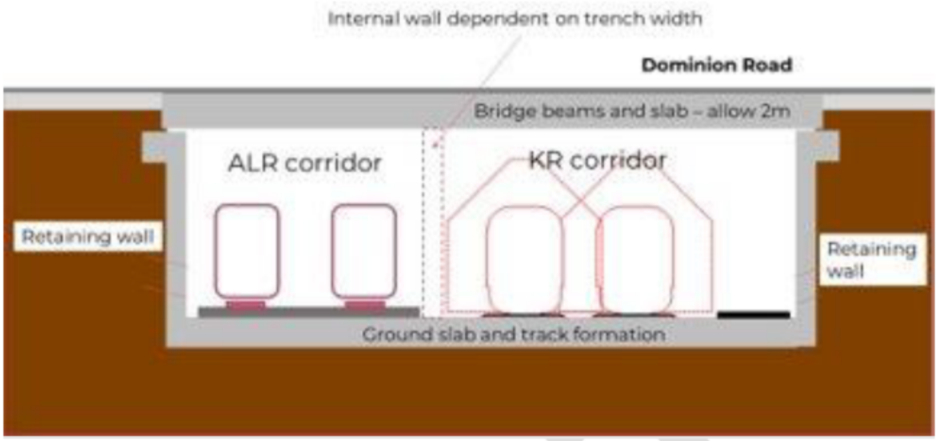


Figure 3-8 Trench cross section

3.11 Surface alignment

Approximately half of the ALR alignment is surface running (i.e. not in a tunnel, bridge or viaduct). The construction of the railway will be in the following stages:

Earthworks

Land will be cleared, including vegetation removal. Excavating or filling of the terrain is required depending on the cut/fill balance at each section. Soil or rock will be compacted to create a level and stable foundation for the track.

Track Slab

The design at this stage assumes track slab across the entire alignment. Options to pour in-situ or utilise precast concrete are available. Precast has been assumed for its consistent track geometry, longer operating expense, and reduced maintenance requirements. Using a modular construction system, the reinforced concrete slab track will be manufactured offsite before being transported to site.

Rail Alignment and Levelling

Once the track components are in place, rails are aligned and levelled to ensure smooth and safe train operations. The fixing of the point machine will be in the slab next to the turnout, making the interface with signalling and turnout simpler (compared to mounting onto a sleeper in ballast tracks).

Signalling and Communication

Rail tracks are equipped with signals, switches, and other communication devices to operate train control systems and ensure safety.

Electrification

Overhead catenary masts will be installed with overhead wires to supply power to the trains. The Standard OCS is formed by contact wire and messenger/catenary wire. It is auto tensioned that generally allows spans of up to 60-65m. The Standard OCS will be installed in open route areas of the ALR.

3.12 Viaduct alignment

The viaduct locations between Wesley and Onehunga will be founded on piled foundations, typically into ECBF or basalt. The piles will generally be installed with a bored piling rig. Once piles have been excavated, reinforcing cages are dropped into the pile holes and concrete subsequently placed. If basalt is present close to the surface, small, localised areas of blasting or breaking will be required to construct the pile caps. Down-the-Hole hammer (DTH) piling may be required when piling through basalt layers, depending on proximity of sensitive receivers.

Viaduct pier locations are based on a typical span length of 30m (with a maximum of approximately 35m) to allow standard precast concrete super-tee construction. Reinforced concrete (RC) piers and headstocks will be constructed in-situ, assumed currently with 2m diameter piers (maximum pier height of 10m). Mobile cranes or a self-launching gantry will lift in the precast viaduct beams, dependent on available site footprint. An in-situ concrete topping will be placed to the viaduct deck and edge barriers installed.

Expansion joints and pot bearings are installed at the top of each pier to accommodate movement caused by thermal changes, dynamic loads (trains) and dead loads (pier deck and track). The deck consists of four precast prestressed concrete super tee beams. Once the structural components are complete, the track slab system, drainage channels and overhead catenary are fit out.

3.13 Traffic management and access

The project requires works on and around the live Waka Kotahi and Auckland Transport corridors of state highways and arterial roads. There will be temporary disruption to the existing transport network, including public transport operations. Temporary Traffic Management (TTM) will be undertaken where required in accordance with some or all the typical measures set out below:

- Temporary reduction in the number of traffic lanes, lane widths and shoulder closures to allow space for adjacent construction.
- Temporary speed limit reductions, with positive speed management measures and enforcement. These will include 30, 50 and 70km/h temporary speed limits as required.
- Temporary site access points to construction zones and CSAs.
- Temporary traffic detours. Should unacceptable delays to through traffic be identified by the contractor through the development of temporary traffic management plans, detour routes may be implemented with appropriate detour signage.
- Traffic management coordination and interface will also be required with other construction projects in the area.

The Integrated Transport Assessment will consider the potential effects of this scenario and provide suitable mitigation measures for addressing the effects.

3.14 Earthworks [generic only]

Civil design for the project includes site survey, earthwork design, surface design levels, stormwater management and utilities design. Earthworks activities across the project will mainly comprise topsoil stripping, contouring and earthworks cut and fill construction (including wetland) and pavement construction. Construction will aim to utilise the

Auckland earthwork season between October and April, smaller sites may seek permission from Auckland Council for works outside this period. Earthworks on the site will be undertaken to achieve/construct the following:

- Elevated surface levels above the 1% Annual Exceedance Probability (AEP) flood level.
- Design surface cross falls (minimum of 1% and a maximum of 5%).
- Overall site grading.
- Main station access road bus interchange.
- Station carpark and bus interchange.
- Recontouring excavation in order to volumetrically offset potential flood effects from construction of new hard stand areas.
- Excavations associated with foundation works for station building structures and pedestrian overbridges.

A Contaminated Land Management Plan (CLMP), will be prepared and submitted separately to Auckland Council as a standalone report for certification. It will provide information on methodologies to manage risks associated with contaminated land hazards and management or mitigated through proposed construction. Details on methods for managing groundwater on site, such as de-watering, are covered in the Groundwater and Settlement Monitoring and Contingency Plan, which is also a standalone report submitted to Auckland Council for certification.

4. Indicative construction staging and programme

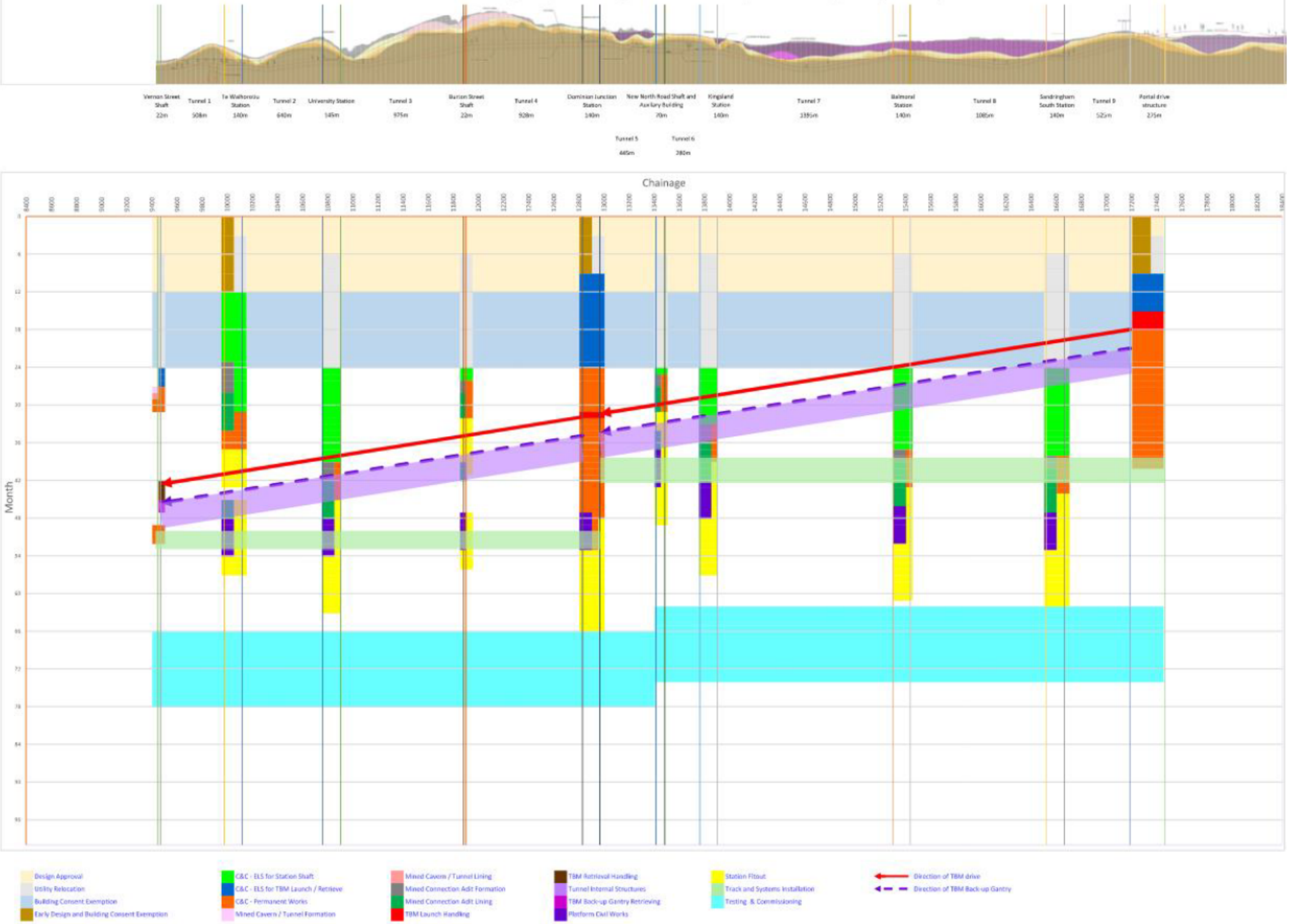
TBC based on Consent Strategy and construction guidance.

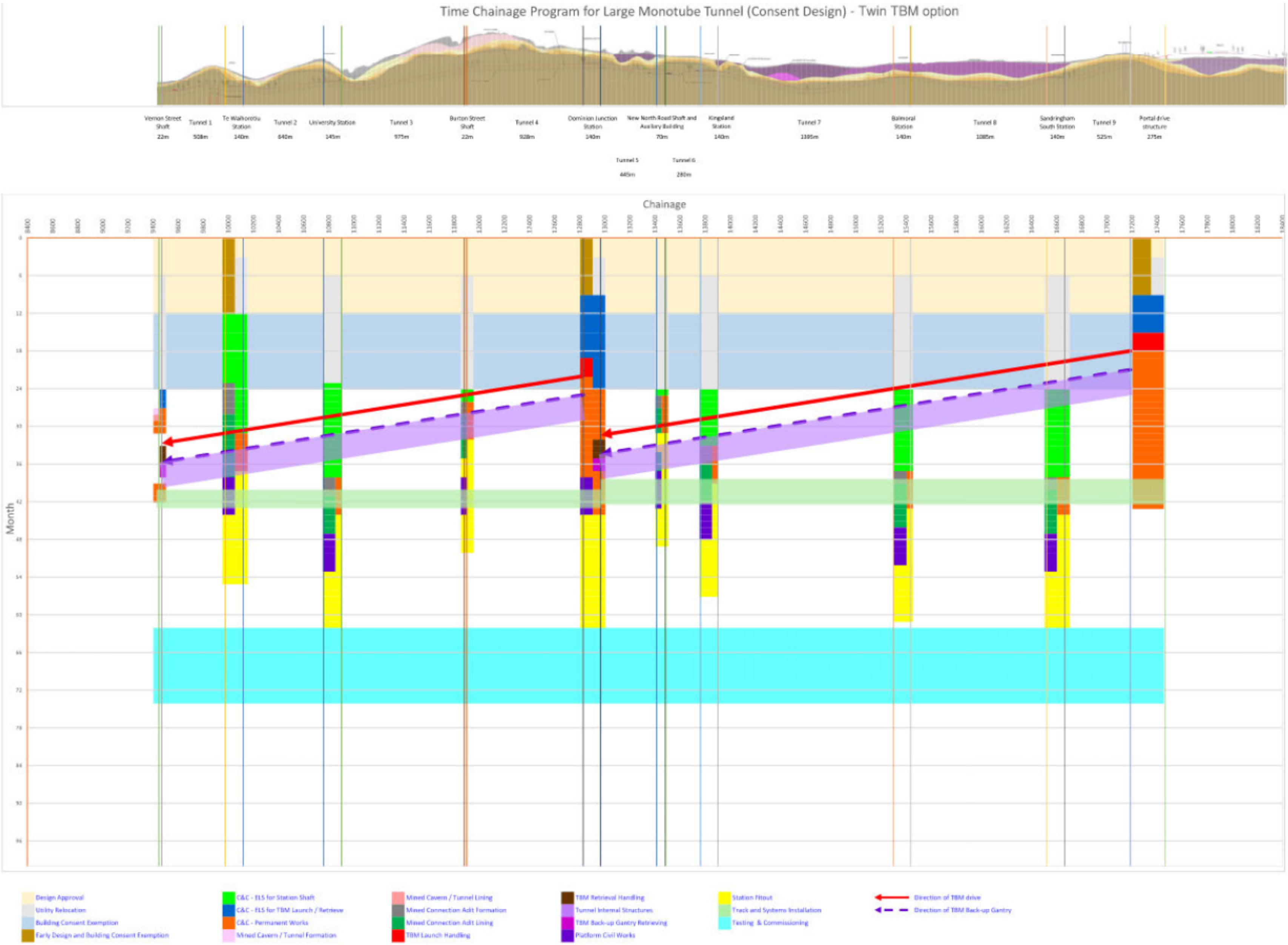
D&S show both options TBM drive in construction programme.

Two options for the TBM tunnel construction are shown below;

1. Single TBM drive northwards from Mt Albert Portal Dive Structure.
2. Concurrent Twin TBM drives northwards from Mt Albert Portal Dive Structure and Dominion Junction.

Time Chainage Program for Large Monotube Tunnel (Consent Design) - Single TBM option





Time Chainage Program for Large Monotube Tunnel (Consent Design) - Twin TBM option
Vernon Street Shaft 22m
Tunnel 1 508m
Te Waihorotiu Station 140m
Tunnel 2 640m
University Station 145m
Tunnel 3 975m
Burton Street Shaft 22m
Tunnel 4 928m
Dominion Junction Station 140m
New North Road Shaft and Auxiliary Building 70m
Kingsland Station 140m
Tunnel 7 1395m
Balmoral Station 140m
Tunnel 8 1085m
Sandringham South Station 140m
Tunnel 9 525m
Portal drive structure 275m
Tunnel 5 445m
Tunnel 6 280m
Chainage
Month
Design Approval
Utility Relocation
Building Consent Exemption
Early Design and Building Consent Exemption
C&C - ELS for Station Shaft
C&C - ELS for TBM Launch / Retrieve
C&C - Permanent Works
Mined Cavern / Tunnel Formation
Mined Cavern / Tunnel Lining
Mined Connection Adit Formation
Mined Connection Adit Lining
TBM Launch Handling
TBM Retrieval Handling
Tunnel Internal Structures
TBM Back-up Gantry Retrieving
Platform Civil Works
Station Fitout
Track and Systems Installation
Testing & Commissioning
Direction of TBM drive
Direction of TBM Back-up Gantry

5. Notice of Requirement methodology

5.1 Introduction

This section sets pit the general methodology used to define the NoR boundary for the different areas of the proposed alignment:

- Tunnel substratum
- Substratum Protection
- Stations
- Shafts
- Surface Rail
- Depot

5.2 NoR 1: Tunnel Substratum

5.2.1 Introduction

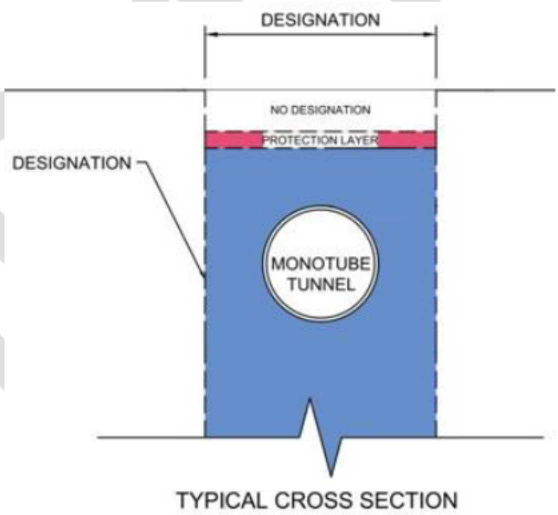


Figure 5-1 Typical Tunnel Substrata Designation

As shown in the Figure 5-1, the proposed land requirement for the monotube tunnel aspects of the ALR will follow the same approach that was taken for the CRL project.

The Substratum NoR has been determined to allow for safe construction and operation of ALR and includes reasonable spatial tolerances for:

- Design development, such as re-alignment within the proposed substrata boundaries.
- Excavation and support beyond the monotube tunnel for passenger/BoH and ventilation system shafts and adits.

From the surface, across the width of the Substratum NoR there will be a minimum 5m depth of strata that is unconstrained (i.e. no designation is proposed) in terms of loading and unloading changes and land-use generally, except three localised roads/streets (Queen Street, Wellesley Street West, Mt Albert Road) with shallow cover, where the unconstrained depth is 2m.

Above the substratum designation there will be a protection layer that varies depending upon the depth to the top of the sub-stratum designation. Physical incursion or loading changes within this protection layer would be subject to a detailed engineering review by ALR of the effects upon the ALR belowground structures.

No incursions inside the substratum designation would be allowed once it is properly confirmed.

Establishing such protection measures is necessary to manage the risks from investigation and construction activities of proposed developments on the operational railway.

It will be necessary to consider the following scenarios:

- Construction of the ALR prior to any adjacent development and what constraints (if any) the presence of ALR structures may present to adjacent land developers, and
- Construction of developments prior to construction of ALR.

The following principles arise:

- Development that occurs prior to tunnel construction must not place physical obstacles (such as foundations) in the path of the future tunnel, nor should any subsurface structures constructed disturb the ground to a degree whereby they introduce construction risks (it is assumed that new developments, because of building code compliance requirements are reasonably robust with respect to the effects of adjacent tunnelling).
- Development that occurs after the tunnel has been constructed should not damage the tunnels or reduce their durability, either by direct contact, or by inducing deformations.

For all future development more than five metres below Natural Ground Level, the detailed interaction between future buildings or structures and their potential impact upon ALR would need to be reviewed by ALR Limited, with the objective minimising risks to the operational railway but achieving the 'highest and best use' of the adjacent developments.

5.2.2 Identified Constraints

Table 5-1 summarises the constraints identified for the tunnel alignment.

Table 5-1 Summarised constraints for Tunnel Alignment

Constraint	Description
Freshwater Ecology	Oakley Creek is present in Walmsley and War Memorial parks. Consequently, it is vital to avoid impacts to Oakley Creek and minimise impacts within its margins. West of Sandringham Road has undergone restoration and naturalisation. East of Sandringham Road, Oakley Creek is concrete lined and presents an excellent restoration opportunity.
Built Heritage	There is a presence of historic air raid tunnels in Albert Park.
Construction Noise and Vibration	Tunnelling through basalt and tomo/caves must be avoided from Victoria Street to Kingsland and Kingsland to Mt Albert Road.
Volcanology	Volcanology constraints have been mapped for Victoria Street to Kingsland and Kingsland to Mt Albert Road.

Operational Noise and Vibration	From Victoria Street to Kingsland, the area of potential effects is approximately 80 to 100 metres either side of the tunnel. Consequently, a track form design-based mitigation is likely required through Aotea (theatres, etc.), University of Auckland (lab/studio) and Auckland City Hospital, Newmarket (tv/studios) and other places identified through the process. From Kingsland to Mt Albert Road, the area of potentially effects is also approximately 80 to 100 metres either side of the tunnel. Consequently, a track form design-based mitigation is likely required through Aotea (theatres, etc.), University of Auckland (lab/studio) and Auckland City Hospital, Newmarket (tv/studios) and other places identified through the process.
Blast Noise and Vibration	A geological assessment is required to identify the horizon of competent rock mass necessitating blasting. Subsequently, the rock level will be compared to the finished level of the station box. The proximity of commercial sensitive receivers will affect the scale of blasting that can be completed and provide acceptable fragmentation and diggability. Additionally, the proximity of busy roads potentially restrict the timing of blasts where there could be a requirement to temporarily close traffic. Residential properties along the northern side of Stoddard Road, Farrelly Avenue, Potter Avenue, Skeates Avenue and William Blofield Avenue and their proximity to the works would necessitate a lower vibration criterion than the commercial properties and potentially affect the scale of blasting. Finally, the proximity of Wesley Intermediate School on Sandringham Road adjacent to the excavation area would likely affect the time of blasting and likely prevent blasting during peak school times.
Landscape	The existing environment for this NoR boundary is predominantly residential with areas of business. However, the following matters are considered: • Public open space constraint (including community facilities) • Education – existing land use constraint
Stormwater and Hydrology	The alignment is located in a floodplain and flood prone area, with an overland flow of 35m³/s.
Social	The removal of housing will displace people from within the community, thus potentially impacting social cohesion. However, there is a potential for a positive outcome with intensive housing with Rapid Transit Network station and higher density. Additional constraints in the expanded area have been mapped. These constraints predominantly pertain to active and passive recreation, including play equipment, pump tracks, sports clubs and associated facilities. Some additional community/cultural facilities will also be affected.

5.2.3 Design development and response

The alignment design process commenced with the consideration of various station design options. Following confirmation of the station platform positions and the identification of potential alignment constraints represented by existing infrastructure (such as building basements and piles, Vector Tunnels, City Rail Link [CRL] Te Waihorotiu [Aotea] Station, Orakei Main Sewer, Central Motorway Junction [CMJ], CRL tunnels at Mount Eden and KiwiRail Western line and Kingsland Station) and geological features (such as lava caves). However, a general principle has been to maximise the alignment within road reserve.

Tunnel mainly bores through East Coast Bays Formation (ECBF) rock, underneath basalt (if any) with a minimum turning radius of R350m for TBM operation and maximum 6% grading in vertical alignment.

To allow flexibility on the future development above the proposed alignment, underground utilities maintenance and Waka Kotahi's road network, a minimum 5m depth of "No Designation" zone is proposed within the NoR boundaries. Three localised roads/streets (Queen Street, Wellesley Street West, Mt Albert Road) with shallow cover, have the 'No Designation' zone reduced to 2m because of localised site constraints. Figure 5-2 and 5-3 presents the typical substrata NoR boundary along the proposed tunnel alignment.

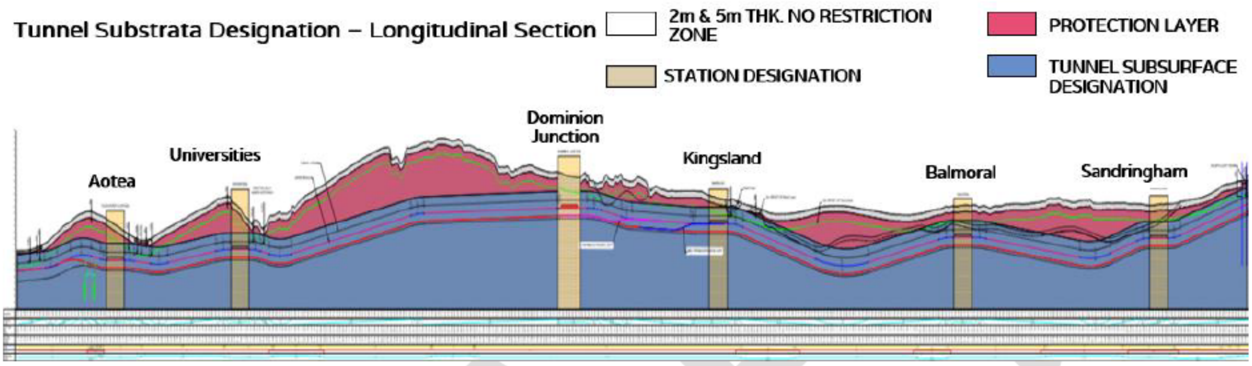


Figure 5-2 Typical Substrata NoR Boundary – Longitudinal Section

5.2.4 Construction methodology/constructability

Refer to sections 1.2.4, 2.5 and 3.3 for tunnel construction considerations.

5.3 NoR 2: Substratum Protection

5.3.1 Introduction

The basis of substrata protection boundaries is to cover the areas where future developments have the potential to adversely impact the performance of the support elements of underground infrastructure and operations of the planned light rail infrastructure. These limits are determined based on appreciation of general ground support principles (e.g. ground support to distribute loadings and for symmetry of loadings), design positioning tolerance and construction tolerance, including out of alignment and over-excavation.

Any proposed developments within the protection zone require an engineering assessment of the works to demonstrate that induced effects on the underground rail infrastructure are acceptable to ALR, in accordance with the performance requirements.

Consideration factors include potential stress and displacement influence zones, unloading, including out of balance ground movement, potential groundwater drawdown influence zone, and vibration influence zone, induced by future development.

5.3.2 Identified Constraints

The constraints for the substrata protection are as per the tunnel substratum (refer to the constraints mapping section in NoR 1).

5.3.3 Design development & response

As described in Section 5.2, there are three layers, "No Designation", "Protection Layer" and "Tunnel Subsurface Designation".

The "Tunnel Subsurface Designation" encompasses the ground that immediately surrounds the underground tunnel infrastructure. This zone represents the area that must not encroach upon by any future development and its construction. These limits are determined based on appreciation of general ground support principles (e.g. ground support to distribute loadings and for symmetry of loadings), design positioning tolerance and construction tolerance, including out of alignment and over-excavation.

The "Protection Layer" zone surrounds "Tunnel Subsurface Designation" and covers the areas where future developments have the potential to adversely impact on the performance of the support elements of underground infrastructure, operations or the feasibility of the planned ALR infrastructure. Any proposed developments within the "Protection Layer" require an engineering assessment of the works to demonstrate that induced effects on the underground rail infrastructure are acceptable to ALR, in accordance with the performance requirements. Consideration factors include potential stress and displacement influence zones, unloading, including out of balance ground movement, potential groundwater drawdown influence zone, and vibration influence zone, induced by future development.

The "No Designation" is a zone which is no restriction on the activities up to the "Protection Layer" zone. The depth of zone below Natural Ground Level (NGL) is determined by assessing the impacts to ALR tunnels due to the activities right above the tunnel or nearby, such as loading and unloading effects.

Generally, as shown in Figure 5-1, the proposed tunnel substrata designation layout has a minimum 5m depth of strata that is unconstrained (i.e. No Designation) with ground cover to tunnel crown equal to or more than 12m and total 28m in width (i.e. 7m between tunnel extrados and designation layout boundary).

The extents of the road corridor along Wellesley Street are less than 28m wide (i.e. less than 7m but more than or equal to 5m between tunnel extrados and designation layout boundary). A narrower tunnel designation, and protection layer have been adopted to keep the designation within the road corridor where possible. This reduces design flexibility in later project stages, however, reduces property impacts. Details are presented in Figure 5-3.

Additionally, a maximum 2m depth of unconstrained strata is arranged with ground cover to tunnel crown less than 12m, as described in Section 5.2.1. (Figure 5-3 and Figure 5-4).

Figure 5-3 Tunnel Substrata Designation – Victoria Street West to Queens Street (along Wellesley Street)

Figure 5-4 Tunnel Substrata Designation – Mount Albert Road

5.3.4 Construction methodology/constructability

Refer sections 1.2.4, 2.5 and 3.3 for tunnel construction considerations.

5.4 NoR 3: Te Waihorotiu Station

5.4.1 Introduction

The ALR Te Waihorotiu station will be a high patronage, underground, interchange station. It is situated in the city centre on Wellesley Street West adjacent to CRL Te Waihorotiu station: a busy, mixed-use environment that prioritises active and public modes of transport and has significant numbers of pedestrians. The surrounding area is not flat, with the ground rising to the west.

This station contains:

- An above ground station building on Wellesley Street
- Below ground station shaft and adits
- Two underground platforms
- Connection to CRL Te Waihorotiu station concourse

5.4.2 Identified Constraints

Table 5-2 summarises the constraints identified for Te Waihorotiu Station.

Table 5-2 Summarised constraints for Te Waihorotiu Station

Constraint	Description
Scheduled Trees	Three scheduled trees (liriodendron tulipifera) are located in proximity to the NoR on Mayoral Drive.
Built Heritage & Archaeology	Eight heritage buildings and two archaeological sites are located in proximity to the NoR boundary. The heritage buildings are likely to have shallow foundations. These will need to be considered in relation to which have the potential settlement and construction phase vibration impacts
Nearby buildings/sensitive receivers	The immediate area is characterised as a mixed-use environment with community facilities, many businesses, and current/planned residential activities.
Traffic	Mayoral Drive and Wellesley/Albert Street are identified arterial roads, with Federal Street a primary collector. Wellesley Street is planned to be used for public and active modes only in future.
Overland Flow Path	There is an identified overland flow path up to $0.5m^3/s$ on Wellesley Street.

5.4.3 Design development & response

Given its central location and intersection with the CRL Te Waihorotiu station, the station needs to cope with high patronage levels and bi-directional pedestrian flow. As part of the original design of the CRL Te Waihorotiu station, provision has been space proofed for future tunnels to connect under and integrate with the heavy rail network at this location.

The station has been designed to avoid the surrounding heritage buildings, thus it is a bespoke underground station design, not following the 'Kit of parts' approach. An underground mined adit connection from the station box to the monotube platform is required beneath Wellesley Street. Due to the depth of Bledisloe House foundations, this is longer in length than the other underground stations.

Accessibility to the station entry is critical and poses a significant constraint due to the steep grades at Wellesley Street and Mayoral Drive. The proposed station entry will require an area of appropriately sized "level" access (bespoke entrance shafts have been designed to suit). Bus stops may be relocated or added to provide better connections and a plaza adjacent to Mayoral Drive will provide sufficient space for pedestrians. Impacts on the street trees located on Wellesley Street will be minimised. One tree will be impacted by the temporary shaft located on Wellesley Street. Scheduled trees on Mayoral Drive will be impacted by construction works. Removal is recommended to improve spoil load out efficiency during shaft excavation.

The proposed design allows for a future over-station development. The station structure will need to avoid the existing CRL over site development (OSD) foundations to prevent loading issues.

5.4.4 Construction methodology/constructability

This section outlines the indicative construction sequencing assumed to inform the designation footprint for both the temporary construction works and the operational designation footprint. It also provides an outline of the range of durations for construction effects. This does not preclude construction activities occurring in another order or concurrently to complete the construction programme. The final construction sequence will be confirmed once a contractor is appointed and detailed design is complete.

The indicative staging of works include:

- Site preparation - including demolition, site clearance, utilities relocation/protection. Establish site offices, amenities, dewatering & sediment control systems. Protection/monitoring is to be installed to heritage buildings (Duration ~6+months).
- Install ground support to station perimeter–- anticipate bored secant piles or diaphragm walls. (Duration ~3-6 months).
- Excavation of station shaft. Propping & internal concrete wall lining. (Duration ~12+months).
- Mine adits to connect shaft to monotube tunnel, including the Wellesley Street shaft (Duration ~6+months).
- Connection to existing CRL Te Waihorotiu station.
- Station fitout (Duration ~8+ months).
- Upgrades and reinstatement to surrounding streetscape.

Standard hours of work for this site are anticipated to be 7am-6pm Mon-Sat. Any works outside of these hours will be notified and coordinated with impacted local residents.

The station construction support area will provide functions, as detailed in section 3.7.

The existing trees on Mayoral Drive require removal to facilitate site access and spoil removal.

Spoil will be removed from site by a large capacity truck and trailer or articulated truck units where possible. This offers much greater trucking efficiency and reduced traffic impacts than smaller six-wheeler earthmoving trucks.

Traffic management during construction will vary depending on the stage of construction. The Temporary Traffic Management (TTM) will set out proposed road closures. The guiding TTM philosophy is:

- Buses & general traffic

- Mayoral Drive - Maintain one lane minimum southbound. Western footpath closed.
- Wellesley Street - Maintain one lane minimum each direction on Wellesley Street. Note that the southern footpath will require closure for some duration of construction.
- Pedestrians & active transport modes
- Ensure sufficient pedestrian through-routes and access to the CRL Te Waihorotiu station is maintained.
- Construction traffic
- Full freedom site entrance and exit options onto Mayoral Drive and Wellesley St. Being able to turn large trucks either way gives more flexibility and efficiency on trucking spoil to tip sites, and minimising impact on inner city streets.
- Federal Street–- some short-term access will be required during utilities relocation, demolition and deliveries to site. Access is to be maintained at all times for businesses and residents on Federal Street.

The site's estimated construction traffic volumes are:

- Long term peak (one week + duration): 54 trucks/day (occurs during shaft excavation – duration ~12+ months).
- Short term peak (one day duration): 129 trucks/day (occurs during floor slab concrete pour).

5.5 NoR 4: Universities Station

5.5.1 Introduction

Universities station will be a high patronage, underground station. It is situated south-east of Symonds Street and Wellesley Street; a busy, mixed-use environment that prioritises active and public modes of transport. The station location reduces the station depth whilst allowing it to serve the University of Auckland and Auckland University of Technology. The surrounding area is not flat, with the ground rising to the west.

This station contains:

- An entrance plaza on Symonds Street
- An above ground station building adjacent to Wellesley Street
- A below ground station shaft and adits
- Two underground platforms
- Pedestrian connection to Symonds Street

5.5.2 Identified Constraints

Table 5-3 summarises the constraints identified for Universities station.

Table 5-3 Summarised constraints for Universities station

Constraint	Description
Scheduled trees	Two scheduled tree groups and trees at St Pauls Church could be impacted.
Built heritage	Nine Historic heritage buildings could be impacted.
Settlement Principles	Sensitive/heritage structures are supported by shallow foundations. Deep station/adits excavation and dewatering may reduce significant ground settlement/movement impacts on sensitive/heritage structures.
Blasting Noise and Vibration	The proximity to commercially sensitive receivers to works will affect the scale of blasting. Additionally, the proximity to busy roads will potentially restrict blast timings, due to requirements which could temporarily close traffic. The adjacent Auckland University of Technology could house highly sensitive technological equipment, thus potentially precluding blasting as an excavation method. The area occupied by pedestrians immediately adjacent to the excavation area would require temporary closure during blasting (likely outside of peak times). The proximity of sensitive receivers at the Universities would require strict control, thus impacting blast design and productivity. Finally, the proximity to Northwest Highway could impact scale of blasting pertaining to assurances against flyrock.
Structures	The station building is currently drawn over the University of Auckland's Security Control Room and is adjacent to Wellesley Station. Stations are also surrounded by high rise buildings (likely to have pile foundations) and low rise heritage buildings with shallow foundations. Construction vibration and settlement might impact surrounding buildings.
Archaeology	There is potential sub-surface evidence of two archaeological sites (buildings which appear to be demolished). Furthermore, there is a likely presence of Mana whenua and pre-1900 European archaeological sites. Finally, there are three additional Cultural Heritage Inventory (CHI) items.
Traffic	Wellesley Street and Symonds Street both have very high bus movements, with the former being the busiest destination station. High pedestrian movements around the site and new/upgraded road changes will be required. Due to high to very high pedestrian and cycle/micro mobility flows during

	university hours, sufficient space will be required around construction areas. Consequently, clearing footpaths for an extended period of time is unlikely to be viable.
Operational Noise and Vibration	Surface location(s) of mechplant/stair pressurisation fans/vent(s) have minimal apparent noise sensitive receivers in this location. University spaces (e.g., lab/studio) are susceptible to increased noise or/or vibration sensitivity.
Landscape	Station building locations and entrance opportunities are constrained. Consequently, the site on NE corner (University of Auckland land) is preferred for entry.

5.5.3 Design development & response

Given its catchment includes the University of Auckland and Auckland University of Technology, the station needs to cope with high patronage levels and significant numbers of pedestrians. It also should allow for a future over-station development.

The station has been designed to avoid the heritage buildings, apartment towers and St. Paul's Church. Bus stops may be relocated or added to provide better connections. A plaza adjacent to Symonds Street will provide connectivity to the station entrance to the east, downhill, and adjacent to the end of Whitaker Place.

5.5.4 Construction methodology/constructability

This section outlines the indicative construction sequencing assumed to inform the designation footprint for both the temporary construction works and the operational designation footprint. It also provides an outline of the range of durations for construction effects. This does not preclude construction activities occurring in another order or concurrently to complete the construction programme. The ultimate construction sequence will be confirmed once a contractor is appointed and detailed design is complete.

The indicative staging of works: include:

- Site preparation, including demolition, site clearance, utilities relocation/protection. Establish site offices, amenities, dewatering & sediment control systems. Protection/monitoring is to be installed to heritage buildings.
- Install ground support to station perimeter–- anticipated bored secant piles or diaphragm walls.
- Excavation of station shaft.
- Mine adits to connect shaft to monotube tunnel.
- Station fitout.

Standard hours of work for this site are anticipated to be 7am-6pm Mon-Sat. Any works outside of these hours will be notified and coordinated with impacted local residents.

The construction support area will provide functions, as detailed in section 3.7.

The site topography requires extensive perimeter walls and earthworks to create two level platforms at the upper and lower platform. The upper platform provides space for construction facilities and access to install the over-site foundation piles. The lower platform is required to facilitate construction of the main station shaft. Additionally, the construction site footprint requires temporary closure of the existing shared-use path and creation of a permanent cul-de-sac at the end of Whitaker Place.

Construction traffic requirements for this site include:

- Provide a temporary site access point from the SH16 offramp.

- Provide a permanent site access and exit point from/to Wellesley Street.
- Have full freedom site exit options onto Wellesley St–- being able to turn large trucks either way gives more flexibility and efficiency on trucking spoil to tip sites, whilst minimising impact on inner city streets.

Estimated construction traffic volumes are:

- Long term peak (one week+ duration): 27 trucks/day (occurs during shaft excavation).
- Short term peak (one day duration): 129 trucks/day (occurs during floor slab concrete pour).

There will be careful transport management during construction to ensure sufficient access to CRL station, businesses and residents on Federal Street. Construction traffic will be able to access the site from Mayoral Drive or Wellesley Street, although there will be some lanes maintained for buses and general traffic.

5.6 NoR 5: Dominion Junction Station

5.6.1 Introduction

Dominion Junction Station will be an underground station, situated adjacent to Dominion Road and New North Road. It currently has poor pedestrian and cycle connectivity due to the existing road network, which includes a multi-level grade separated road junction – constructed in the 1960s for a proposed motorway that did not eventuate.

This station contains:

- An above ground station building adjacent Dominion Road and New North Road
- Below ground station box
- Two underground platforms
- Road reconfiguration to an at-grade intersection to provide accessibility and connectivity

5.6.2 Identified Constraints

Table 5-4 summarises the constraints identified for Dominion Junction station.

Table 5-4 Summarised constraints for Dominion Junction station

Constraint	Description
Built Heritage	A better understanding of consent design is required to either remove, partially remove or go underneath nearby heritage buildings identified (Bridgens and Company Shoe Factory [former: Cat B]).
Blasting Noise and Vibration	Basalt issues on the site require a geological assessment to identify the horizon of competent mass necessitating blasting. Proximity of commercially sensitive New North Road receivers will affect the scale of blasting that can be completed and provide acceptable fragmentation and diggability. A lower blast threshold than applicable for buildings and amenity would be necessary for businesses that could potentially contain sensitive equipment. The proximity of busy roads potentially restrict the timing of blasts where there could be requirements to temporarily close traffic. Residential properties along multiple streets necessitate a lower vibration criterion than commercial properties, thus potentially affecting the scale of blasting. Furthermore, the proximity of pedestrian walkways immediately adjacent to the excavation area would require temporary closure at the time of blasting and likely prevent blasting during peak times.
Stormwater and Hydrology	The eastern and western ends of the site have been Identified as flood prone with overland flows of 5.7m³/s (2-yr) to 18.6m³/s (100-yr). Consequently, the site is at risk of potentially catastrophic flooding.
Volcanology	The site location lies on the medial slopes of a basalt lava field that extends eastward from Maungawhau/Mount Eden volcano (noting that any excavation would involve basalt rock). Consequently, possible constraints arise if the volcano viewshafts are compromised.
Operational Noise and Vibration	The surface locations of mechanical plant/stair pressurisation fans/vents should avoid adjacency to sensitive receivers and residential properties to the south. Any television/radio studios with sensitivity must be considered.
Construction Noise and Vibration	Construction noise will impact nearby residential receivers. A work site layout must be designed which minimises potential night-time noise effects to apartments and standalone houses. Proactive planning is required to reduce the disruption of basalt piling adjacent to Fenton

	Street. Additionally, high noise and vibration construction near apartments/nearby offices must be minimised where practicable. Vibration is not predicted to be a significant constraint at Dominion Junction.
Arboriculture	49 trees on Wynyard Road, Brentwood Avenue and Wrights Spur and four groups of trees west of Dominion Road might be impacted by ALR works. Trees should be avoided where possible.
Traffic	The form of the new intersection to replace the flyover interchange must prioritise walking, cycling and bus amenities. Additionally, this intersection shouldn't necessarily provide enough lanes to make the intersection work purely from a transport capacity perspective. The current amenity for active road trips in the vicinity of the Dominion/New North flyovers/underpasses is very poor. ALR proposes to replace the flyover interchange with a smaller at grade intersection to improve amenity. This will require careful planning/staging and temporary works to adequately accommodate traffic and active modes. Any new at grade intersection must be cognisant of gradient/clearance issues, to allow road to pass over rail. The new station must allow bus stops on New North Road, as close as practicable to the station entrance. Finally, the replacement of flyover interchange with at grade signals will allow the potential closure of George Street level crossing.
Settlement Principles	The majority of the structures within the NoR boundary are low rise commercial buildings founded on shallow pads/footings. The potential for adverse effects arising will be presented in the NoR as a settlement contour.
Structures	The station is surrounded by low rise buildings, some of which may be founded on shallow footings. This could have construction settlement and vibration impacts on the buildings.

5.6.3 Design development & response

Given its location, significant changes are required to provide accessibility and connectivity, which is achieved via reconfiguring the Dominion Road – New North Road intersection to be at-grade. The station should also allow for a future over-station development.

The station is accessed via a plaza adjacent to the at-grade intersection, and bus stops will be relocated to provide improved connections.

5.6.4 Construction methodology/constructability

This section outlines the indicative construction sequencing assumed to inform the designation footprint for both the temporary construction works and the operational designation footprint. It also provides an outline of the range of durations for construction effects.

This does not preclude construction activities occurring in another order or concurrently to complete the construction programme. The ultimate construction sequence will be confirmed once a contractor is appointed and detailed design is complete.

The Dominion Junction site comprises of two key elements:

- The cut & cover station box – which also serves as a central node for the ALR tunnelling operations;
  - Launch site for the northern TBM (24/7 operation at this site for duration of northern tunnelling).
  - Retrieval site for the southern TBM.

- Intersection upgrades – The surrounding area also requires significant surface works to remove the existing segregated interchange and construct a new level intersection. This will include temporary road layouts to enable demolition and construction activities to be undertaken safely while minimising impacts on traffic flows.

The sequence of these activities is yet to be determined, however the indicate staging is set out below.

The station and road realignment sites are currently occupied by industrial and commercial buildings. Initial site preparation activities will include:

- Noise, vibration and settlement monitoring of any particularly sensitive heritage buildings.
- Utilities protection/relocation.
- Demolition of existing buildings.
- Site clearance and installation of site offices/amenities.
- This will require careful planning and sequencing to minimise impacts on neighbouring properties and traffic.

5.6.4.1 Indicative staging of the works:

Station & Tunnelling

The indicative staging of works include:

1. Demolition, site clearance, utilities relocation/protection. Establish site offices, amenities, dewatering & sediment control systems. Protection/monitoring is to be installed to sensitive neighbouring buildings (*Duration ~3~6 months).*
2. Install ground support to station perimeter – details to be confirmed. Anticipated either bored secant/spaced piles, or D-wall with underlying rock cutting/anchoring (*Duration ~3-6 months).*
3. Excavation of station shaft. Propping & internal concrete wall lining. Top down methodology to accommodate tunnelling activities *(Duration ~12+months).*
4. Tunnelling activities
    1. Southern TBM retrieval
    2. Northern TBM launch & tunnelling support activities *(Duration ~12-24+ months).*
5. Station fitout *(Duration ~8+ months)*
6. Station OSD (TBC)
7. Upgrades and reinstatement to surrounding streetscape *(Duration ~3 months)*

Standard hours of work for this site will be:

- 24/7 for the duration of the northern TBM tunnelling activities.
- 7am-6pm Mon-Sat for other construction activities. Any works outside of these hours will be notified and coordinated with impacted local residents.

Intersection Upgrades

The indicative construction sequence for the intersection upgrades activities includes:

1. Buildings demolition, site clearance, utilities relocation/protection. Establish site offices, amenities, dewatering & sediment control systems. Protection/monitoring is to be installed to sensitive neighbouring buildings (*Duration ~3-6 months).*
2. Construction of temporary traffic lanes to divert traffic flows around construction areas *(Duration ~2-6 months depending on staging selected).*
3. Demolition of the existing flyover and bridges *(Duration ~2-12 months, depending on level of traffic closures approved).*
4. Construction of a new level interchange, including reinstatement to surrounding streetscapes *(Duration ~6-18 months, depending on level of traffic closures approved).*

Standard hours of work for the intersection upgrades are anticipated to be 7am-6pm Mon – Sat.

Some works will be required to occur at night or over extended weekend/holiday closures, particularly the flyover and bridge demolition activities. Any works outside of the regular hours will be notified and coordinated with impacted local residents.

5.6.4.2 Earthworks and Spoil Disposal

Station & Tunnelling

The station and tunnel earthworks will comprise of the following stages.

1. **Excavation for temporary ground support structure** – removal of excavated material during installation of ground support. (Anticipated either bored secant/spaced piles, or D-wall with underlying rock cutting/anchoring. Down the hole hammer methodology anticipated if piling through basalt layers.)
2. **Shaft excavation**
   The existing fill and ECBF material will be excavated using medium-large excavators within the shaft. Basalt will be removed using a combination of blasting and breaking. Spoil will be loaded into a crane skip and transported to the surface. It will then be loaded either directly into trucks, or into a surge pile for later removal.
3. **TBM tunnelling** – spoil will be transported from the tunnelling face by a conveyor and separated into muck bays for grading/drying prior to being loaded onto trucks for removal from site.

Intersection Upgrades

Demolition of impacted buildings, the flyover and bridges will generate some traffic during removal of construction debris.

Construction of the new road will require excavation to subgrade level and removal of unsuitable material, importation of roading aggregate and surfacing material.

5.6.4.3 Construction Traffic

The required site boundaries and temporary traffic management footprints will vary depending on the stage of construction.

Pedestrian management will be a high priority as the adjacent CRL Mt Eden station will be functional during construction.

Station & Tunnelling

- Estimated construction traffic volumes during station construction:

- Long term peak (1 week + duration): 54 trucks/day (occurs during shaft excavation)
- Short term peak (1 day duration): 129 trucks/day (occurs during floor slab concrete pour)

Intersection Upgrades

The temporary traffic management guiding philosophy is currently to maintain one lane of traffic in all directions whenever practicable.

Some stages may require full closure of traffic lane(s) for specific works to be completed safely and efficiently. In these cases, the timing and duration of the works will be coordinated with the Road Controlling Authority and notified to the public to minimise disruption. Examples of this include:

- Night works closures (activities which can be completed in a single shift).
- Weekend/holiday closures (activities lasting several days). This may be required during some stages of the flyover demolition process.
- Longer term closures – may be available if significant programme or cost advantage scan be demonstrated. Opportunities are yet to be confirmed at this stage.

Peak construction traffic movements are anticipated during the demolition and backfill phases, with up to ~50 truck movements per day.

5.7 NoR 6: Kingsland Station

5.7.1 Introduction

Kingsland station will be an underground, interchange station. It is situated between the KiwiRail corridor, New North Road and Sandringham Road: an environment that prioritises active and public modes of transport. The surrounding area rises to the north of the KiwiRail corridor.

This station contains:

- An above ground station building on Sandringham Road
- A below ground station shaft and adits
- Two underground platforms
- A plaza on New North Road, connected to the station via a pedestrian bridge over the KiwiRail corridor.

5.7.2 Identified Constraints

Table 5-5 summarises the constraints identified for Kingsland station.

Table 5-5 Summarised constraints for Kingsland station

Constraint	Description
Arboriculture	Street trees and privately owned trees within the site vicinity might be impacted by works however there are no scheduled trees within the NoR boundary.
Built Heritage	Portland Buildings, Page's Grain & Forage Store and Kingsland post office (former) might be impacted by the works.
Archaeology	Kingsland Train Station has been heavily modified, however it is possible there are some structural components still existing. Additionally, there is a dry stonewall and midden within the site vicinity. It Is to be noted that any potential pre-1900 houses to be demolished within Sandringham Road require archaeological authority.
Blasting Noise and Vibration	A geological assessment is required to identify the horizon of competent rock mass necessitating blasting. Given the proximity of commercially sensitive receivers off New North Road, it is likely the scale of blasting will provide for acceptable fragmentation and diggability.
Stormwater and Hydrology	The Kingsland site is affected by floodplains, and overland flowpaths between 1.0m³/s and 2.9m³/s. However, flood risks can likely be managed within the site using standard design methods to keep effects to a minimum.
Construction Noise and Vibration	It is assumed that a block of dwellings will be demolished to establish the worksite. Additionally, the Kingsland site is close to many residential dwellings in Sandringham Road, which will likely be affected by construction noise and vibration. Construction noise from sheet/impact piling can be a potential issue due to proximity. Rock breaking is not likely to be an issue, as noise barriers can be used to mitigate effects. Furthermore, construction vibration issues are unlikely due to distance. Night works and high noise and vibration construction methods are to be avoided and minimised

	respectfully. In order to mitigate these effects, prior communications with nearby households and commercial businesses nearby will be pertinent.
Traffic	New North Rd and Sandringham Rd are both arterial roads with high bus flows, with each carrying approximately 20,000 vehicles per day. The New North/ Sandringham/Bond intersection is a local constraint, with the speed limit expected to be 30 km/h through the town centre. Additionally, crowd management and construction staging is necessary to accommodate for approximately 20,000 Eden Park patrons who might use ALR and Western Line Stations pre- and post-match. Furthermore, construction staging must also be cognisant of Eden Park Patrons accessing the existing stations, buses and town centre. Finally, AT's Connected Communities project proposes a protected two way cycle path on the north side of New North Rd, (reducing capacity at New North/Sandringham) plus additional bus priority.
Landscape	The general station location is well suited, with the identified teardrop-shaped area of land bound by rail line and Sandringham Road offering an opportunity to achieve interchange function in a location also having potential to achieve good connections to both Kingsland centre to north and Eden Park and surrounding residential streets to the south. Further development of a station in this location would ideally have the following characteristics: • Direct, legible and high-quality north-south linkages to New North Road (Kingsland centre). • High visibility and frontage to Sandringham Road. • Potential entry at corner on sightline of Sandringham and Walters Road aligning and connecting to links to New North Road via Edendale Road. • Shape factor that maximises re-development potential of residual land as well as catalyses further redevelopment potential of the surrounding area. • Potential for adverse effects on villa and bungalow streets to south (Sandringham and Walters Roads) but also potential opportunity for integrated redevelopment of some of this area that addresses existing amenity issues and may enhance overall integration of ALR. • No natural character effects.
Settlement Principles	The majority of the structures within the NoR boundary extent are low rise residential and commercial buildings founded on shallow pads/footings. The potential for adverse effects arising from settlement will be presented in NoR as a predicted settlement contour.

5.7.3 Design development and response

Given its location, the station needs to cater to higher patronage levels during event mode at Eden Park and provide quality connections to KiwiRail Kingsland station and New North Road.

The station has been designed to avoid the existing KiwiRail Kingsland station. A new pedestrian bridge provides an interchange with KiwiRail and connection to New North Road. Bus stops may be relocated or added to provide better connections. A large plaza adjacent to Sandringham Road will provide space for pedestrians.

5.7.4 Construction methodology/constructability

This section outlines the indicative construction sequencing assumed to inform the designation footprint for both the temporary construction works and the operational designation footprint. It also provides an outline of the range of durations for construction effects. This does not preclude construction activities occurring in another order or concurrently to complete the construction programme. The ultimate construction sequence will be confirmed once a contractor is appointed and detailed design is complete.

The indicative staging of works include:

- Site preparation – including demolition, site clearance, utilities relocation/protection. Establish site offices, amenities, dewatering & sediment control systems. Protection/monitoring is to be installed to heritage buildings (*Duration ~3-6+months).*
- Install ground support to the station perimeter–- anticipated bored secant or spaced piles (*Duration ~3-6 months).*
- Excavation of station shafts. Propping & internal concrete wall lining *(Duration ~12+months).*
- Mine adits to connect shaft to monotube tunnel *(Duration ~4-6 months).*
- Station fitout *(Duration ~8+ months).*
- Station above ground structure and footbridge over rail corridor *(Duration ~4-6 months).*
- Station OSD
- Upgrades and reinstatement to surrounding streetscape to enhance pedestrian access to the station and connection to Eden Park *(Duration ~3 months).*

Standard hours of work for this site are anticipated to be 7am-6pm Mon-Sat. Any works outside of these hours will be notified and coordinated with impacted local residents.

The station construction support area will provide functions as detailed in section 3.7.

The station site is currently occupied by residential housing and several small commercial buildings. Initial site preparation activities will include:

- Install noise, vibration and settlement monitoring to adjacent heritage buildings and other relevant sensitive receivers.
- Utilities protection/relocation.
- Demolition of existing buildings.
- Site clearance and installation of site offices/amenities.

This will require careful planning and sequencing to minimise impacts on neighbouring properties and traffic.

The required footprint will vary depending on the stage of construction. The TTM closure footprint on Sandringham and New North Roads may be reduced during some stages if suitable. The temporary traffic management guiding philosophy is:

- Sandringham Road – Maintain one lane minimum each direction. Note that the northern footpath will require closure for most of the construction duration.
- New North Road – A shoulder closure or contraflow will be required during some stages of construction of the site north of the new footbridge.

Pedestrian management will be a high priority as the adjacent heavy rail station will be functional during construction. There will also be crowd control considerations during events at Eden Park. Estimated construction traffic volumes are:

- Long term peak (one week+ duration): 27 trucks/day (occurs during shaft excavation)
- Short term peak (one day duration): 129 trucks/day (occurs during floor slab concrete pour)

5.8 NoR 7: Balmoral/St Lukes Station

5.8.1 Introduction

Balmoral/St Lukes station will be an underground station. It is situated adjacent to Sandringham Road. The surrounding ground is relatively flat.

This station contains:

- An above ground station building
- Below ground station shafts and adits
- Two underground platforms

5.8.2 Identified Constraints

Table 5-6 summarises the constraints identified for Balmoral/St Lukes station.

Table 5-6 Summarised constraints for Balmoral/St Lukes station

Constraint	Description
Blasting Noise and Vibration	A geological assessment is required to identify the horizon of competent rock mass necessitating blasting. Subsequently, the rock level will be compared to the finished level of the station box. The proximity of the commercial Shopping Centre at St. Lukes Road could affect the scale of blasting that can be completed and provide acceptable fragmentation and diggability. Residential properties along Balmoral Road, Grove Road, Patterson Street, Lancing Road and Watson Avenue would necessitate a lower vibration criterion than the commercial properties and potentially affect the scale of blasting. Additionally, the proximity of busy roads could potentially restrict the timing of blasts where there could be a requirement to temporarily close traffic. Finally, the proximity of Mount Albert Grammar School on Alberton Avenue adjacent to the excavation area would likely affect the time of blasting and likely prevent blasting during peak school times.
Stormwater and Hydrology	Floodplain and overland flow must be avoided where possible. Additionally, Water Sensitive Urban Design (WSUD) drainage mitigation measures will be required.
Volcanology	TBM tunnelling might be impacted by localised basalt.
Social	The church, Early Childhood Centre and Plunket Centre might be impacted by works, thus potentially disrupting social cohesion. Furthermore, construction works will impact all residents, in addition to potentially displacing some residents due to loss of residential properties. Finally, access to bus stops on Sandringham Road (8312 and 8309), and reliability of public transport when traffic changes will create delays during construction.

5.8.3 Design development & response

The station needs to provide quality connections to Sandringham Road and to the west toward St Lukes shopping precinct. The station should also allow for future adjacent development.

The station has been designed to connect to Sandringham Road whilst being compatible with a rail alignment that has the TBM tunnel predominantly below the basalt. Surface works provide connectivity towards St Lukes, and bus stops may be relocated or added to provide better connections.

5.8.4 Construction methodology/constructability

This section outlines the indicative construction sequencing assumed to inform the designation footprint for both the temporary construction works and the operational designation footprint. It also provides an outline of the range of durations for construction effects. This does not preclude construction activities occurring in another order or concurrently to complete the construction programme. The ultimate construction sequence will be confirmed once a contractor is appointed and detailed design is complete.

The indicative staging of works include:

- Site preparation, including demolition, site clearance, utilities relocation/protection. Establish site offices & amenities.
- Install ground support to station shafts perimeter–- anticipated bored or DTH secant pile walls (pending basalt depth confirmation)
- Excavation to station shafts – anticipate blasting for basalt.
- Mine adits to connect shaft to monotube tunnel.
- Station internal construction and fitout.
- Surface buildings and streetscaping.

Standard hours of work for this site are anticipated to be 7am-6pm Mon-Sat. Any works outside of these hours will be notified and coordinated with impacted local residents.

The station construction support area will provide functions as detailed in section 3.7.

The station site is currently occupied by residential housing and a petrol station. Initial site preparation activities will include:

- Install noise, vibration and settlement monitoring to adjacent sensitive receivers.
- Utilities protection/relocation.
- Demolition of existing buildings. It is yet to be confirmed if the petrol station on the corner of Sandringham & Balmoral Roads is to be removed or retained. Impacts are to be assessed for both cases.
- Site clearance and installation of site offices/amenities.

This will require careful planning and sequencing to minimise impacts on neighbouring properties and traffic.

Site access points will be provided from Balmoral Road, Sandringham Road and Lancing Road. Estimated construction traffic volumes are:

- Long term peak (one week+ duration): 26 trucks/day (occurs during shaft excavation)
- Short term peak (one day duration): 129 trucks/day (occurs during floor slab concrete pour)

5.9 NoR 8: Sandringham Station

5.9.1 Introduction

Sandringham station will be an underground station. It is situated at the southern end of the Sandringham village precinct. The surrounding ground is relatively flat.

This station contains:

- An above ground station building
- Below ground station shafts and adits
- Two underground platforms

5.9.2 Identified Constraints

Table 5-7 summarises the constraints identified for Sandringham station.

Table 5-7 Summarised constraints for Sandringham station

Constraint	Description
Built Heritage	One scheduled Cat B building could be affected by works.
Construction Noise and Vibration	Care is to be taken during demolition/construction of any vibration sensitive heritage or other buildings.
Blasting Noise and Vibration	A geological assessment is required to identify the horizon of competent rock mass necessitating blasting. Subsequently, the rock level will be compared to the finished level of the station box. Key commercial facilities along Sandringham Road should be identified to confirm there is no equipment for activities that would necessitate a more stringent vibration criterion than applied for building protection or amenity. The proximity of busy roads potentially restricts the timing of blasts where there could be a requirement to temporarily close traffic. Residential properties along Calgary Street, Carrie Street, Kitchener Road, Haverstock Road, Lambeth Road, Harwood Street and Halesowen Avenue and their proximity could necessitate a lower vibration criterion than the commercial properties and potentially affect scale of blasting.
Stormwater and Hydrology	The floodplain located within the NoR boundary has been mapped. Above ground infrastructure shown within a significant 100yr Average Recurrence Interval (ARI) flood prone area is to be avoided. Additionally, above ground infrastructure located within the significant Meola floodplain is to be avoided.
Arboriculture	Multiple street trees could be affected by works. Tree removal may be necessary where the access and egress to and from the work site on Lambeth Road and Harwood Road conflicts with tree locations. Additionally, tree alteration (i.e. pruning) may be required to facilitate the works, however it is expected that adverse effects can be managed through the tree management plan.
Traffic	Sandringham Road is an arterial road with moderate bus movements. Additionally, the site hosts a busy walking area around the town centre. The closure of Harwood street will require a new link road to Parry Street.

5.9.3 Design development and response

Given its central location, the station needs to be designed to cope with relatively high bus interchanges. The station should also allow for future adjacent development.

The station has been designed to reduce impacts to surrounding land use, which is achieved by an elevated station and realignment of Sandringham Road. Bus stops may be relocated or added to provide better connections. A plaza adjacent to Sandringham Road will provide sufficient space for pedestrians.

5.9.4 Construction methodology/constructability

This section outlines the indicative construction sequencing assumed to inform the designation footprint for both the temporary construction works and the operational designation footprint. It also provides an outline of the range of durations for construction effects. This does not preclude construction activities occurring in another order or concurrently to complete the construction programme. The ultimate construction sequence will be confirmed once a contractor is appointed and detailed design is complete.

The indicative staging of works include:

- Site preparation, including demolition, site clearance, utilities relocation/protection. Establish site offices & amenities.
- Install ground support to station shafts perimeter– anticipated bored or DTH secant pile walls (pending basalt depth confirmation).
- Excavation to station shafts – anticipate blasting for basalt.
- Mine adits to connect shaft to monotube tunnel.
- Station internal construction and fitout.
- Surface buildings and streetscaping.

Standard hours of work for this site are anticipated to be 7am-6pm Mon-Sat. Any works outside of these hours will be notified and coordinated with impacted local residents.

The station construction support area will provide functions as detailed in section 3.7.

The station site is currently occupied by residential housing. Initial site preparation activities will include:

- Install noise, vibration and settlement monitoring to adjacent sensitive receivers.
- Utilities protection/relocation.
- Demolition of existing buildings.
- Site clearance and installation of site offices/amenities.

This will require careful planning and sequencing to minimise impacts on neighbouring properties and traffic.

Site access points will be provided from Sandringham Road, Lambeth Drive and Harwood Street.

- Estimated construction traffic volumes:
  - Long term peak (one week+ duration): 26 trucks/day (occurs during shaft excavation)
  - Short term peak (one day duration): 129 trucks/day (occurs during floor slab concrete pour)

5.10 NoR 9: Wesley Station

5.10.1 Introduction

Wesley station will be an elevated station. It is situated on the north east side of Sandringham Road and Stoddard Road. The surrounding area is relatively flat.

This station contains:

- An aboveground station on Sandringham Road
- Two elevated platforms

5.10.2 Identified Constraints

Table 5-8 summarises the constraints identified for Wesley station.

Table 5-8 Summarised constraints for Wesley station

Constraint	Description
Freshwater Ecology	Oakley Creek is present in Walmsley and War Memorial Parks. It is important to avoid impacts on Oakley Creek and minimise impacts within its margins. It is to note that the area west of Sandringham Road has undergone restoration and naturalisation. East of Sandringham Road, the Creek is concrete lined and presents an excellent restoration opportunity.
Blasting Noise and Vibration	A geological assessment is required to identify the horizon of competent rock mass necessitating blasting. Subsequently, the rock level will be compared to the finished level of the station box. The proximity of commercial sensitive receivers will affect the scale of blasting that can be completed and provide acceptable fragmentation and diggability. Additionally, the proximity of busy roads potentially restrict the timing of blasts where there could be a requirement to temporarily close traffic. Residential properties along the northern side of Stoddard Road, Farrelly Avenue, Potter Avenue, Skeates Avenue and William Blofield Avenue and their proximity to the works would necessitate a lower vibration criterion than the commercial properties and potentially affect the scale of blasting. Finally, the proximity of Wesley Intermediate School on Sandringham Road adjacent to the excavation area would likely affect the time of blasting and likely prevent blasting during peak school times.
Landscape	No hard constraints have been identified, the existing environment for this NoR boundary is predominantly residential with areas of business. However, the following matters are considered: Public open space constraint (including community facilities) Education – existing land use constraint State Highway corridor/severance constraint
Stormwater and Hydrology	Various sources of flooding are present for this station location (the station is located in a floodplain and flood prone area and overland flow–- 35m³/s). The station is located adjacent to an unnamed watercourse which may also be a source of additional flooding, but further information will be required to conduct a more in-depth assessment.
Social	The removal of housing will displace people from within the community, thus potentially impacting social cohesion. However, there is a potential for a positive outcome with intensive housing with Rapid Transit Network (RTN) station and higher density.

Parks and Open Spaces	Two public open spaces are within the NoR boundary; Mount Roskill War Memorial Park and Walmsley Park and may be impacted by the works. Mount Roskill War Memorial Park is a high use suburb park that provided for a wide range of recreational and community activities, including sports, community markets and activities at the community centre and youth zone, natural and cultural values.
Traffic	Stoddard and Sandringham are both arterial roads with high bus movements. Consequently, the cut and cover beneath Stoddard Road is likely to have moderate to major traffic effects. Furthermore, the station requires an integrated bus terminus, noting very high forecasted interchange movements.

5.10.3 Design development & response

Given its central location, the station needs to cope with relatively high bus interchanges. The station should also allow for future adjacent development.

The station has been designed to reduce impacts to surrounding land use, which is achieved by an elevated station and realignment of Sandringham Road. Bus stops may be relocated or added to provide better connections. A plaza adjacent to Sandringham Road will provide sufficient space for pedestrians.

5.10.4 Construction methodology/constructability

This section outlines the indicative construction sequencing assumed to inform the designation footprint for both the temporary construction works and the operational designation footprint. It also provides an outline of the range of durations for construction effects. This does not preclude construction activities occurring in another order or concurrently to complete the construction programme. The ultimate construction sequence will be confirmed once a contractor is appointed and detailed design is complete.

The indicative staging of works include:

- Site preparation–- including demolition of site clearance, utilities relocation/protection. Establish site offices, amenities, dewatering & sediment control systems. Install monitoring to neighbouring buildings if required.
- Realign Sandringham Road to the new western alignment.
- Install viaduct pile foundations and pile caps.
- Construct in-situ viaduct piers and headstocks.
- Lift in precast viaduct beams using mobile crane (where space permits), or self-launching gantry in tight sections.
- Place in-situ concrete topping to viaduct deck and install edge barriers.
- Station fitout & tracks installation.
- Construct bus interchange adjacent to station.
- Streetscape reinstatement and upgrades to local roads to enhance pedestrian access to the station.

Standard hours of work for this site are anticipated to be 7am-6pm Mon-Sat. Any works outside of these hours will be notified and coordinated with impacted local residents.

The station construction support area will provide functions as detailed in section 3.7.

Initial site preparation activities will include:

- Install noise/vibration/settlement monitoring to neighbouring buildings if required.
- Utilities relocation/protection.
- Demolition & site clearance.
- Establish site offices, amenities, laydown areas, dewatering & sediment control systems.

Peak traffic movements will depend on the number of open excavation/demolition work fronts at any one time. The peak truck movements anticipated for any one particular site access point are anticipated to be in the order of ~40 trucks/day.

5.11 NoR 10: Shafts – Vernon Street, Burton Street and New North Road

5.11.1 Introduction

To support the tunnel ventilation, emergency intervention and maintenance access, auxiliary shafts are required across the tunnel route. These are provided at:

- Vernon Street, Victoria Park
- Burton Street, Grafton
- New North Road Shaft and Auxiliary Building, Kingsland

5.11.2 Identified Constraints

Table 5-9 summarises the constraints identified for Vernon Street Shaft.

Table 5-9 Summarised constraints for Vernon Street Shaft station

Constraint	Description
Arboriculture	A notable tree group identified in the north-western portion of the shaft site, one notable tree in the immediate west and four trees located within the Burton Street shaft site could be affected by works.
Built Heritage	The Drake Pub is a scheduled Historic Place that could be affected by works. Additionally, several other scheduled buildings and Cultural Heritage Inventory were identified as constraints. Consequently, sites identified in the table and map diagram are recommended to be avoided. A potential shaft site location may be in the triangle of land bounded by Wellesley Street W, Sale Street and Vernon Street. This avoids a scheduled Historic Heritage Place – the Drake Pub, and additionally avoids numerous recorded CHI sites in the blocks to the west. Furthermore, several heritage features were identified within the Burton Street Shaft vicinity, which are recommended to avoided during works. A potential shaft site location might be the motorway curtilage below the vicinity of Grafton Road, which avoids the character area overlay and the HNZ historic heritage area for Upper Symonds Street. Finally, the numerous heritage features identified within the George Street Shaft vicinity (including scheduled sites and SCA sites) are recommended for avoidance during works.
Construction Noise and Vibration	Heritage, residential and industrial/commercial buildings nearby might be affected by construction noise and vibration.
Stormwater and Hydrology	Regular flooding has been identified immediately to the east of the shaft site at the intersection of Halsey, Victoria, Wellesley, Drake, and Vernon “"Corner"". Floodwaters can be contaminated with wastewater due to existing Watercare trunk sewer main running through this area. Additionally, isolated areas of ponding has been identified near George Street (these areas are unlikely to impact the shaft, but further detail of location is required to confirm this).
Social	Various small businesses, including apartments and hotels might be vulnerable to construction impacts and business disruption. Any effects on Victoria Park playground could be substantial, as it is the only playground besides Wynyard Quarter within the city. Consequently, apartment dwellers whose children visit Victoria Park will be affected. Part of the walking and cycling path in the park, as well as the cycle lane on Victoria Street West are also in the circle, thus alternative paths will need to be provided if these are closed. Additionally, residential properties and parking lots potentially affected

	by works might impact businesses on Symonds Street. Similarly, works might impact businesses within the George Street vicinity. The potential disruption of access to Glendale Reserve might also impact patrons from exercising or relaxing outside. Possible impacts to Monkey Hill Reserve should be mitigated, in order to preserve exercise, dog walking and recreation. Finally, works should avoid impacting Curate Church at 44 George Street due to its cultural and community functions.
Landscape	Land either side of Vernon Street and part of Vernon Street itself is subject to E10 or E16 volcanic viewshafts, however this is unlikely to be a height constraint to this infrastructure (c.65m above GLs). There is a single large oak tree in the roundabout at Wellesley and Victoria Street intersection, which has been flagged by an arborist as having landscape value. The AT Wellesley Street Bus Priority project has identified a potential public space opportunity that involves closing access between Drake/Vernon and Wellesley (current slip lanes). Te Ha Noa Victoria Street linear park – future streetscape/public space change to Victoria Street West through to Victoria Park intersection Heritage street lights in association The Drake pub: 3 x 1920s street lights in the public footpath outside the pub at Drake and Vernon re also scheduled historic heritage. The ability to integrate with other buildings/structures through future redevelopment of residual land as a means of mitigating effects, and/or ability to be located internal to sites away from public street edges such it can be sleeved/separated by other buildings/uses in future. Volcanic view shaft – Area south of motorway around Burton and Nugent Streets subject to E10, but unlikely to be a height constraint to this infrastructure (c.19.5m above GLs) Location closer to motorway environment the better in terms of minimising potential adverse visual and urban amenity effects on surrounding streetscapes and city centre fringe mixed use neighbourhoods at Grafton / Khyber Pass Road areas either side of motorway Pohutukawa trees: - several mature pohutukawa trees on private sites to east side of Grafton Road have landscape value and worthy of retention (one corner Burton St & Grafton, one opposite end of Orion Health site) St David's Church and site surrounds – historic heritage – extends to site surrounds including mature trees Ability to integrate with landscape planting areas near motorway environment as means of mitigating effects Ability to integrate with other buildings / structures as means of mitigating effects Location closer to railway corridor, and away from New North Road street edge the better in terms of minimising potential adverse visual and urban amenity effects on surrounding streetscape and anticipated urban lift to wider neighbourhood between stations

5.11.3 Design development and response

5.11.3.1 Vernon Street Shaft

Vernon Street Shaft comprises of circular rectangular secant pile walls with waler beams providing clearance to the TBM. Vernon Street Shaft has been located in close proximity to the end of the tunnel to reduce the extent of additional mining required. This constraint limits land parcels appropriate to position the shaft. In positioning the shaft, notable tree groups and heritage buildings have been avoided, however the effects of construction vibration will need to be monitored.

The shaft also includes a cut and cover structure at Wellesley Street which is proposed to be staged and top-down. In the temporary case, the site will be used for removal of the TBM and for mining the stub end. In the permanent case, the facility will be used for train turnback which requires the site to accommodate ventilation plant, emergency egress and a low point sump and pump. This will include a building above ground with basement levels below ground. There will also be a low point sump near the north-western end of mined tunnel.

5.11.3.2 Burton Street Shaft

Burton Street Shaft is located between University and Dominion Junction stations, due to the distance (approximately 2km) between both stations, a mid-length emergency access point is required. The shaft position must be located in close proximity to the TBM tunnel, with good access at the surface level for emergency services.

In positioning the shaft, notable tree groups, heritage buildings, Auckland Hospital and a Watercare tank have been avoided. Effects of construction vibration will need to be monitored on the heritage buildings. The height of the shaft headhouse will be kept below 19.5m from GL to protect the volcanic viewshaft landscape. The site boundary is back from State Highway 1 to avoid impacts to the road network.

The Burton Street Shaft concept comprises of permanent diaphragm walls founded into the ECBF-unweathered layer. Ring beams are provided and at the interface between the diaphragm walls and shaft lining. The shaft is approximately 60m deep.

5.11.3.3 New North Road Shaft and Auxiliary Building

The New North Road site is required to house a traction power substation, vent shaft, fire egress and substation and backup control. The position of the shaft is highly constrained: it must be located at the mid-point of shunt tracks and passing loops between Dominion Junction and Kingsland stations to fit within the single TBM running tunnel. An offline shaft construction has been considered which requires mined adits to the running tunnel.

The shaft will be circular with secant piles installed into the soft soil. The shaft extending below the pile walls has a lining supported by permanent ground anchors and shotcrete in the mined adit. Adits connect to both sides of the TBM tunnel.

5.11.4 Construction methodology/constructability

This section outlines the indicative construction sequencing assumed to inform the designation footprint for both the temporary construction works and the operational designation footprint. It also provides an outline of the range of durations for construction effects. This does not preclude construction activities occurring in another order or concurrently to complete the construction programme. The ultimate construction sequence will be confirmed once a contractor is appointed and detailed design is complete.

The indicative staging of works at each shaft location include:

- Site preparation, including demolition, site clearance, utilities relocation/protection. Establish site offices & amenities.
- Install ground support to shafts perimeter.
- Excavation of station shafts.
- Shaft specific elements.
  - Vernon St Shaft
    A sequential cut & cover excavation will be undertaken beneath Wellesley St adjacent to the main shaft access. This enables some traffic lanes to be maintained by switching traffic back and forth as the cut & cover components are completed.
  - Burton & New North Road shafts
    Mine adits to connect shafts to the monotube tunnel.
- Station internal construction and fitout.
- Surface buildings and streetscaping.

Standard hours of work for each shaft site are anticipated to be 7am-6pm Mon-Sat. Any works outside of these hours will be notified and coordinated with impacted local residents.

The shaft construction support areas will provide functions as detailed in section 3.7.

The three shaft sites are currently occupied by commercial and industrial buildings. Initial site preparation activities will include:

- Install noise, vibration and settlement monitoring to adjacent sensitive receivers.
- Utilities protection/relocation.
- Demolition of existing buildings.
- Site clearance and installation of site offices/amenities.

This will require careful planning and sequencing to minimise impacts on neighbouring properties and traffic.

Site access points will be provided from the existing adjacent roads.

- Estimated construction traffic volumes at each shaft site:
  - Long term peak (one week+ duration): 26 trucks/day (occurs during shaft excavation)
  - Short term peak (one day duration): 129 trucks/day (occurs during floor slab concrete pour)

5.12 NoR 11: Surface Rail – North of Wesley Station to north side Manukau harbour

5.12.1 Introduction

The rail alignment will come down Sandringham Road on a viaduct and then land alongside SH20, running parallel to the state highway towards Onehunga. This section contains two at grade stations, namely Puketāpapa near May Road and an at grade station at Hayr Road. The rail alignment is on a combination of at grade, trench and viaduct and will be fully segregated. For the section from Sandringham Road down to Hillsborough Road, the ALR alignment will be running adjacent to two future KiwiRail tracks in the existing KiwiRail designation. The KiwiRail tracks are located closest to the motorway. resulting in a grade separated crossing between Hayr and Hillsborough Road. The crossing allows KiwiRail to continue following their designation in land from the motorway while the Project will follow

SH20. It is proposed that ALR trenches underneath the KiwiRail tracks which will be on a low-level structure to gain adequate clearance for the grade separation.

Into Onehunga, the alignment will be on a viaduct to limit impacts on the local transport network. After the elevated Onehunga station, there will be an elevated connection to the ALR depot, with the main line running towards Manukau harbour.

5.12.2 Identified Constraints

Table 5-10 summarises the constraints for the Surface Rail – North of Wesley Station to north side Manukau harbour.

Table 5-10 Summarised constraints for Surface Rail - North of Wesley Station to north side Manukau harbour

Constraint	Description
Built Heritage	• Historic Heritage Extent of Plan: Lagoon
Freshwater Ecology	• Open water courses • Piped water courses • Potential wetlands offset will be required • Reclamation of streams potentially problematic
Landscape/	Alignment within the state highway corridor is logical as it follows that of the existing infrastructure. This does however come with existing severance issues for connectivity across the corridor, and the potential to exacerbate or create additional severance issues. It is to be noted that a volcanic viewshaft (~20m) has been identified within the corridor.
Archaeology	The majority of the route will be within land that likely heavily modified during the southwestern motorway construction. The portion through Onehunga will encounter archaeology with dense Mana whenua and 19th Century European occupation around the Onehunga CBD. The majority of the route will be within land that was likely heavily modified during the southwestern motorway construction.
Blasting Noise and Vibration	A geological assessment is required to identify the horizon of competent rock mass necessitating blasting. Subsequently, the rock level will be compared to the finished level of the station box. The proximity of Southwestern Motorway could impact upon the scale of blasting with respect to assurances against flyrock. Finally, the proximity of other busy roads potentially restrict the timing of blasts where there could be a requirement to temporarily close traffic.
Operational Noise and Vibration	The area of potential effects comprises of approximately. 150m either side of rail Additionally, the tight turning radius at the end of the alignment could cause noise issues
Stormwater and Hydrology	There are flood prone areas/flood plain areas within the site. Additionally, there is Hydrology State Highway flooding west to Mt Roskill Rd.
Social	The Lagoon is a significant recreational facility utilised by the community. Consequently, works potentially affecting it would have social impacts on residents. Furthermore, commercial businesses affected by works might impact employees and customers, who might need to travel further for

	work or to patronise businesses. Additionally, there is a church on the other side of the road which might be impacted by works.
Volcanology	Mt Roskill/ Puketāpapa is located to the south of SH20.
Landscape	Alignment within the State Highway corridor is logical as it follows that of the existing infrastructure. However, this comes with existing severance issues for connectivity across the corridor, and the potential to exacerbate or create additional severance issues.
Arboriculture	A large number of trees planted alongside the motorway are now well established. Important groups of trees have been mapped.
Parks and Open Spaces	Two public open spaces are within the NoR footprint; Onehunga Bay Reserve / Onehunga Lagoon and Taumanu Reserve. Onehunga Bay Reserve is a destination park that provides for casual use and some organised use. It is popular place for walking, with a network of pathways, including a loop track around the lagoon. The park also provides for organised recreation activity on the lagoon, adult fitness stations, children's play and activities for young people via the skate ramp. Taumanu Reserve is a newly created park that also provides for walking and informal recreation, with a boat launching, walking and cycleways and extensive ecological restoration and plantings, as well as interpretation of the cultural heritage of the area. It provides viewshaft across the Mangere Inlet to Mount Mangere. The two parks are linked via two pedestrian bridges across the motorway, allowing access across the motorway to the wider walking and cycling network in the area. Effects on those two parks could impede recreational activities and casual use, as well as natural and cultural values present at the lagoon.

5.12.3 Design development & response

The alignment has responded to the constraints outlined above and ensured that the impacts of the works are manageable. A significant amount of interfacing has occurred with KiwiRail to develop a scheme and alignment compatible with the combined ALR and KiwiRail requirements. Interfacing has also occurred with other stakeholders, notably with Waka Kotahi and Transpower to adjust the alignment to be compatible with their requirements.

The alignment along the Onehunga Bay Lagoon has been located hard up against SH20 to limit impacting the coastal marine area.

5.12.4 Construction methodology/constructability

The NoR has accounted for the indicative construction requirements and the staging areas required to support the works. As outlined above, the works are comprised of a combination of at grade track; trenching; cut and cover; viaducts; road underpasses and MSE walls.

Key areas include:

- Embankment cuts and MSE walls (various locations on alignment).
  These will require installation of various retaining wall types and bulk earthworks cut/fill to achieve required levels.

- May Road bridge modifications.
  The existing bridge design is to be reviewed to establish if construction staging can maintain traffic movements during this activity.
- Dominion Road crossing - cut & cover trench.
  A staged cut & cover trench will enable TTM shuffling to maintain traffic access during construction.
  Basalt is noted in this location, blasting may be required during trench excavation.
  This will require a focus on utilities protection and relocation.
- Hillsborough Road crossing – cut & cover trench.
  A staged cut & cover trench will enable TTM shuffling to maintain traffic access during construction. This will require a focus on utilities protection and relocation.
- KiwiRail tracks crossing over ALR tracks between Hillsborough and Hayr Road.
  A staged cut & cover trench will enable future KR tracks to span over ALR tracks.
- Viaduct sections (various locations on alignment)
  Temporary access is to be created to pier locations to enable piling, pilecaps, pier and headstock construction.
  Precast super-tee beams can be installed by either mobile crane (where access is adequate) or self-launching gantry (where access is constrained & turning radius permissible).

Initial site preparation activities will include:

- Install noise/vibration/settlement monitoring to neighbouring buildings if required.
- Utilities relocation/protection.
- Demolition & site clearance.
- Establish site offices, amenities, laydown areas, dewatering & sediment control systems.

Standard hours of work for this site are anticipated to be 7am-6pm Mon-Sat. Any works outside of these hours will be notified and coordinated with impacted local residents. Some nightworks motorway closures of SH20 will be required.

Excavation along the alignment is in a variety of materials, including basalt. Breaking and blasting activities are anticipated where basalt is encountered.

Site access for the alignment construction will be via the SH20 shoulder, the station sites, and adjacent side streets where suitable. Construction space may require some reductions in lane widths and nightworks road closures.

The adjacent vacant KiwiRail corridor will provide ALR with additional construction space for much of the alignment along the section of shared corridor.

Peak traffic movements will depend on the number of open excavation/ demolition work fronts at any one time. The peak truck movements anticipated for any one particular site access point are anticipated to be in the order of ~40 trucks/day.

5.13 NoR 12: Puketāpapa Station

5.13.1 Introduction

Puketāpapa (Mt Roskill) Station will be an island platform station running parallel to SH20 and perpendicular to May Road. The station is located on the main commercial trip of Denbigh Avenue. This will give public frontage to the station site and allow commuters to connect with existing and proposed bus routes along Stoddard Road and May Road.

The station contains:

- At grade, fully segregated station typology with island platform arrangement
- Enhancements to May Road to provide intermodal facilities, active modes access and to connect with on-street bus services
- Station forecourt providing, cycle parking, bus bays, kiss and ride bays and public realm

5.13.2 Identified Constraints

Table 5-11 summarises the constraints identified for Puketāpapa station.

Table 5-11 Summarised constraints for Puketāpapa Road Station

Constraint	Description
Archaeology	The majority of the route will be within land that was likely heavily modified during the southwestern motorway construction.
Blasting Noise and Vibration	A geological assessment is required to identify the horizon of competent rock mass necessitating blasting. Subsequently, the rock level will be compared to the finished level of the station box. Furthermore, the proximity of Southwestern Motorway could impact upon the scale of blasting with respect to assurances against flyrock. Finally, the proximity of other busy roads potentially restrict the timing of blasts where there could be a requirement to temporarily close traffic.
Landscape/Volcanology	Alignment within the State Highway corridor is logical as it follows that of the existing infrastructure. This does however come with existing severance issues for connectivity across the corridor, and the potential to exacerbate or create additional severance issues. It is to be noted that a volcanic viewshaft (~20m) has been identified within the corridor.
Stormwater & Hydrology	State Highway flooding west to Mt Roskill Rd. Flood prone areas/flood plain areas.
Construction Noise and Vibration	If possible, tunnelling through basalt must be avoided. Tunnelling through basalt
Archaeology	A portion of the NoR boundary is within 200 metres of R11/19 Puketāpapa. Consequently, there is a higher risk of associated archaeological features within this distance of the maunga.
Built Heritage	A small section of special character is to the east of the NoR boundary .
Landscape	Limited constraints have been identified due to predominantly residential land uses. There is an outstanding Natural Feature (ONF) constraint (Puketāpapa, Mt Roskill maunga), in addition to a volcanic viewshaft/height sensitive overlay constraint (R1 + R2, Mt Roskill and Mt Roskill Height Sensitive Areas).
Stormwater and Hydrology	The ALR station entry and alignment must be kept about flood level.
Volcanology	Mt Roskill/ Puketāpapa is located to the south of SH20.

5.13.3 Design development and response

The station has a narrow corridor between the KiwiRail designation and State Highway 20 to fit a station. This has required the platform to be built with a link bridge back to the main station building where greater space for development is available. The platform will operate as an island configuration, with tracks running either side. Secondary fire egress from the platforms is provided via an overbridge at each end of the platform.

The main station building is at grade with May Road, with provision for bus stops outside the entrance. Passing through the entrance gateline, passengers will walk up a ramp to reach the top of the link bridge. As space is confined on the platform side, a second ramp would not fit. Therefore, lifts and staircase are provided.

The station building and bridges must be no taller than 9m to not disturb the Outstanding Natural Features and Volcanic views within the area. Water Sensitive Urban Design, such as raingardens, rainwater harvesting, and permeable paving will be considered to provide mitigation methods to stormwater and flooding.

5.13.4 Construction methodology/constructability

This section outlines the indicative construction sequencing assumed to inform the designation footprint for both the temporary construction works and the operational designation footprint. It also provides an outline of the range of durations for construction effects. This does not preclude construction activities occurring in another order or concurrently to complete the construction programme. The ultimate construction sequence will be confirmed once a contractor is appointed and detailed design is complete.

The indicative staging of works include:

- Site preparation, including demolition, site clearance, utilities relocation/protection. Establish site offices and amenities.
- The station construction zone is to be used as a central hub for constructing the adjacent sections of rail corridor.
- Undertake modifications to May Road bridge. The existing bridge design is to be reviewed to establish if staging can maintain traffic movements during this activity.
- Reconstruct Citrus Grove bridge to New World supermarket.
- Construct new station platform & structures.
- Streetscapes upgrades.

Standard hours of work for this site are anticipated to be 7am-6pm Mon-Sat. Any works outside of these hours will be notified and coordinated with impacted local residents. The station construction support area will provide functions as detailed in section 3.7.

Initial site preparation activities include:

- Install noise/vibration/settlement monitoring to neighbouring buildings if required.
- Utilities relocation/protection.
- Demolition & site clearance.
- Establish site offices, amenities, laydown areas, dewatering & sediment control systems.

Site access for Puketāpapa Station will be via May Road. The adjacent KiwiRail corridor will provide ALR with additional construction space for the alignment along the section of shared corridor. Furthermore, the majority of the alignment site can be accessed directly from the SH20 shoulder. It is to be noted that construction space may require local reductions in lane widths and nightworks road closures.

5.14 NoR 13: Hayr Road Station

5.14.1 Introduction

Hayr Road Station will be an island platform station running parallel to SH20 and perpendicular to Hayr Road. Its primary function is to serve as an interchange and transfer node for bus services, with the #27 being a frequent service on Hayr Road and requiring 3x bus stops in each direction. Additionally, there are another three terminating services (#29, 68, 285) using Carr Road that require layover in vicinity of the station.

The station contains:

- An allowance for four tracks (including KiwiRail).
- At grade, fully segregated station typology with island platform arrangement.
- Enhancements to Carr Road to provide intermodal facilities, active modes access and to connect with on-street bus services.
- Station forecourt providing cycle storage, bus bays, kiss and ride bays and public realm.

5.14.2 Identified Constraints

Table 5-12 summarises the constraints identified for Hayr Road station.

Table 5-12 Summarised constraints for Hayr Road station

Constraint	Description
Built Heritage	• Historic Heritage Extent of Plan: Lagoon
Freshwater Ecology	• Open water courses • Piped water courses • Potential wetlands offset will be required • Reclamation of streams potentially problematic
Landscape	Alignment within the State Highway corridor is logical as it follows that of the existing infrastructure. This does however come with existing severance issues for connectivity across the corridor, and the potential to exacerbate or create additional severance issues.
Stormwater and Hydrology	• State Highway flooding west to Mt Roskill Rd • Flood prone areas/flood plain areas
Social	Lagoon: Significant Recreational Facility Churches in close proximity
Social	Commercial businesses affected by works might impact employees and customers, who might need to travel further for work or to patronise businesses. Additionally, there is a church on the other side of the road which might be impacted by works.
Stormwater and Hydrology	The above ground station is located outside of the adjacent floodplain, however the below ground station is located in the floodplain within the NoR boundary . Therefore, flood prone areas near the station and may require further assessment with up-to-date data sets. The station might also benefit from WSUD features.

Traffic	Hayr Road is one of the few arterial roads crossing over SH20. Consequently, it will be important to prioritise active modes and bus travel close to the station, and over the motorway.

5.14.3 Design development and response

Hayr Road station is an at grade station, similar to Puketāpapa. The design philosophy is similar, with the platform located within the existing KiwiRail designation and constrained by SH20 and future proposed KiwiRail platforms. This has required the platform to be built with a link bridge back to the main station building where greater space for development is available. The platform will operate as an island configuration with tracks running either side. Secondary fire egress from the platforms is provided via an overbridge at each end of the platform.

The main station building has been positioned to not interfere with areas of social importance, such as the churches or lagoon around Hayr Road. The station building is at grade with Carr Road, with provision for a bus interchange outside the entrance. Stairs and lifts provide the vertical transport between the link bridge, station building and platform. To provide connectivity with the Southwestern Cycleway, a new pedestrian bridge is proposed to span over SH20 adjacent to the station.

Water Sensitive Urban Design, such as raingardens, rainwater harvesting, and permeable paving will be considered to provide mitigation methods to stormwater and flooding. The station location is positioned to not be affected by freshwater ecology of the Puhea stream.

5.14.4 Construction methodology/constructability

This section outlines the indicative construction sequencing assumed to inform the designation footprint for both the temporary construction works and the operational designation footprint. It also provides an outline of the range of durations for construction effects. This does not preclude construction activities occurring in another order or concurrently to complete the construction programme. The ultimate construction sequence will be confirmed once a contractor is appointed and detailed design is complete.

The indicative staging of works include:

- Site preparation – including demolition, site clearance, utilities relocation/protection. Establish site offices and amenities.
- Station construction zone to be used as a central hub for constructing the adjacent sections of rail corridor.
- Undertake modifications to Hayr Road bridge. The existing bridge design is to be reviewed to establish if staging can maintain traffic movements during this activity.
- Construct new footbridge across SH20.
- Construct new station platform & structures.
- Streetscapes upgrades.

Standard hours of work for this site are anticipated to be 7am-6pm Mon-Sat. Any works outside of these hours will be notified and coordinated with impacted local residents.

The station construction support area will provide functions as detailed in section 3.7.

The station and alignment sites are currently occupied by industrial & commercial properties, residential houses, local roads & KiwiRail/motorway corridor.

Initial site preparation activities will include:

- Install noise/vibration/settlement monitoring to neighbouring buildings if required.
- Utilities relocation/protection.

- Demolition & site clearance
- Establish site offices, amenities, laydown areas, dewatering & sediment control systems.

The eastern site access to Hayr Road Station will be via Carr Road and the SH20 shoulder. Conversely, the western site access for the footbridge pier will be available via Melrose Road. In order to construct the new SH20 footbridge, bridge spans will be installed under nightworks, whereby the motorway will be closed.

The majority of the alignment can be accessed via the SH20 shoulder, with additional access points from neighbouring side streets where possible. Construction space may require local reductions in SH20 lane widths and nightworks road closures. Some sections of SH20 may require a localised narrowing of lanes with reduced speed limits, while maintaining the current number of traffic lanes wherever possible. It is to be noted that the adjacent KiwiRail corridor provides additional construction space along the section of shared corridor.

5.15 NoR 14: Onehunga Station

5.15.1 Introduction

Onehunga station is a mid-block elevated station with high interchange demand located within a broader regeneration area, including a Frequent Transit Network (FTN) bus route connecting to Royal Oak Town Centre, industrial employment land and the foreshore area. Onehunga station works include an extension of O'Rorke Street to establish a through site link connecting with Neilson Street, with the former street being predominantly used for bus access.

This station contains:

- Elevated station typology with side platform arrangement
- Two tracks
- Access to the platforms via escalators and lifts that land at the eastern end of the platform

5.15.2 Identified Constraints

Table 5-13 summarises the constraints identified for Onehunga station.

Table 5-13 Summarised constraints for Onehunga station

Constraint	Description
Built Heritage	The lagoon and 19 Princes Street could be affected by works.
Landscape	Alignment within the State Highway corridor is logical as it follows that of the existing infrastructure. However, this comes with existing severance issues for connectivity across the corridor, and the potential to exacerbate or create additional severance issues. At Onehunga, specific consideration is required of the historic town's natural and built landscape values. Consideration should also be given to the extent to which such values have been affected historically by the convergence of infrastructure at Onehunga. A key consideration is how the ALR infrastructure will connect with Onehunga and thread through its urban landscape which includes sensitive town centre and coastal environment contexts
Archaeology	The majority of the route will be within land that likely heavily modified during the southwestern motorway construction. The portion through Onehunga will encounter archaeology with dense Mana whenua and 19th Century European occupation around the Onehunga CBD.
Social	The Lagoon is a Significant Recreational Facility utilised by the community. Consequently, works potentially affecting it would have social impacts on residents.
Stormwater and Hydrology	There are flood prone areas/flood plain areas within the site.
Arboriculture	A large number of trees planted alongside the motorway are now well established. Important groups of trees have been mapped.
Blasting Noise and Vibration	To confirm whether blasting will be undertaken.

Operational Noise and Vibration	• Complete in GIS • the area of potential effects comprises of approximately. 150m either side of rail • Additionally, the tight turning radius at the end of the alignment could cause noise issues.
Arboriculture	There is an indication of a piped watercourse, open waterbody, and upstream open watercourse. A site visit will be required to verify these indications. Impacts on the open watercourse must be minimised where possible. Additionally, stormwater quality and sediment must be adequately managed.
Built Heritage	The RSA Bowling Club and Former Carnegie Library could be affected by works.
Blasting Noise and Vibration	A geological assessment is required to identify the horizon of competent rock mass necessitating blasting. Subsequently, the rock level will be compared to the finished level of the station box. The proximity of commercial sensitive receivers will affect the scale of blasting that can be completed and provide acceptable fragmentation and diggability. Furthermore, the proximity of busy roads potentially restrict the timing of blasts where there could be a requirement to temporarily close traffic. Key commercial facilities should be identified to confirm there is no equipment for activities that would necessitate a more stringent vibration criterion than applied for building protection or amenity. The proximity of pedestrian walkways immediately adjacent to the excavation area would likely require temporarily closure at the time of blasting and likely prevent blasting during peak times.
Stormwater and Hydrology	Notes from planning indicate there are flood plains and flood prone areas east of the NoR boundary . Consequently, a further study of flood prone characteristics will be required. Consideration will also need to be made for overland surface water flows as the station, appears to be in a low position.
Landscape	Connections from Princes Street to 10B Onehunga must be considered a special case due to the historic values associated with the town, its settlement pattern and buildings. It is also a location where different transport and infrastructure (e.g. overhead power lines) converge. Other constraints relate to those associated with the landscape and coastal environment values. A key consideration is to identify how the ALR infrastructure will connect and thread through Onehunga. Volcanic Viewshaft/Height Sensitive Overlay
Social	38 Neilson St. Onehunga and Districts Bowling Club is an important recreational and social facility for the community. Due to its typical older demographic, it is also an important social space. It may also be a facility available to rent as a venue for the wider community. Loss of this could impact community cohesion, with people needing to travel further to undertake the same activity (which might deter some from travelling entirely). Ultimately, social connections could be lost, thus impacting people's health and wellbeing. 5 Pearce St – The 'Y' – Sir William Jordan Recreation Centre is a Not for Profit focusing on youth development and strengthening communities. It is a community recreation asset available for rent, and a provider of afterschool care, youth activity and holiday programmes. Additionally, it runs a local basketball league and gym. Consequently, the loss of this facility to the community would be significant. Whilst the PWA will compensate owners, the loss of commercial/light industry businesses could mean a loss of employment, thus impacting families and livelihoods. Additionally, businesses might not be able to re-establish in the area, as there is no undeveloped commercial land enabling

	this. Consequently, businesses could be lost to the area, with people potentially needing to travel further to access the same services/businesses.
Traffic	Neilson Street is an important (strategic) east-west route, running between SH1 and SH20. It currently accommodates a high volume of freight vehicles . Connections between Neilson Street and SH20 (south) are via the southern part of Onehunga Mall/Onehunga Harbour Road, meaning that this route is also important for traffic (and freight). The function of Neilson Street will change significantly if/when the East-West Link is implemented. The interchange between Light Rail and Heavy Rail (i.e. the Onehunga Branch Line) and between Light Rail and bus will be important. Bus travel between Onehunga and the south will be less important following the completion of ALR, as ALR will become the main PT mode. Provision for active mode trips will also be important adjacent to the station, within Onehunga town centre. The choice of level (meaning ALR travels into Onehunga via viaduct, at grade or trench) will significantly alter the extent of effects on local traffic and active mode movements. There may be some effects during construction on SH20. A reduction in traffic lanes should be avoided, but some reduction in lane widths, and shoulder widths should be tolerable. Pedestrian access to public transit (bus and train) should be retained during construction. Other locations of interest include at/adjacent to each motorway interchange, and in the Onehunga area.
Parks and Open Spaces	Onehunga Districts and Bowling Club is located within the NoR boundary. This is a recreational asset in the centre of the town centre of Onehunga, an area which is lacking in public open space. Recreational use is likely to be significantly affected due to required removal of the site for the station.

5.15.3 Design development and response

The station has been located within the town to avoid Onehunga Bay Reserve, which also has benefits of avoiding stormwater flooding risks. The station will be elevated, supported by viaduct alignment either side of the town centre. Within Onehunga town, the station will be located between Onehunga Mall and Selwyn Street to avoid built heritage (Carnegie Library) and archaeological important sites. The RSA Bowling club land will be required for the station. Detailed Design process will be to mitigate individual elements such as heritage bluestone wall along O'Rorke Street redevelopment.

Onehunga station will have elevated side platforms and a viaduct alignment running through the middle. The gateline is locate at street level, with vertical transport provided beyond this, access to the platforms will be by lifts and escalators to each individual platform. Piers will be located either side of O'Rorke Street to allow the road to continue to operate. The station location allows for passenger interchange connection with the existing Onehunga Station.

5.15.4 Construction methodology/constructability

This section outlines the indicative construction sequencing assumed to inform the designation footprint for both the temporary construction works and the operational designation footprint. It also provides an outline of the range of durations for construction effects. This does not preclude construction activities occurring in another order or concurrently to complete the construction programme. The ultimate construction sequence will be confirmed once a contractor is appointed and the detailed design is complete.

The indicative staging of works include:

- Site preparation – including demolition, site clearance, utilities relocation/protection. Establish site offices, amenities, dewatering and sediment control systems. Install monitoring to neighbouring buildings if required.
- Install pile foundations and pile caps.
- Construct in-situ viaduct piers and headstocks.
- Lift in precast viaduct beams using mobile crane.
- In-situ topping to viaduct deck and install edge barriers.
- Station fitout and tracks installation.
- Streetscape reinstatement and upgrades to local roads to enhance pedestrian access to the station.

Standard hours of work for this site are anticipated to be 7am-6pm Mon-Sat. Any works outside of these hours will be notified and coordinated with impacted local residents.

The station construction support area will provide functions as detailed in section 3.7.

Initial site preparation activities will include:

- Install noise/vibration/settlement monitoring to neighbouring buildings if required.
- Utilities relocation/protection.
- Demolition & site clearance.
- Establish site offices, amenities, laydown areas, dewatering and sediment control systems.

Peak traffic movements will depend on the number of open excavation/ demolition work fronts at any one time. The peak truck movements anticipated for any one particular site access point are anticipated to be in the order of ~40 trucks/day.

Access for construction traffic entering and exiting the station site will be via:

- Onehunga Mall
- Neilson Street
- Princes Street
- Selwyn Street.

Full freedom turning movements for entry and exit movements are assumed at this stage.

5.16 NoR 15: Depot – Onehunga

5.16.1 Introduction

Onehunga Depot will be the sole location at which trains for the ALR will be inspected, maintained and overhauled. The site (which will be located within property space acquired from the Green Gorilla waste recycling facility) will also accommodate the vast majority of the train stabling capacity.

The depot will:

- Contain all maintenance functions for the rolling stock (passenger and infrastructure maintenance vehicles) with workshops for the repair/refurbishment of appropriate infrastructure, storage of spare parts for rolling stock and infrastructure and delivery/lay down areas for maintenance and renewal of trackwork, overhead catenary and trackside cabling.
- Be envisaged as the operation and administrative headquarters of the rail operator and therefore the Operational Control Centre (OCC), administration and management offices, training facilities, staff welfare facilities and associated vehicle parking (staff, visitors, and deliveries) will also be located at the site.
- House a power intake substation which will provide power for traction, both in the depot and along the mainline as well as the loads of the depot itself.

5.16.2 Identified Constraints

Table 5-14 summarises the constraints identified for Onehunga Depot.

Table 5-14 Summarised constraints for Onehunga Depot

Constraint	Description
Built Heritage Scheduled trees	Cat B Waikaraka Grounds and Cemetery (including military) to the east of the NoR boundary must be avoided if possible.
Freshwater Ecology	The piped stream parallel to Alfred Street connects marine environment to an open watercourse at Captain Springs Reserve (Te Papa Reserve), which is recognised as an SEA (SEA_T_6229) for its threat status and rarity. Within this reserve, there is an open watercourse which is reported to be spring fed and banded kokopu have been recorded. Several other native fish species have previously been recorded within this small catchment. There is an opportunity to daylight the piped section of stream. A consideration/minimisation of impacts on the piped section of stream is important. Additionally, Auckland Council have mapped an unlined channel (stormwater watercourse layer) along the rail corridor. Bycroft Reserve is a piped stream downstream of this and an SEA_T_6247 and Conservation Zone. The threat status of the reserve is related to Fissidens berteroi – threatened aquatic moss (Threatened – Nationally Vulnerable). Additionally, wetland habitat is potentially threatened. Impacts on Bycroft Reserve must be avoided, whilst minimising/considering impacts on the piped stream. There is potential for daylighting stream and restoring/enhancing Bycroft Springs within the reserve itself. A site visit is recommended if there are likely to be impacts in proximity.
Arboriculture	Two notable trees are to be avoided. At the time of writing, multiple street trees might be affected (not mapped).
Archaeology	As the original shoreline is within the NoR footprint, it is possible that some archaeological sites may exist beneath the reclamation. This can be easily navigated during construction through topsoil strip, removal of reclamation material and investigation/monitoring of area.

Settlement Principles	The majority of the structures within the NoR footprint) are low-rise commercial/industrial structures. Land preparation works specifically addressing variable compressibility of former landfill material will be required in order to satisfy proposed settlement performance criteria.
Stormwater and Hydrology	Floodplains exist on the site.
Volcanology	There is a crater to the west of the potential depot location.
Landscape	• Waikaraka cemetery Volcanic viewshaft/height sensitive overlay Natural character Contamination (potential for remediation) Integration with potential East-West project Integration with Manukau Harbour crossing (more awkward for the Option 4 reuse of existing bridge) Eke Panuku plans for land redevelopment in area
Construction Noise and Vibration	Construction methods that minimise construction noise and vibration levels and duration (i.e. down the hole hammer and blasting) are recommended.
Traffic	Neilson Street is part of the strategic transport network. Routes to/from SH20 are important, with the intersection of Neilson Street/Onehunga Mall a particular constraint. Access to depot will be an important issue – but use of site as a depot implies removal of traffic associated with the existing use of site.
Operational Noise and Vibration	The site is a good location, as it is separated from residential activities.
Social	The area is commercial and will have significant employment. Loss of businesses could mean loss of employment and livelihoods for many, especially businesses that cannot readily relocate. There are limited/no vacant commercial land/buildings in the area.
Parks and Open Spaces	Manukau Foreshore East Cycleway, which runs along the foreshore between Onehunga Mall/ Onehunga Harbour Road and Alfred Street, is located within this NoR and could be affected through the works. This shared cycle/ walkway is part of a route that provides a scenic connection that stretches as far as Hillsborough in the West and Penrose in the East. Effects could include loss of recreational opportunities and impediment to access to the park itself and impact connectivity of the wider parks/ recreational cycling network. Waikaraka Park and Cemetery are also in could proximity and could be affected.

5.16.3 Design development and response

The depot location presents an opportunity to address environmental issues from its former use as a landfill site. The design is not seeking to remove offsite, any contaminated earthworks. The existing site is not flat, with level variation from RL+18m at the west end and RL+5.00 at the eastern end. The design solution is to move some of the cut from the west to the east and then balance the fill, noting capping will be required to make the final level. A retaining wall will be required along the perimeter of the depot varying from 2 to 5m high. The alignment design of the entry/exit tracks to the depot slope downwards to the site to minimise the RL height of the depot and minimise the height differential with the existing ground.

The depot footprint avoids the Waikaraka Grounds and Cemetery to the east, keeping inside of Alfred Street. The height of the depot has been set as low as possible, with buildings located to the eastern side of site to minimise visual impacts at the cemetery and avoid encroachment into the viewshaft to Maungakiekie. Additionally, the southern boundary of the raised depot area has been kept as far away from the Coastal Management Area to minimise impact both visually and on the leachate management.

A concrete slab will be cast across the entire site, including the train stabling area, workshops, washplant and test track. Upon this foundation, a steel frame will be erected to set the building frames for the depot workshops and substation building.

5.16.4 Construction methodology/constructability

This section outlines the indicative construction sequencing assumed to inform the designation footprint for both the temporary construction works and the operational designation footprint. It also provides an outline of the range of durations for construction effects. This does not preclude construction activities occurring in another order or concurrently to complete the construction programme. The ultimate construction sequence will be confirmed once a contractor is appointed and detailed design is complete.

The indicative staging of works include:

- Site preparation – including demolition, site clearance, utilities relocation/protection. Establish site offices, amenities, dewatering and sediment control systems (Duration ~2-6 months).
- Bulk earthworks to bring site to finished level. Extent of contaminated material to be confirmed, minimise disturbance and removal from site where possible (Duration ~12-36 months depending on source material).
- Site perimeter retaining wall constructed. Anticipated either reinforced soil slope (RSS), MSE wall or post and panel wall (Duration ~4-12 months).
- Backfill site using engineered fill/potentially tunnel spoil. Ground Settlement and stability works undertaken.
- Concrete podium slab cast across site (Duration ~6+ months).
- Depot buildings construction – foundations & erect steel frames for depot workshops and substation building (Duration ~9-12+ months).
- Buildings fitout.
- Reinstatement and upgrades to surrounding streetscape where required (Duration ~ 3-6 months).
- Testing and commissioning of substation, OCC and depot facilities.

Standard hours of work for this site are anticipated to be 7am-6pm Mon-Sat. Any works outside of these hours will be notified and coordinated with impacted local residents.

The construction support area will provide functions as detailed in section 3.7.

Initial site preparation activities will include:

- Install noise/vibration/settlement monitoring to neighbouring buildings if required.
- Utilities relocation/protection.
- Demolition & site clearance.
- Establish site offices, amenities, laydown areas, dewatering & sediment control systems.

Construction traffic will access the depot site via Alfred Street and Victoria Street. Estimated construction traffic volumes are:

- Long term peak (one week+ duration): 330 trucks/day (this occurs if all the TBM spoil removal trucks are directed to the depot site during bulk fill operations)

- Short term peak (one day duration): 50 trucks/day (occurs during demolition & podium floor slab concrete pour phases).

5.17 NoR 16: Surface Rail – South side Manukau Harbour to north of Māngere Town Centre

5.17.1 Introduction

The rail alignment then crosses Manukau harbour on a new bridge structure to the east of the existing SH20 southbound bridge. It lands on the southern shore alongside SH20 with the existing earth embankment widened supported by a mechanically Stabilised earth (MSE) wall. It then dives underneath Mahunga Drive off ramp in a covered trench emerging south of Rimu Road overbridge on the eastern side of SH20.

It then runs at grade with the first station in this area located at grade south of Miro Road, with a new walking & cycling bridge over SH20 to connect the station to Māngere Bridge town. South of Māngere Bridge station, the alignment continues at grade, where it crosses Te Ararata Creek on a new bridge structure matching the vertical alignment of the existing SH20 bridge, with a clear span over the creek to avoid works in the water.

South of the creek, it then travels via a trench structure under Walmsley Road before returning to at-grade running, where the next station (Te Ararata) will be located, at grade, at Hall Avenue, where a new walking & cycling bridge will replace the existing bridge to connect the station to communities on the western side of SH20.

5.17.2 Identified Constraints

Table 5-15 summarises the constraints identified for Surface Rail.

Table 5-15 Summarised constraints for Surface Rail

Constraint	Description
Coastal	The coastal marine area (CMA) is located to the southern area of alignment. Works in this area would require a coastal resource consent. Designers should avoid works/structures in the CMA (span over the top preferred). There is a volcano crater located in Te Hopua/Gloucester Park.
Volcanology	There is a volcano crater located in Te Hopua/Gloucester Park.
Blasting Noise and Vibration	A geological assessment is required to identify the horizon of competent rock mass necessitating blasting. Subsequently, the rock level will be compared to the finished level of the station box. The proximity of residential sensitive receivers along Bader Drive to the north of George Bolt Drive, Idlewild Avenue and Takon Place might affect the scale of blasting that can be completed and provide acceptable fragmentation and diggability. Additionally, the proximity of commercially sensitive receivers along Orly Avenue might affect the scale of blasting that can be completed and provide acceptable fragmentation and disability. Finally, the proximity of Te Kura Kaupapa Māori O Māngere School would likely affect the time of blasting and likely prevent blasting during peak school times.
Built Heritage	Shaldrick Residence (AUP Category B) might be impacted by works
Landscape	There is a volcanic viewshaft/height sensitive overlay that is indicatively 25m in height. Alignment within the state highway corridor is logical as it follows that of the existing infrastructure. However, this comes come with existing severance issues for connectivity across the corridor, and the potential to exacerbate or create additional severance issues.

Stormwater and Hydrology	Overland flood paths, flood plains, and areas prone to flooding must be avoided or managed. Small floodplains are mapped and marked amber but should be able to be designed to accommodate.
Settlement Principles	The management of landfill materials is potentially required (depot location).
Freshwater Ecology	There are potential wetlands north of Māngere Town Centre. Furthermore, Te Ararata Creek and potential wetlands are located to the south section of the alignment. Additionally, there are piped water courses between the depot and MHX. Finally, there is a stormwater channel within the KiwiRail alignment.
Arboriculture	Multiple street trees could be affected by works. Additionally, the removal of multiple street trees/motorway plantings may be contentious, however various tree groups can be managed adequately.
Archaeology	This alignment generally leads through an area which has been under recorded archaeologically. Consequently, there is potential for Mana whenua archaeology along the alignment. There are more recorded sites near the AIAL end, but this can be more attributed to the recent development by AIAL in past 20 years.
Construction Noise and Vibration	Avoid tunnelling through basalt. Additionally, a work site layout must be designed which minimises high noise and vibration construction methods near standalone houses and businesses.
Operational Noise and Vibration	A tight turning radius in several locations could cause noise issues, with the area of potential affects being approximately 150m either side of rail.
Traffic	There may be some effects during construction on SH20 and SH20A. A reduction in traffic lanes should be avoided, but some reduction in lane widths, and shoulder widths should be tolerable. Active mode links (e.g., over SH20) should be retained during construction. Other locations of interest include at/adjacent to each motorway interchange, and in the Māngere Town Centre area.
Parks and Open Spaces	Waterfront Road Reserve, with its shared walking and cycling connections, provides a green link adjacent to the Mangere Inlet and beyond. The route gives opportunity for recreation cycling from Auckland Airport to Ambury Regional Park. The park and its walking and cycling connection could be affected by the Project.

5.17.3 Design development & response

The alignment has responded to the constraints outlined above and ensured that the impacts of the works are manageable. Consideration has been given to minimising impacts on the SH20 network where we interface along the eastern side of their designation.

The proposed crossing of Te Ararata Creek and the alignment alongside Mahunga Drive off ramp has accounted for the surveyed extents of the coastal marine area to ensure works in the water are avoided.

5.17.4 Construction methodology/constructability

The NoR has accounted for the indicative construction requirements and the staging areas required to support the works. As outlined before, the works are comprised of a combination of at grade track; trenching; cut and cover; road underpasses and MSE walls.

Key areas include:

- Embankment cuts and MSE walls (various locations on alignment).
  These will require installation of various retaining wall types and bulk earthworks cut/fill to achieve required levels.
- Cut & cover trenches – beneath Mahunga Drive offramp and Walmsley Road.
  Staged cut and cover trench enabling TTM shuffling to maintain traffic access during construction.
  This will require a focus on utilities protection and relocation.
- Rimu Road bridge modifications.
  The existing bridge design is to be reviewed to establish if construction staging can maintain traffic movements during this activity. It is anticipated that installation of soil nails beneath the existing bridge abutment may be sufficient.

Initial site preparation activities will include:

- Install noise/vibration/settlement monitoring to neighbouring buildings if required.
- Utilities relocation/protection.
- Demolition and site clearance.
- Establish site offices, amenities, laydown areas, dewatering and sediment control systems.

Standard hours of work for this site are anticipated to be 7am-6pm Mon-Sat. Any works outside of these hours will be notified and coordinated with impacted local residents. Some nightworks motorway closures of SH20 will be required.

Excavation along the alignment is expected to be in a variety of rippable materials through this section.

Site access for the alignment construction will be via the SH20 shoulder, the station sites, and adjacent side streets where suitable. Construction space may require some reductions in lane widths and nightworks road closures.

Peak traffic movements will depend on the number of open excavation/ demolition work fronts at any one time. The peak truck movements anticipated for any one particular site access point are anticipated to be in the order of ~40 trucks/day.

5.18 NoR 17: Māngere Bridge Station

5.18.1 Introduction

Māngere Bridge Station will provide access to ALR for the residents and facilities of Favona and Māngere Bridge as well as employment located adjacent to Mahunga Drive. The proposed platforms will run parallel to SH-20 and perpendicular to Miro Road. The station will provide a rapid and reliable public transport connection to Onehunga Town Centre to the north and Māngere Town Centre to the south. The station location respects the Te Puea Memorial Marae situated just to the north of the station site.

The station contains:

- At grade, fully segregated station typology with side platform arrangement.
- Provision for other transport modes/interchange.
- Access to platform 2 via underpass from station building (via gateline) to northern platform end.

5.18.2 Identified Constraints

Table 5-16 summarises the constraints identified for Māngere Bridge Station.

Table 5-16 Summarised constraints for Māngere Bridge Station

Constraint	Description
Coastal	The coastal marine area Coastal Marine Area (CMA) is located to the southern area of alignment. Works in this area would require a coastal resource consent. Designers should avoid works/structures in the CMA (span over the top preferred).
Freshwater Ecology	Te Ararata Creek and potential wetlands are located to the south section of the alignment.
Stormwater and Hydrology	Small floodplains are mapped and marked amber but should be able to be designed to accommodate.
Construction Noise and Vibration	Avoid tunnelling through basalt.
Traffic	There may be some effects during construction on SH20 and SH20A. A reduction in traffic lanes should be avoided, but some reduction in lane widths, and shoulder widths should be tolerable. Active mode links (e.g., over SH20) should be retained during construction. Other locations of interest include at/adjacent to each motorway interchange, and in the Māngere Town Centre area.
Arboriculture	Scheduled trees mapped could be affected by the works.
Stormwater and Hydrology	The station is located within a large source of flooding within a floodplain and flood prone area, which must be avoided. The station is located adjacent to the Māngere Inlet flood plain. The flood prone area has an overall catchment size of 382,595m^2 and a ponding depth of 0.75m. Further investigations would be required to establish the ponding depth at the station location.

5.18.3 Design development and response

Māngere Bridge Station has been positioned to align with the new Manukau Harbour Crossing adjacent the motorway corridor to the south. Te Puea Memorial Marae is of significant importance, the design has ensured that it will not be affected but is close enough to retain location benefit with the town. South of the location is a costal marine area, which the footprint was careful to avoid.

A new pedestrian and cycle bridge will be provided over State Highway 20 to allow connectivity with Māngere Bridge town. The station building is at grade with Miro Road, located east of the highway with bus stops and car drop off provisions. The platform arrangement differs from the other at grade stations with side platforms. Passing through the entrance gateline, passengers can access Platform 1 directly from the paid concourse. Platform 2 is accessed with lifts and stairs down to an underpass under the tracks.

The station is located within a floodplain and flood prone area. Water Sensitive Urban Design, such as raingardens, rainwater harvesting, and permeable paving will be considered to provide mitigation methods to stormwater and flooding.

5.18.4 Construction methodology/constructability

This section outlines the indicative construction sequencing assumed to inform the designation footprint for both the temporary construction works and the operational designation footprint. It also provides an outline of the range of durations for construction effects. This does not preclude construction activities occurring in another order or concurrently to complete the construction programme. The ultimate construction sequence will be confirmed once a contractor is appointed and detailed design is complete.

The indicative staging of works include:

- Site preparation – including demolition, site clearance, utilities relocation/protection. Establish site offices and amenities.
- Station construction zone to be used as a central hub for constructing the adjacent sections of rail corridor.
- Construct new SH20 footbridge. Bridge spans can be installed under nightworks motorway closure.
- Demolish/remove existing SH20 footbridge. Bridge spans can be removed during nightworks motorway closure.
- Construct new station platform & structures.
- Streetscapes upgrades.

Standard hours of work for this site are anticipated to be 7am-6pm Mon-Sat. Any works outside of these hours will be notified and coordinated with impacted local residents.

The station construction support area will provide functions as detailed in section 3.7.

Initial site preparation activities will include:

- Install noise/vibration/settlement monitoring to neighbouring buildings if required.
- Utilities relocation/protection.
- Demolition & site clearance.
- Establish site offices, amenities, laydown areas, dewatering & sediment control systems.

The alignment through Māngere Bridge is predominantly at grade along the eastern side of SH20. Access will be via neighbouring side streets (Hastie Ave, Mahunga Drive, Miro Road) and the motorway shoulder. Some sections of SH20 may require localised narrowing of lanes with reduced speed limits, while maintaining the current number of traffic lanes wherever possible.

Station - East side of SH20

- Construction traffic to access station via Mahunga Drive in both directions.
- Access to be maintained to adjacent church (Livingstone Evangelism Ministry).

West side of SH20

- Construction traffic to access station via Miro Road and Crawford Avenue in both directions.
- Also via Hastie Avenue for junction upgrades at Coronation Road and Crawford Avenue.
- Access to be maintained to properties along Miro Road adjacent to SH20.

5.19 NoR 18: Te Ararata Station

5.19.1 Introduction

Te Ararata Station will provide access to ALR for the residents of Favona and Māngere. The proposed platform will run parallel to SH20 and perpendicular to Hall Avenue. The station is located at the existing elevated footbridge at Hall Avenue. This footbridge will be replaced to allow for safe pedestrian and cycle connectivity across SH20. To enable seamless connections between modes of public transport, the station forecourt will have the capacity for bus bays.

This station contains:

- At grade, fully segregated station typology with island platform arrangement.
- Enhancements to existing streetscapes to provide active modes access and to connect with bus services.
- Provision for intermodal spaces.

5.19.2 Identified Constraints

Table 5-17 summarises the constraints identified for Te Ararata Station.

Table 5-17 Summarised constraints for Te Ararata station

Constraint	Description
Traffic	There may be some effects during construction on SH20 and SH20A. A reduction in traffic lanes should be avoided, but some reduction in lane widths, and shoulder widths should be tolerable. Active mode links (e.g., over SH20) should be retained during construction. In particular, Hall Avenue provides one of the few east-west connections across SH-20 for active modes, thus it should be retained during the construction phase. Other locations of interest include at/adjacent to each motorway interchange, and in the Māngere town centre area.
Landscape	Alignment within the State Highway corridor is logical as it follows that of the existing infrastructure. This does however come with existing severance issues for connectivity across the corridor, and the potential to exacerbate or create additional severance issues.
Arboriculture	Multiple street trees could be affected by works. Additionally, the removal of multiple street trees/motorway plantings may be contentious amongst the community, however various tree groups can be managed adequately.
Construction Noise and Vibration	A work site layout must be designed which minimises high noise and vibration construction methods near standalone houses.
Volcanology	A volcanic viewshaft is located to the west of the NoR boundary.
Stormwater and Hydrology	Flood prone areas on western edge are to be avoided. Additionally, large areas of flood plain and flood prone areas to the eastern edge are to be avoided.
Settlement Principles	Potential adverse settlement effects apply given the presence of thick, soft and compressible soil. Consequently a site-specific ground investigation must be undertaken to inform settlement magnitude, with raft or deep foundation systems depending on structure loading.
Social	The removal of housing will displace people from within the community, thus potentially impacting social cohesion. However, there is a potential for a positive

	outcome with intensive housing near a Rapid Transit Network station and higher density.

5.19.3 Design development & response

Te Ararata Station has been located alongside SH20 to avoid disruption to the area. This section of the rail alignment is surface running, therefore any diversion from the highway corridor would require additional land and property impacts. The location also offers the opportunity to address community severance created by the SH20 by improving east-west connectivity with a new east-west pedestrian and cycle bridge over the motorway.

Te Ararata Station is a surface island station, with the ALR tracks separating the main station building from the platform. The primary station entrance will be provided from Fatafehi Place. Secondary egress from the platform will be a staircase which will connect to the new motorway spanning pedestrian and cycling bridge. Accessible and safe access to the platforms beyond the gateline is through an underpass with lifts and stairs provided.

5.19.4 Construction methodology/constructability

This section outlines the indicative construction sequencing assumed to inform the designation footprint for both the temporary construction works and the operational designation footprint. It also provides an outline of the range of durations for construction effects. This does not preclude construction activities occurring in another order or concurrently to complete the construction programme. The ultimate construction sequence will be confirmed once a contractor is appointed and detailed design is complete.

The indicative staging of works include:

- Site preparation- including demolition, site clearance, utilities relocation/protection. Establish site offices, amenities, dewatering & sediment control systems (Duration ~3-6 months).
- Install retaining walls and excavate alignment alongside SH20. Install tracks & systems (Duration ~6-12 months).
- Construct rail trench beneath Walmsley Road. Staged approach to allow traffic routes to be maintained (Duration ~6-12 months).
- Construct new footbridge and demolish existing Hall Rd footbridge sequenced to ensure that active mode access across SH-20 is maintained at all times (Duration ~6 months).
- Construct station access trench, platform, services building (Duration ~6 months).
- Station fitout (Duration ~8 months).
- Upgrades and reinstatement of surrounding streetscapes (Duration ~3 months).

Standard hours of work for this site are anticipated to be 7am-6pm Mon-Sat. Any works outside of these hours will be notified and coordinated with impacted local residents. Some nightworks motorway closures of SH20 will be required, particularly during the pedestrian footbridge replacement.

The construction support area will provide the functions as detailed in section 3.7.

The station and alignment sites are currently occupied by residential houses, local roads & motorway corridor.

Initial site preparation activities will include;

- Install noise/vibration/settlement monitoring to neighbouring buildings if required.
- Utilities relocation/protection.
- Demolition & site clearance.
- Establish site offices, amenities, laydown areas, dewatering & sediment control systems.

The following information relates to access to the Te Ararata site for construction traffic:

East side of SH20 – Station site

- Access via Hall Avenue (both directions) and from Donnell Avenue (to the south only).
- Access to adjacent residential properties and streets to be maintained during construction.

East side of SH20 – Alignment

- Access directly from the SH20 shoulder where possible
- Access from the station construction compound.
- Access from side streets where property rationalisation & demolition provides a direct connection (Kingfisher Place, Rehua Place, Masters Place, Ashmore Place).

West side of SH20 – footbridge western abutment.

- Construction traffic to access site via Elmdon Street & Hall Ave.

The existing SH20 footbridge will be demolished/removed. Bridge spans can be removed during nightworks motorway closure. It is to be confirmed whether piers require removal. Central median and eastern piers will require demolition access from the motorway median and onramp lanes. Upon the destruction of the existing footbridge, a new SH20 footbridge with bridge spans is be installed under nightworks motorway closure.

Appendix A Drawing set

Refer to the 17 NOR drawings

Appendix B Basis of Design Report

Refer to ALRPC-ALRA-ZZZZZZZZ-ZZZ-ZZ-ZZZ-RP-RPT-000002

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