Northern Corridor Improvements

Design and Constructability Report

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NZ TRANSPORT AGENCY
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Glossary of Abbreviations	
AEE	Assessment of Environmental Effects
AFGL	Above Finished Ground Level
AMA	Auckland Motorway Alliance
ARC	Auckland Regional Council
AT	Auckland Transport
AT CoP	Auckland Transport Street Lighting Code of Practice
ATMS	Advanced Traffic Management System
BPO	Best Practicable Option
CSA	Construction Support Area
CZ	Construction Zone
DCR	Design & Constructability Report
DHC	Double Hollow Core
ECBL	East Coast Bays Link
ESCP	Erosion and Sediment Control Plan
FIH	Federation International Hockey
HHCT	Harbour Hockey Charitable Trust
HWG	Hockey Working Group (New Zealand Transport Agency, North Harbour Hockey, Harbour Hockey Charitable Trust, Hockey New Zealand, Watercare Services Limited, Auckland Council)
ITS	Intelligent Transport Systems
JMAC	Joint Modelling Application Centre
LED	Light Emitting Diode
MSE	Mechanically Stabilised Earth (block walls)
NCI	Northern Corridor Improvements
NHH	North Harbour Hockey
NoR	Notice of Requirement

Glossary of Abbreviations	
NZ Transport Agency	New Zealand Transport Agency
PWA	Public Works Act
RSA	Road Safety Audit
SH1	State Highway 1
SH18	State Highway 18
SID	Safety In Design
SUP	Shared Use Path
TFUG	Transport for Future Urban Growth
The Project	The Northern Corridor Improvements Project; including Alterations to Designations and activities requiring Resource Consents
TTM	Temporary Traffic Management
UC	U-Channel
UHH	Upper Harbour Highway
WRR	Western Ring Route
WSL	Watercare Services Limited

Terms and Definitions

Terms	Definitions
Alignment	The route or position of the proposed motorway.
Auckland Council (AC)	The unitary authority in terms of the Local Government (Auckland Council) Act 2009 and the Local Government (Auckland Transitional Provisions) Act 2010 which replaced the eight existing councils in the Auckland Region as of October 2010.
Best Practicable Option (BPO)	Defined in Section 2 of the RMA. In relation to a discharge of a contaminant or an emission or noise, this means the best method for preventing or minimising the adverse effects on the environment.
Culvert	A pipe, designed to convey water under an embankment
Designation	Defined in Section 2 and Section 166 of the RMA as provision made in a district plan to give effect to a requirement made by a requiring authority under section 168 or section 168A or clause 4 of Schedule 1.
Discharge	An activity that results in a contaminant being emitted, deposited, or allowed to escape.
Effect	As defined in Section 3 of the RMA, the term effect includes: Any positive or adverse effect; and Any temporary or permanent effect; and Any past, present, or future effect; and Any cumulative effect which arises over time or in combination with other effects – regardless of the scale, intensity, duration, or frequency of the effect, and also includes- Any potential effect of high probability; and Any potential effect of low probability which has a high potential impact.
Hydrology	The branch of science concerned with the properties of the earth's water.
Motorway	As defined in Part 2 of the Public Works Act 1981: A motorway declared as such by the Governor-General in Council under section 138 of this Act; and includes all bridges, drains, culverts, or other structures or works forming part of any motorway so declared; but does not include any local road, access way, or service lane (or the supports of any such road, way, or lane) that crosses over or under a motorway on a different level
Overland Flow Path	The natural flow path of stormwater over the ground.
Paul Matthews Road Interchange	A new interchange inclusive of the reconfiguration of the existing Caribbean Drive intersection, a new eastbound off-ramp from SH18 and a direct connection of Paul Matthews Road to Upper Harbour Highway via a new bridge structure.

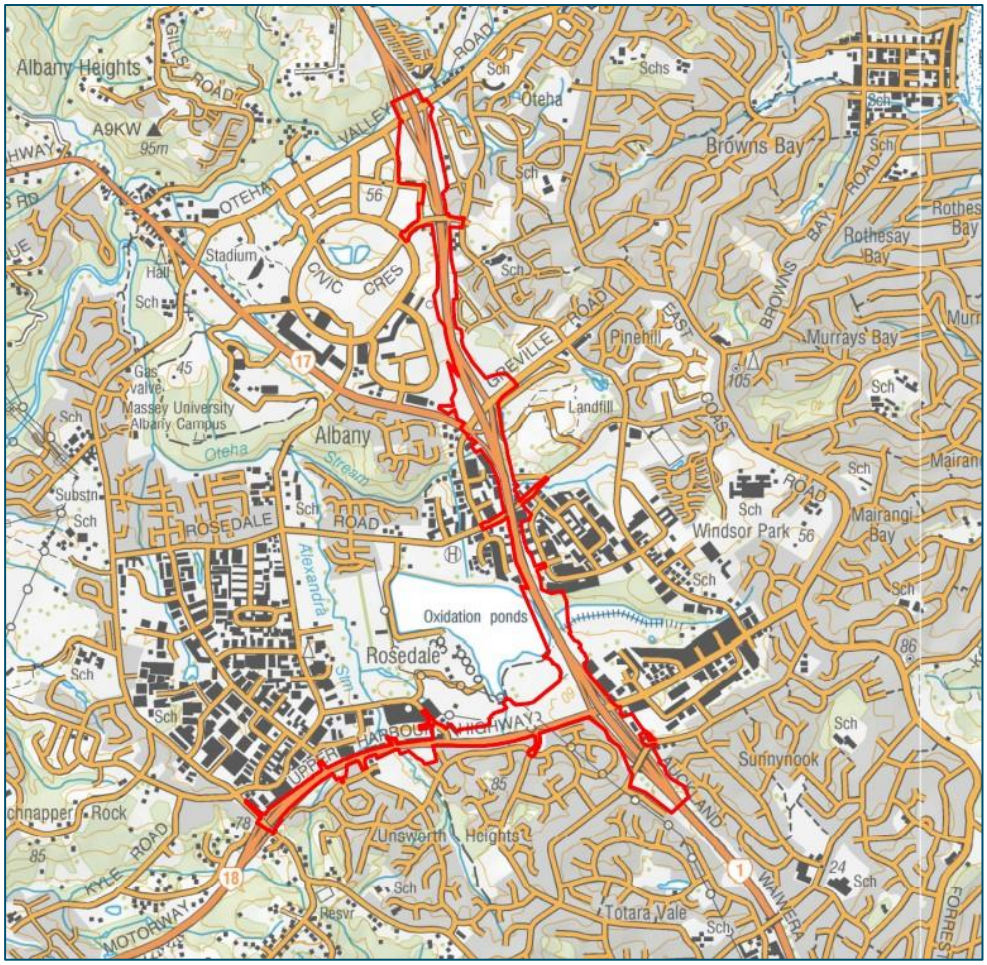
Terms	Definitions
Pedestrian/Cycleway	A dedicated facility for the shared-use of pedestrians and cyclists.
Pier	Vertical support structure for a bridge.
Project Area	The Project area is the Project corridor and immediate surrounds as shown in Figure 1.
Sediment Control	Capturing sediment that has been eroded and entrained in overland flow before it enters the receiving environment.
Western Ring Route (WRR)	A strategic State highway route which provides an alternative to SH1 as a regional route for traffic traversing Greater Auckland. The WRR requires the completion of links and new lanes to combine the South-western (SH20), North-western (SH16) and Upper Harbour (SH18) highways into a continuous 48km motorway. The WRR will link the North Shore, West and South Auckland.

1 Introduction

1.1 Project Overview

The Northern Corridor Improvements Project (the Project) is an accelerated project. The Project area covers the area of SH18 between Albany Highway and Constellation Drive, and SH1 between Upper Harbour Highway (UHH) interchange to just beyond the Oteha Valley Road Interchange as indicated on **Figure 1** below and confirmed in the suite of plans provided in **Volume 5**.

Figure 1 Extent of Project Area



Source: Base Map from LINZ

The Project proposes to upgrade the existing State highways within the Project area. In summary, the key elements of the Project are as follows:

- North and West Motorway Interchange connections – SH1/SH18;
- State highway capacity and safety improvements;
- Northern busway extension from Constellation Station and connection to Albany Station;
- Reconfiguration of Constellation Station converting it from a terminus station to a dual direction station

- Shared Use Path (SUP) provision along existing SH1 and SH18 routes for the full extent of the Project corridor
  - Constellation Station to Oteha Valley Road
  - Constellation Drive to Albany Highway
  - Intermediate linkages to local network

A full description of the Project, including its components and construction, is contained in section 5 of the Assessment of Environmental Effects

1.2 Project Objectives

The objectives for the project are:

- To help facilitate interregional travel between Auckland and Northland by completing the Western Ring Route to motorway standard
- To improve connectivity of the SH1 and SH18 interchange
- To improve safety, efficiency, reliability and the capacity of
  - SH1 between SH18 and Albany; and
  - SH18 between SH1 and Albany Highway.
- To provide safe walking and cycling facilities adjacent to SH1 and SH18 and connections to local transport networks.
- To extend the North Shore Busway from Constellation Bus Station to the Albany Bus Station.

1.3 Purpose of this Report

This Design and Constructability Report (DCR) prepared by Aurecon New Zealand Limited (Aurecon) is an appendix to the Assessment of Environmental Effects (AEE) which supports the New Zealand Transport Agency's (NZ Transport Agency) Notices of Requirement (NoR) and suite of Resource Consent Applications for the Project.

The DCR describes the indicative design, construction and operation of the Project works to provide a clear understanding of the Project components.

This is to enable an understanding of the scale of the potential effects on the environment as a result of the Project, sufficient to inform technical specialists undertaking the required assessments.

1.4 Report Structure

This report is structured to describe an overview of the Project, relevant physical works, construction methodologies and other considerations relevant to the Project resource consent requirements. The report follows the following structure:

- **Section 2:** Project Constraints – Describes the key physical and programme constraints on the Project;
- **Section 3:** Design Approach – Introduces the historical design development, the current design philosophy and principles which influence the design;
- **Section 4:** Design Description – Describes the key elements of the design including any key design and environmental considerations;
- **Section 5:** Construction Zones & Construction Support Areas – Introduces the Construction Zones and the works within them;
- **Section 6:** Construction Duration & Staging – Describes the overall timing and sequencing of the physical works;

- **Section 7:** Construction Methodology – Describes the construction methodology assumed for each key element including any specific requirements and/or limitations;

The report is supported by the following appendices:

- Appendix A: Sketches showing indicative options for the proposed causeway works.
- Appendix B: A drawing of the proposed construction zones.
- Appendix C: Indicative Construction Programme.
- Appendix D: A drawing showing the indicative cut and fill volumes by construction zone.

2 Project Constraints

There are two key categories of constraint for the Project. There are physical constraints which predominantly affect the development of the design solution, and time constraints which impact the anticipated construction staging, methodology and cost.

The physical constraints which have influenced the design to date generally result from the dense existing urban environment and the engineering challenges associated with this. The main physical constraints relating to the Project are shown in the table and further described below.

Table 1 Physical Constraints

Key Constraint	Description
Property	The Project corridor is constrained by the proximity of adjoining land uses. Commercial, industrial, residential and open space activities all abut the Alignment.
Topography	Due to the topography of the area, the construction of a significant number of retaining walls (cut and fill) will be necessary along the Project Alignment.
Utilities	There are several key utility assets within the project area including Watercare's Rosedale Waste Water Treatment Plant and associated Pondlink, TS5 & TS7 sewers, Transpower's 220kV cables and Vector's 110kV cables.
Stormwater	The Project Area already experiences flooding in various locations, and includes a number of Auckland Council stormwater ponds critical to its network that will be affected by the works and need to be reinstated. There is also considerable cross catchment flow across the Project Area which will be affected by the motorway embankment works. This flow will be managed by cut-off drains located within the Designation.
Geometric Design	The alignment is constrained by the requirement for compliance with geometric design standards as far as practicable. This has particular relevance for the tie in to the existing SH18 and SH1 corridors and the need for the busway to tie into the existing Constellation and Albany stations.
Environmental	The extension of the busway impacts the Rosedale Closed Landfill. Any impact on the landfill needs to be mitigated appropriately.
Existing Structures	Existing structures affect the geometric design and overall Project solution including existing bridge levels, clearances, bridge conditions, structural capacities, acceptable structural forms and an influence on urban design outcomes.
Growth/future projects	Wherever possible the design should not preclude future NZ Transport Agency aspirations such as south-facing SH1/SH18 ramps and allowance for future TFUG projects.
Construction Noise	Due to the close proximity of dwellings and businesses to the construction works, there are many locations where construction methods will need to be developed to minimise construction noise.

The time constraints which have influenced the development of the anticipated construction staging, methodology and cost are outlined in the table below.

It should be noted that the construction staging and methodology described within this DCR represents a realistic and feasible methodology from which the anticipated effects on the environment of these activities can be identified. It is intended to be indicative and does not represent a definitive methodology which will be developed by the contractor once appointed at a later stage of design development.

Time constraints are constraints which are expected to influence the timing of construction activities including:

- The ability of the contractor to begin the activity/works;
- The duration of the activity/works; and
- Working hours (e.g. night works, weekend works).

Table 2 Time Constraints

Key Constraint	Description
Live Carriageway	The construction of the Project is highly constrained by the requirement to minimise disruption to the existing service levels of the carriageway, and in particular existing public transport operations including Constellation Station and Albany Park & Ride.
North Harbour Hockey	Availability of all existing North Harbour Hockey Club facilities to host the 2016-17 Women's FIH World League Final in November 2017. This includes the clubhouse, parking and 4 pitches on the existing site.
Property Acquisition	The acquisition of property either as a result of willing buyer/willing seller or through application of the Public Works Act (PWA) has a direct impact on the construction timetable. Provision of access to required properties by the contractor is critical to the construction of various elements of the Project.
Earthworks	The earthworks season is within the driest months (2 October to 31 April) in order to control sedimentation.

3 Design Approach

3.1 Design Development

A number of early investigations and studies had been undertaken by the NZ Transport Agency (as well as the Auckland Council and Auckland Transport) since 2010 on a number of the components that now form part of the Project. These formed the starting point for the development of the design for lodgement as described in this report.

3.2 Design Principles

3.2.1 Safety In Design (SID)

Safety in Design (SID) considerations for construction, operations, maintenance and decommissioning have been considered in development of all design elements and are recorded within the project SID register.

3.2.2 Road Safety Audit (RSA)

The design has undergone a further Road Safety Audit (RSA). Previous issues raised by the auditors during earlier stages of design have been successfully closed out and new issues raised are relatively minor with no fundamental flaws.

It is expected that further RSAs will be completed during development of the detailed design.

3.2.3 Road Geometry & Signage

The proposed works are intended to create a safe and efficient section of highway and improve the overall function of SH1, SH18 and the adjoining network where affected. The design has been developed based on the principle that the design:

- will not exacerbate any existing design deficiencies; and
- will improve or remove existing deficiencies where practicable.

3.2.4 Road Lighting

The road lighting has been designed to provide for the following whilst minimising spill lighting, glare and skyglow:

- Provision or replacement of any lighting including infrastructure necessary on local authority-controlled roads to tie in with new interchange lighting.
- A limit of reticulation on the existing motorway and local roads that will be either sufficient to transition into the existing lighting system (where one exists), or sufficient to illuminate the furthest physical island that is constructed as part of the overall works in unlit situations.

3.2.5 Earthworks

The key design principles adopted are as follows:

- All cut/fill slopes will be stabilised to prevent any fretting or erosion after construction. Spill-through abutment slopes shall be surfaced with paving stone blocks to eliminate the potential for weed growth and erosion;
- An overall project cut/fill balance will be maintained as far as practicable; and

- Earthworks, cut slopes, and fill embankments have been designed with gradients of 1V:3.0H (vertical:horizontal). In some constrained areas, fill slopes have been increased in gradient to 1V:2.5H (vertical:horizontal). These parameters require confirmation following detailed site investigation results.

3.2.6 Busway extension

The busway design principles are as follows:

- Busways are about moving people more efficiently, more reliably, more comfortably, safely and faster;
- Busways and stations should also provide the ability to transfer between local/ feeder services and rapid and frequent express services;
- Busways and stations should be flexible to potential changes in network strategies -
  - Infrastructure should allow for future network design;
  - land use change, maintenance diversions and emergency access/egress; and
  - Infrastructure should protect for future co-location of regular buses with higher-capacity vehicles.
- Busways and stations should be easy to use and attractive to potential public transport patrons on and off the busway network;
- Busways and stations should be sensitive to their context while maintaining legibility, quality and functionality;
- Busways and stations should minimise fire and life safety risks to patrons and the broader community; and
- The preferred hierarchy for access modes to all busway stations is:
  - walk/cycle;
  - other public transport (i.e. feeder buses);
  - taxi;
  - kiss and ride; and
  - park and ride.

For the reconfiguration of Constellation Station the following architectural principles have been adopted:

- A range of modular design elements applicable to a wide range of situations;
- Key themed architectural elements within the ‘kit of parts’, including ‘Clouds’, ‘Masts’, and ‘Landscape’, that express the essence of the Auckland Region;
- Community safety focus with maximised user visibility; and
- Cost-effective, robust and easily maintained materials.

3.2.7 Bridges and Structures

The key design principles adopted are as follows:

- Design life of 100 years for new structures (including new elements attached to existing). The existing structures are to have a minimum remaining serviceable life of 20 years following construction;
- The seismic assessment of the existing bridges is based on a 500 year minimum return period event;
- Edge protection to be TL4-HT (overbridges) or TL5-HT (motorway structures) barriers (as per NZTABM Appendix B);

- Allowance made for existing and future services;
- Allowance for future retrofit of anti-throw screens where structures are over the motorway;
- If possible the design should attempt to eliminate joints, bearings and associated maintenance requirements through semi-integral/integral design; and
- Kerbs on bridges adjacent to footpaths/shared paths should be semi-mountable.

3.2.8 Rosedale Closed Landfill

The design of the highway, busway and SUP in the vicinity of the Rosedale Closed Landfill has been developed based on the following design principles:

- Minimisation of the cut into the existing landfill and in particular the existing refuse;
- Minimisation of the impact on the existing Auckland Council Closed Landfill gas monitoring and leachate reticulation systems; and
- Safety of construction.

3.2.9 Stormwater and Hydrology

The key principles adopted for the design of the stormwater and hydrology are described within the Assessment of Stormwater Management, Technical Assessment 11 of **Volume 3**.

3.2.10 Landscaping and Urban Design

Landscaping and urban design are described within the Assessment of Landscape & Visual Effects, Technical Assessment 11 of **Volume 3** and the Urban Design and Landscape Framework, **Volume 4**.

4 Design Description

4.1 General

This section describes the proposed design of the NCI Project as outlined in the following suite of plans provided in **Volume 5**:

- General Arrangements;
- Constellation Station General Arrangement;
- Typical Cross Sections; and
- Civil Structures.

The description is separated into the following key elements:

- Highway & Local Road Works
- Busway
- Walking & Cycling: Shared Use Path (SUP)
- Structures
- Causeway Works
- Landfill
- Stormwater
- Works in and around streams
- Utilities

It should be noted that the proposed design described within this DCR is a preliminary design and will be developed further during the implementation phase once a contractor is appointed.

4.2 Highway and Local Road Works

4.2.1 General

The Project includes the following main highways and roading elements:

- Upper Harbour Highway (SH18) is to be upgraded to full Motorway status and separated from the local roads.
- New direct connections are to be provided, between SH1 (north) and SH18 (westbound), and between SH18 (eastbound) and SH1 (north).
- The existing third northbound lane on SH1 will be extended across the Upper Harbour Interchange as far as the new connection from SH18.
- Additional (fourth and fifth) lanes are to be provided northbound on SH1 between the new SH18 eastbound connection and the Greville interchange.
- An additional (fourth) lane is to be provided northbound on SH1 between the Greville Interchange and the Oteha Valley Interchange. This will allow an additional general traffic lane to be provided, next to the existing climbing lane.
- Additional (third and fourth) lanes are to be provided southbound on SH1 between the Greville Interchange and the new SH18 westbound connection.

- There will be a lane drop, from four to three lanes, southbound on SH1, at the new connection to SH18, but the third lane will continue beyond the Upper Harbour southbound off ramp.
- An additional lane will be provided on SH1, across the Greville Interchange, in both the northbound and southbound directions.
- Extension of the Northern Busway from the Constellation Bus Station to the Albany Bus Station.
- Shared walking and cycle path on the eastern side of the Northern Motorway between the the Constellation Bus Station and the Albany Bus Station.
- Further walking and cycling connections are to be provided alongside SH18, between SH1 and the SH18 Albany Interchange.
- Modified connections are to be provided to Paul Matthews Road including a new bridge structure, with local road access retained and walking and cycling access added along and across SH18.
- Increasing the vertical clearance from Rosedale Road to the SH1 bridge soffit by lowering Rosedale Road.
- The proposed layout along the mainline of the motorway is shown within the General Arrangement plans provided within **Volume 5**.

4.2.2 Grade separation of SH1 and SH18 (Motorway to Motorway ramps)

The proposed system interchange will include two direct Motorway to Motorway ramp connections between SH1 southbound to SH18 westbound and SH18 eastbound to SH1 northbound.

The SH1 southbound to SH18 westbound ramp will be a two-lane exit with two lanes at the nose. The ramp will cross over SH1 and the two lanes will continue to form the eastern end of the westbound carriageway of the SH18 Motorway.

The SH18 eastbound to SH1 northbound ramp will be a two lane ramp with ramp meter and a bypass transit lane. The ramp commences at the eastern end of the realigned SH18 Motorway. The ramp will be two lanes at the entry nose and the SH1 northbound carriageway will gain two auxiliary lanes after the ramp merge.

4.2.3 State Highway 1 (SH1)

4.2.3.1 SH1 / Upper Harbour Interchange

The existing Upper Harbour Interchange (sometimes referred to as the SH1 Constellation Drive Interchange) is a closed diamond configuration with the mainline elevated over Upper Harbour Highway. It includes both north facing and south facing ramps, with signalised intersections at the two intersections of the Motorway ramps with Upper Harbour Highway (northbound ramps) and Constellation Drive (southbound ramps). The northbound on ramp has a bus lane which bypasses the ramp meter signals.

The existing northbound off ramp is a 1 lane diverge with subsequent lane drop. The existing ramp widens from one to three lanes after the ramp nose. As part of the NCI Project it is proposed to widen the ramp by one lane from three to four lanes at the terminal intersection, adding a second left turn lane to increase capacity.

The existing northbound on-ramp is configured as a two lane ramp with ramp-meter and bypass bus-lane. It merges to one lane at the ramp nose and then joins SH1 as a third auxiliary. As part of the NCI Project the ramp will be realigned to suit the widened northbound carriageway, the bypass bus lane will be removed as it will no longer be required due to the busway extension and a new enforcement bay added near the ramp meter.

The existing southbound off-ramp is a one lane simple diverge with a bus-lane shoulder. The ramp widens to four lanes after the nose at the terminal intersection, including a bus lane with buses able to enter the Constellation Bus Station at the foot of the ramp. As part of the NCI Project, the ramp will be realigned to suit the widened SH1 southbound carriageway and the bus-lane and bus-shoulder will be removed as it will no longer be required.

The existing southbound on-ramp is configured as a two-lane ramp with ramp meter and bypass T2 transit lane. It merges to one lane at the ramp nose and then is a simple merge with the two lane SH1. No modifications are proposed to this ramp as part of the NCI Project.

4.2.3.2 SH1 / Greville Road Interchange

The Greville Road Interchange is a part-diamond, part-loop (Trumpet Type A) arrangement with the mainline elevated over Greville Road.

The existing southbound off-ramp is a one lane ramp with subsequent lane drop. The existing ramp widens after the nose to three lanes including a bus lane at the terminal intersection. As part of the NCI Project, the exit will be changed from a lane drop to a simple diverge with taper. The terminal intersection with Greville Road will be modified from a part-signalised tear-drop roundabout to a conventional four-arm signalised intersection. Two lanes will be provided at the ramp terminal without a bus-lane.

The existing southbound on-ramp is a two lane ramp with ramp meter and bypass T2 transit lane. It is one lane at the nose. As part of the NCI Project the ramp will be realigned and widened to two lanes at the nose and the SH1 southbound carriageway will gain one auxiliary lane after the ramp merge.

The existing northbound off-ramp is a two lane exit. After the nose the ramp widens from two to five lanes at the terminal intersection with Greville Road. The NCI Project proposes to realign the ramp and reconfigure the ramp lane development to ensure there are no trapped lanes at the terminal intersection. The exit will be modified to a two-lane exit with subsequent lane drop.

The existing northbound on-ramp is a single lane loop ramp. The existing ramp merges with the SH1 northbound carriageway as an auxiliary climbing lane. The NCI Project is proposing to realign the ramp and retain the climbing lane.

4.2.3.3 SH1 / Oteha Valley Road interchange

The existing interchange is a closed diamond configuration with the mainline elevated over Oteha Valley Road.

The existing northbound off-ramp is a single lane exit with subsequent lane drop. The ramp gains a lane after merging with an exit ramp from the Albany Bus Station. As part of the NCI Project, the ramp will be realigned and widened to a two-lane exit with subsequent lane drop. The ramp will be widened to three lanes at the merge with the bus station exit ramp.

All other ramps will not be modified as part of the NCI Project.

4.2.4 State Highway 18 (SH18)

4.2.4.1 SH18 / Albany Highway Interchange

The existing Albany Highway interchange is a conventional diamond configuration. The on-ramps are single lane simple merge type ramps and the off-ramps are single lane simple diverge type ramps.

As part of the NCI Project, it is proposed to improve the existing substandard westbound off-ramp sight distance. No other modifications to the interchange are proposed.

4.2.4.2 SH18 / Paul Matthews Road Interchange

The proposed Paul Matthews Road Interchange will be a half diamond configuration with only a westbound on-ramp and eastbound off-ramp. The westbound on-ramp will be a 2 lane ramp with ramp meter. The two lanes will merge into one lane at the ramp nose and will be a simple merge with the 2 lane motorway. The eastbound off-ramp will be a single lane simple diverge widening to two lanes after the nose.

The eastbound off-ramp terminal will be a roundabout with an entry speed of 30km/h and suitable speed reducing curves prior to the roundabout.

4.2.5 Lighting

4.2.5.1 Main Carriageway

To minimise the visual impact on the environment the main carriageway shall have the lighting columns located within the protective central median concrete barrier with infill lighting positioned on the shoulders where ramps are located for on and off ramps. Wider sections with 5 lane arrangements will require infill lighting from the shoulder from a dual opposite arrangement to improve the uniformity and compressed centres to meet the design levels defined within the New Zealand Transport Agency's M30 Specification for Road Lighting including joint Australia New Zealand AS/NZS1158 Road Lighting Standards.

The optimum elevation of the lighting columns for the main carriageway will be a nominal height of 12-14m above finished ground level (AFGL) with an outreach arm of 1.2-3m with provision to extend to a maximum of 4.2m if necessary. For visual uniformity, the ramps will have the same column height but with a shorter outreach arm of a minimum of 1.2m-2.4m pending on the offset from the kerbline or low-level protection. Where lighting poles along the shoulder require safety clearances from HV overhead lines then the lighting poles will be assessed in overall height to meet the minimum distances.

The lighting columns will be direct buried in the shoulder with the appropriate foundation type of shear, flanged or frangible bases. Columns located within a protective concrete barrier will be flange based. Central median lighting will be twin outreach arrangement with the ramps having a single luminaire per column. The lighting columns will be located at a general spacing of 60m along the central median with 45-55m spacing along the shoulders where ramps are located.

4.2.5.2 Busway

The busway is separate from the main carriageway and treated as a separate road. The busway serves travel in both directions and is intended for dedicated public transportation and emergency service vehicles. The lighting is intended to be located within the outer barrier with a double outreach lighting over the shared use path.

4.2.5.3 Shared Use Path

The shared use path runs along the eastern edge of the dedicated bus lanes with protective barrier separation. As the alignment, runs parallel with sections of the bus lane, these segments will be lit from a double outreach arm. The fixed heights are to be determined and may result in a staggered height arrangement in relation to the lower path. Lighting of any pedestrian walkways or cycle ways shall be to AS/NZS1158:2005 Cat P2 or as required by AT CoP. For sections of the cycleway that run parallel to SH1, direct lighting may not be required

4.2.5.4 Intersections

The intersections serve as connecting arterial roads to the proposed NCI Project and provide both controlled traffic and turning lanes to existing tie in roads. The intersection will be lit to meet local council authority requirements and the Auckland Transport Street Lighting Code of Practice (AT CoP). The power supply will be connected to the local Vector network and metered to the local council authority as required by the AT CoP.

The connecting arterials are to be agreed with local authorities to identify the extent of works. This detail is critical to ensure electrical connections and metering is coordinated with the correct authorities.

4.2.5.5 Bridges

Provision for lighting to bridges located to the side of the deck and behind protective railing is required. Underside lighting may be required and will be investigated further by the NZ Transport Agency and AT in subsequent design stages.

4.2.5.6 Pedestrian crossings (AT)

Joint use poles will be coordinated with traffic management to combine the use of general road lighting and signals. Where controlled pedestrian crossings are located then lighting levels will be designed to meet AT CoP with a white light source (LED) to provide good colour rendering and vertical illuminance thereby improving pedestrian visibility to oncoming traffic. Painted out Zebra Type crossings will also comply with AT CoP guidelines.

4.2.6 Earthworks

Earthworks cut slopes and fill embankments have been designed with gradients of 1V:3.0H (vertical:horizontal). In some constrained areas, fill slopes have been increased in gradient to 1V:2.5H (vertical:horizontal). Where further constrained and a simple earthworks solution is not possible retaining walls have been proposed.

4.2.7 Pavements & Surfacing

Specific design of pavements and surfacing has not been undertaken for the preliminary design of the NCI Project. Further ground investigation and existing pavement testing is required to progress the pavement and surfacing design.

4.3 Busway

4.3.1 Busway Constellation to Albany

The northern busway will be extended from Constellation Station to Albany Station along the eastern side of SH1. This includes new structures over Constellation Drive, Rosedale Road, Greville Road and SH1 into Albany Station which are described further in Section 4.5 below.

4.3.2 Constellation Station Reconfiguration

Reconfiguration of Constellation Station will include the following key features:

- Extension of existing platform 2 (southbound platform) including the cantilevered canopy structure;
- Widening of the busway carriageway to the east along with a new median traffic island to create 2 southbound lanes and 2 northbound lanes;
- Creation of a new northbound platform (platform 1) partly on retained fill, including a cantilevered canopy structure;

- Creation of a lift and stair tower between platform 2 and 3 and a lift and stair tower adjacent to platform 1, supporting a new pedestrian overpass structure across the busway; and
- Reconfiguring the internal layout of the concourse between existing platforms 2 and 3 requiring the relocate the electrical and communications rooms.

4.3.3 Albany Station circulation

The Project includes minor reconfiguration of the Albany Bus Interchange with re-alignment of the existing bus only access to the station from Cornerstone Drive to provide integration of the proposed Northern Busway extension with the Albany Bus Interchange.

Discussions are ongoing between the Transport Agency and Auckland Transport regarding the details of the interface between the new busway connection and AT Metro's connector and local services.

4.4 Walking and Cycling: Shared Use Path (SUP)

The project proposes to include the following new walking & cycling components:

- North/south shared path adjacent to (east of) the new Busway from Constellation station to Oteha Valley Road, a distance of approximately 4km with connections to local roads at:
  - Lavender Garden Lane;
  - McClymonts Road;
  - Spencer Road;
  - Greville Road;
  - Rosedale Road;
  - Arrenway Drive; and
  - Constellation Drive.
- East/west shared path along Upper Harbour Highway and SH18 from Constellation Station to Albany Highway, a distance of 2.3km, with connections to local roads at;
  - Caribbean Drive;
  - Paul Matthews Road;
  - Alexandra Creek cycle path; and
  - William Pickering Drive.
- The existing Alexandra Creek underpass will be extended to allow for the widening of SH18; and
- Controlled pedestrian / cycle crossings at the following signalised intersections:
  - Constellation Drive southbound SH1 on-ramp;
  - Constellation Drive northbound SH1 off-ramp; and
  - Caribbean Drive intersection.

4.5 Structures

4.5.1 Bridges

The Project incorporates several existing road crossings and interchanges in addition to the proposed grade separation of SH1 and SH18 intersections and will achieve a motorway standard along SH18 and a reliable journey time along the SH1 busway corridor. This results in several new bridges and the widening or lengthening of existing structures.

4.5.1.1 Bridge List

Below is a comprehensive list of bridge structures, excluding major culverts which are included in section 4.5.3 below.

Table 3 Bridge List

Name**	Existing / New	Drawing No.*
Albany Station Busway Bridge	New	1310
McClymonts Rd Bridge Replacement	New	1315
Greville Rd Busway Bridge	New	1320
Greville Rd Bridge Widening	Existing	1325
Rosedale Rd Busway Bridge	New	1330
Rosedale Rd Bridge Widening	Existing	1335
Watercare Pond Link Bridge	New	1340
SH1 - SH18 Westbound Ramp	New	1345
Constellation Dr Busway Bridge	New	1350
Constellation Dr Bridge Widening	Existing	1355
Caribbean Dr Intersection Bridge	New	1365
Paul Mathews Rd Bridge	New	1370
Alexandra Creek Pedestrian Underpass Extension	Existing	1375

* All Drawing Numbers are prefixed with “250310-3PRE-3DES-DRG-“

**In addition to the information on the drawings, a description of the proposed construction at each structure follows later in this report.

4.5.1.2 Departures

Currently no structural departures from standard engineering requirements have been identified as being required, though it is expected that customary departures and agreement with the NZTA will be sought on matters such as collision loads and seismic displacement limits. Several existing AT local road vertical clearances do not meet the NZTA Bridge Manual requirements and departures for these, including slight reductions due to motorway cross-falls, will be agreed with AT in due course.

4.5.2 Retaining Walls

Approximately 7km of retaining walls are required for the Project made up of the following wall types:

- MSE Block Walls
- Bored Pile Walls
- Anchored Bored Pile Walls
- L Shaped Gravity Walls
- Steel UC Walls

For further detail regarding the number, length and maximum height of the proposed retaining walls reference should be made to Section 5 below.

4.5.3 Stormwater Culverts

Cross drainage culverts in the Project Area have generally been found to have adequate capacity to provide the required freeboard and flood protection to the motorway surface. Most culverts can therefore be retained, subject to the structural condition being acceptable. At this stage of the Project, no condition assessments of the existing culverts have been carried out.

Where existing culverts proposed to be retained are found to be defective or in poor condition during subsequent design development, they will be replaced with the same size culvert to minimise impacts to the downstream environment.

Several culverts need to be extended due to the widening of the motorway footprint. In these cases additional loads on the existing length of culvert due to realignment of the motorway, and the lengthening of the culverts will be investigated. Only one new culvert is proposed in this Project. Refer to the table below for a list of existing and proposed culverts on the Project. For further details on each culvert, refer to the Assessment of Stormwater Management, Technical Assessment 11 of **Volume 3**.

Table 4 Proposed cross drainage

Crossing Name	Existing / New	Location	Proposed works
CU-EX-01	Existing	Oteha Valley Road – Spencer Creek (east of SH1)	Retain (no road works proposed)
CU-NEW-01	New	Oteha Valley Road – Spencer Creek (east of SH1)	New culvert
CU-EX-02	Existing	SH1 – CH12420	Extend upstream
CU-EX-03	Existing	SH1 – CH12760	Extend upstream
CU-EX-04	Existing	SH1 – CH12890	Retain / repair
CU-EX-05	Existing	SH1 – CH13350	Extend downstream
CU-EX-06*	Existing	SH1 – CH13970	Retain / repair
CU-EX-07*	Existing	SH1 – CH14330	Retain / repair
CU-EX-08	Existing	SH1 – CH14420	Retain / repair
CU-EX-09	Existing	SH1 – CH14650	New connection at upstream
CU-EX-10	Existing	SH1 – CH15000	Extend and new connection at upstream
CU-EX-11	Existing	SH1 – CH15280	New connection at downstream
CU-EX-12	Existing	SH1 – CH15470	Extend downstream
CU-EX-13	Existing	SH18 – Caribbean Drive	Abandon (replaced with 2 new culverts)
CU-EX-14*	Existing	SH18 – Alexandra Stream	Retain / repair
CU-EX-15	Existing	SH18 – Unsworth Drive	Retain / repair
CU-EX-16	Existing	SH18 – Bluebird Reserve	Retain / repair

* These culverts are considered Major Culverts according to the NZTA Bridge Manual and the Highways Structures Design Guide and are to be designed and constructed in accordance with these references. This is applicable to Rosedale drainage culvert D and E and SH18 Alexandra Creek culvert.

4.6 Causeway Works

In order to accommodate the following works it is necessary to extend the crest of the existing causeway on both sides between WSL Ponds 1 and 2. This will involve:

- Widening of SH1 northbound between Constellation Drive and Greville Road from 3 lanes to 5 lanes;

- Extension of the busway from Constellation Station to Albany Station;
- Inclusion of the SUP between Constellation Drive and Oteha Valley Road;
- Motorway to Motorway ramp from SH1 southbound to SH18 westbound; and
- Motorway to Motorway ramp from SH18 eastbound to SH1 northbound.

The extension of the causeway will not encroach beyond the extents of the existing manmade causeway structure with new material to be confined to being deposited on top of existing fill material.

The maximum extent of permanent works, within the existing structure footprint, is as follows:

- On the western side (northbound) – extension of the crest by approximately 10m.
- On the eastern side (southbound) – extension of the crest by approximately 10m.

The batter slopes achievable are a factor of the ground conditions. The final gradient of the causeway slopes will therefore be finalised at a later stage of design development. Taking a conservative approach and assuming poor ground conditions a batter slope of 1:3 (vertical:horizontal) can be expected.

On the eastern side of the causeway where the busway and SUP are proposed, the causeway will be locally raised by as much as 1m at the southern end.

Reference should be made to the sketches provided in Appendix A.

4.7 Landfill

The vertical alignment of the busway and SUP seeks to minimise the cut earthworks required into the landfill area while limiting the fill wall height to the maximum constructible and environmentally acceptable.

The designed busway vertical alignment requires a maximum cut depth of approximately 5m in the landfill area. Based on limited record information, some excavation of the existing refuse layers is expected at that depth. New gas and leachate collection and disposal systems are required behind the proposed retaining wall alongside the SUP.

This alignment results in a significant increase in height of the busway and SUP adjacent to the properties south of the landfill and between the busway and existing SH1.

A retaining wall is proposed along the eastern edge of the SUP to the south of the landfill, resulting in a maximum estimated fill wall height of 14m. This wall height has been assessed as the maximum height geotechnically and environmentally acceptable.

For greater detail regarding the assessment of effects reference should be made to the Assessment of Effects: Corridor Encroachment on Rosedale Landfill, Technical Assessment 7 of **Volume 3**.

4.8 Stormwater

A high level summary of the proposed stormwater design is outlined below (by sub-catchment). For greater detail regarding the design of the stormwater & hydrology for NCI reference should be made to the Assessment of Stormwater Management, Technical Assessment 11 of **Volume 3**.

- Oteha Valley to McClymonts
  - Two wetlands adjacent to the Oteha Valley Road on and off-ramps.
- McClymonts to Spencer
  - One replacement wetland opposite the motorway for the existing Alpurt A1 Pond 32 to be removed.

- Spencer to Rosedale
  - Proposed Greville Wetland;
  - Proposed Greville Southbound On-Ramp Dry Pond;
  - Proposed Greville Northbound Off-Ramp Dry Pond; and
  - Modifications to existing Alpurt A1 Pond 34 and 35 outlets to provide more live storage
- Rosedale to Constellation
  - A wetland at the location of the existing Auckland Council Moro Pond, adjacent north of Watercare Pond 2; and
  - A replacement wet pond on the western side of SH1, south of Watercare Pond 1 to replace the treatment function of the existing ARC Refuse pond to be removed.
- Constellation to Paul Matthews
  - A wetland to the east of the proposed SH18 Caribbean Drive off-ramp roundabout.
- Paul Matthews to Albany Highway
  - Either, a wetland located in Rook Reserve and a proprietary cartridge device (StormFilter or similar approved) at the abandoned Z service station ramp for treatment of new impervious surfaces; or
  - A wetland located in Bluebird Reserve and a proprietary cartridge device (StormFilter or similar approved) at the abandoned Z service station ramp for treatment of new impervious surfaces.

    The final solution is to be confirmed by the AC Local Board in conjunction with AC Parks department.

4.9 Works in and around streams

4.9.1 General

The Project primarily falls within the Oteha Valley Stormwater Catchment. There is a short section of SH1 north of Spencer Road that falls within the Lucas Creek Stormwater Catchment.

SH1 and SH18 intersect with and collect stormwater which discharges to the following streams:

- Lucas Creek;
- Oteha Valley Stream; and
- Alexandra Creek.

Works around these streams are outlined below. For further detail regarding the construction methodology for outfalls to streams reference should be made to Section 7.8.

4.9.2 Works around Lucas Creek

The following works are proposed in the vicinity of Lucas Creek:

- A proposed new stormwater outfall with rip rap apron discharging to Lucas Creek on the eastern side of SH18.

4.9.3 Works around Oteha Valley Stream

The following works are proposed in the vicinity of Oteha Valley Stream:

- Two proposed new stormwater outfalls with rip rap aprons discharging to Oteha Valley Stream on the western side of SH18.

4.9.4 Works around Alexandra Creek

The following works are proposed in the vicinity of Alexandra Creek:

- Lengthening existing pedestrian underpass on the northern side of SH18;
- Construction of approximately 40m of steel UC wall on the northern side of SH18;
- Construction of a new SUP to the southern side of SH18 with connection to the existing SUP along Alexandra Creek;
- Vegetation removal to increase visibility on the southern side of the existing underpass;
- A proposed new stormwater outfall with rip rap apron discharging to Alexandra Creek on the northern side of SH18; and
- A proposed new stormwater outfall with rip rap apron discharging to Alexandra Creek on the southern side of SH18.

4.10 Utilities

4.10.1 General

The Project affects the following existing services.

- Auckland Council Stormwater network and associated ponds/wetlands;
- Mains water and wastewater networks (Watercare Services Limited)
- Power and Gas distribution (Vector)
- Power transmission (Transpower)
- ITS and ATMS (NZ Transport Agency and Auckland Motorway Alliance)
- AT communications cables (Auckland Transport)
- Telecommunications (Vodafone & Chorus)

Consultation with affected utility owners has been undertaken throughout design development and is still on-going. Utility analysis to date has primarily been desktop based.

The following provisions apply to the consideration of effects on utilities:

- This report covers the major utilities in each affected area, however there will also be a number of minor utilities that need to be addressed;
- The assessment undertaken is based on information obtained from utility operators and is supplemented by physical surveys, ground penetrating radar, and discussions with utility operators;
- The actual location, size and material of utility services can vary from what is identified on the record drawings provided by the utility providers as listed above; and
- This report addresses utilities design development and engagement with network utility operators up to lodgement.
- It is anticipated that further engagement and confirmation of any required relocations with network utility operators will occur during the detailed design phase.
- The designations and consents sought for the NCI Project are intended to authorise any changes required to affected network utilities.

The extent of the required diversion and / or protection of these assets is further described in the following sections.

4.10.2 Stormwater

The following works are proposed for the diversion and/or relocation of existing Auckland Council Stormwater assets as further described in the Assessment of Stormwater Management, Technical Assessment 11 of **Volume 3**.

- Constellation Pond - A wetland to the east of the proposed SH18 Caribbean Drive off-ramp roundabout to replace the existing Constellation pond, which is to be removed;
- ARC Refuse Pond - A replacement wetland on the western side of SH1, south of Watercare Pond 1 to replace the treatment function of the existing ARC Refuse pond to be removed;
- Auckland Council culverts - the extension and/or repair of existing Auckland Council Stormwater culverts affected by the NCI works.

4.10.3 Wastewater (Watercare)

The following works are proposed for the diversion and/or protection of existing WSL wastewater assets.

4.10.3.1 Pond Link

The proposed NCI alignment impacts the existing pond link between WSL ponds 1 and 2 as follows.

- The proposed SH18 eastbound to SH1 northbound ramp conflicts with the location of the two existing inlet structures within WSL pond 1; and
- The proposed SUP on the eastern side of SH1 conflicts with the location of the existing WSL pond 2 inlet structure.

The existing pond link provides a 3.2cumec capacity connection between ponds 1 and 2. As part of WSL's future expansion plans, WSL has a requirement to increase the capacity of this link to 6 cumecs to allow for predicted future flows.

As such, it is proposed to construct the Motorway widening and pond link upgrade together (and under the authority of the consents sought for the NCI Project), resulting in benefits for both the Transport Agency and WSL. This will include:

- A new underpass beneath the Motorway corridor to the south of ponds 1 and 2;
- A new upgraded pond link of 6cumec capacity;
- Space provision for other service corridors within the underpass if required in future; and
- A more direct vehicular link between WSL's WWTP sites in replacement of the existing vehicular underpass beneath SH1.

4.10.3.2 Trunk Sewers TS5 and TS7

The proposed SH18 alignment impacts on the existing Wairau Valley Branch Sewer (TS5), and East Coast Bays Branch Sewer (TS7) which are major lines leading to the RWWTP. It is proposed that these sewer lines are relocated to accommodate the highway. These sewer relocations are major projects in themselves requiring new pipe bridges and significant temporary works to divert flows during construction. As part of the design, a revised TS5 and TS7 alignment, as well as diversion of the local connections to the TS7 main, has been proposed. Agreement in principle for this design is currently outstanding with WSL. The designations and consents sought for the NCI Project are intended to authorise these TS5 and TS7 relocations.

WSL is currently designing an East Coast Bays Link Sewer to supplement the capacity of the existing TS7. It is likely that this will link into the proposed TS7 diversion and there is an opportunity for coordination and cost sharing for this component of work. In addition, WSL is proposing to upsize the existing TS5 from the wastewater treatment facility, and it has expressed an interest in coordinating

this with the proposed NCI works. Further discussions with WSL are underway to progress these designs. Any RMA authorisations necessary for these works will be sought separately by WSL, and their design and construction is not described in this report.

4.10.4 Potable Water (Watercare)

4.10.4.1 General

The following works are proposed as part of the Project:

- Lowering of 250dia. watermain on Rosedale Road due to the required lowering of the vertical road alignment; and
- Diversion of a 100dia watermain on Paul Matthews Road.

4.10.4.2 North Harbour 2

The North Harbour 2 watermain is currently being consented by WSL, and is proposed to be installed adjacent to the SH18 motorway corridor between William Pickering Drive and Albany Highway. A suitable corridor for these works is allowed for within the NCI design beneath the proposed SUP.

4.10.5 Vector Gas

No major relocation of Vector Gas assets has been identified as being necessary as part of the NCI works. There is a 50mm MP4 gasmain on Paul Matthews Drive that may require a localised relocation.

4.10.6 Vector Power

The proposed highway and busway alignments conflict with existing Vector 11KV, 33KV and 110KV overhead and underground lines in multiple locations. The following relocation works have been discussed with Vector and agreed in principle.

Table 5 Vector relocation works

Item	Description
McClymonts Road Bridge	Relocate existing 11kV and 33kV to proposed new McClymonts Road Bridge crossing
North of Greville Road to North of Rosedale Road	Underground existing overhead 33kV lines to accommodate busway
North of Rosedale Road	Replace existing 33kV lines under motorway due to widening. Diversion shall follow the motorway alignment south and then pass beneath the Rosedale Road overbridge.
Rosedale Road Lowering	Lower 11kV lines to allow for road lowering
Western side of SH1 north of Rosedale Road	Underground existing 33kV adjacent to SH1 to accommodate northbound widening
Eastern side of SH1 north of Constellation Drive	Underground existing 11kV adjacent to Constellation Drive Off Ramp to accommodate the busway
SH18/Upper Harbour Highway	Replace existing poles to raise height of existing 110KV and 33KV lines over proposed SH18 alignment.
SH18/Upper Harbour Highway	Relocate (underground) existing 33kV and overhead lines to accommodate Paul Matthews Road Off Ramp
Paul Matthews Road Corner	Relocate existing 33kV underground line to accommodate Paul Matthews Road realignment and bridge.

4.10.7 Transpower

There are existing underground Transpower 220KV power cables and an associated designation (combined Vector/Transpower designation) that follows the northern busway alignment on the eastern side of SH1 as far as Constellation Drive. They then pass beneath SH1 through the Constellation Drive underpass and follow the northern side of Upper Harbour Highway. Before the existing Paul Matthews Road intersection the cables then turn north and traverse along the Hockey and Watercare Rosedale Wastewater Treatment Plant boundary.

The proposed SH18 alignment and ramps cross the Transpower cables in two locations. In each of the locations the cover over the Transpower cables remains the same or is increased. The proposed alignment has been discussed with Transpower and relocation of the existing cables is to be avoided due to the significant costs and procurement lead times associated with such a diversion. The increased fill over the cables would impact their thermal and conductive properties. To mitigate this impact it is proposed that the road will be bridged over the Transpower cables.

The requirements of the bridging detail have been discussed with Transpower and it is proposed that:

- A culvert shall be constructed over the transmission corridor to allow maintenance access along its full length; and
- The culvert will be constructed to allow safe installation over the existing cables while also preserving the ability to install a future cable (second) circuit in the future.

Transpower is currently undertaking further design work, as part of preparing a Solution Study Report, to address:

- A power system study to understand the impacts of any changes to the 220 kV system;
- A preliminary protection study to determine the protection requirements;
- An assessment of SCADA requirements (if required);
- Development of a detailed cost estimate and project plan;
- Confirmation of cable routes to respective site boundaries;
- Civil, Structural and thermodynamic studies;
- Geotechnical and soil resistivity studies;
- The potential redevelopment of single line and relay/instrument diagrams; and
- Development of construction methodologies.

4.10.8 Fibre Backbone

The existing fibre backbone running adjacent to SH1 is impacted by the proposed SH1 widening and busway extension works and subsequently requires relocation. The backbone includes Vodafone and Vector communications and Transport Agency ITS/ATMS infrastructure.

Due to the time and cost of relocation that would be associated with the jointing of the fibre if the backbone were to be generally left in its current location, it is proposed that the full length from Oteha Valley Road southbound on ramp to Constellation Drive be replaced and relocated to beneath the proposed Shared Use Path (SUP).

5 Construction Zones and Construction Support Areas

5.1 General

The Project has been broken up into eight construction zones (CZ) as listed below and shown in Appendix B and further described in the following sections.

- Zone 1 – SH18/SH1 Motorway to Motorway connection and SH18 offline works
- Zone 2 – SH18 Upper Harbour Highway (SH1 to Albany Highway)
- Zone 3 – SH1 northbound widening
- Zone 4 – SH1 southbound widening
- Zone 5 – SH1 median works
- Zone 6 – Albany Station Busway Bridge
- Zone 7 – Busway North (Albany Station to Greville Road)
- Zone 8 – Busway South (Greville Road to Constellation Station)

In addition to the CZs, there are six Construction Support Areas (CSA) as follows, which are required to support construction activities.

- CSA 1 – Paul Matthews Road
- CSA 2 – North-Facing Ramps
- CSA 3 – Greville Road West
- CSA 4 – McClymonts Road
- CSA 5 – Rosedale Road
- CSA 6 – Greville Road East

These areas may be used for the following general activities:

- Site offices and construction personnel amenities;
- Construction vehicle/machinery parking and maintenance;
- Loading and unloading of construction materials;
- Storage of construction materials such as steel reinforcing cages, pre-cast concrete elements, geotextiles, formwork (timber and steel), cement, fuel for generators and construction plant (not including vehicles which can re-fuel off site e.g. trucks);
- Fabrication, reinforcement cutting and bending;
- Storage of plant and equipment and building materials;
- Ground improvement plant and materials;
- Storage of hazardous construction materials (if any);
- Construction vehicle wheel washing areas (where necessary);
- Storm water and groundwater treatment facilities where required;
- Waste storage and collection; and
- Spoil handling and storage.

The CSAs may require earthworks prior to mobilisation to allow for localised re-leveling of surfaces to allow for construction equipment access and placement. These volumes are separate to the totals shown in Section 7.5. Stabilised surfaces may also be used during construction in these areas.

The CSAs will not be needed once construction is complete. After construction, the CSAs will be dis-established, any permanent works in these areas completed (such as completion of wetlands in CSA2 and CS4) and the designation pulled back to the extent of permanent works.

The CSAs are described in more detail within *Section 6 Construction Methodology*.

5.2 Zone 1 - SH18/SH1 Motorway to Motorway connection and SH18 offline works

The key construction activities within Zone 1are as summarised in the table below. For further detail of these works reference should be made to General Arrangement drawing sheets 6, 8 and 9 contained within **Volume 5**.

Table 6 Zone 1 – SH18/SH1 motorway to motorway connection and SH18 offline works

Activity	Description
SH18/SH1 connection	New Motorway connection between the existing SH18 alignment at Upper Harbour Highway west of Paul Matthews Road and SH1 north of Constellation Drive. 50m MSE block wall (fill) max height 3.3m.
SH18/SH1 east to northbound ramp	New earthworks embankment to allow tie in of new connection from SH18 eastbound to SH1 northbound.
SH1/SH18 south to westbound ramp	New multi-span flyover from SH1 southbound to SH18 westbound.
Caribbean Dr Intersection Bridge over SH18 off-ramp	100m MSE block wall (fill) max height 4.8m. 230m MSE block wall (fill) max height 8.2m. 70m MSE block wall (fill) max height 6.1m. 80m MSE block wall (fill) max height 8.0m. 210m MSE block wall (fill) max height 7.6m (SH18 eastbound off-ramp). New single span bridge over the SH18 eastbound off-ramp.
SH18 eastbound off-ramp and roundabout	New eastbound off-ramp terminating in a roundabout with new connection to the existing Caribbean Drive intersection as a fourth arm.
Transpower 220kV	Bridging detail required for protection of 220kV cables.
Vector 110kV	Relocation and raising of Vector pylon for 110kV overhead line and construction of access bay for pylon maintenance.
WSL Trunk Sewer TS5	Diversion of existing sewer
WSL Truck Sewer TS7	Diversion of existing sewer
Auckland Council Constellation Pond	Abandonment/Removal of the existing Constellation Pond.
New Auckland Council High Level Dry Pond	Proposed new dry pond to replace loss of existing Auckland Council Moro Pond, ARC Refuse Pond and Constellation Pond.
New Caribbean Wetland	Proposed new wetland to manage stormwater run-off from existing SH18 Upper Harbour Highway and new motorway ramps.
New ARC Refuse Wet Pond	Proposed refuse wet pond to replace treatment function of existing pond to be removed. Existing culvert 12 to be extended to new pond.

5.3 Zone 2 – SH18 Upper Harbour Highway (SH1 to Albany Highway)

The key construction activities within Zone 2 are as summarised in the table below. For further detail of these works reference should be made to General Arrangement drawing sheets 6, 8, 9 and 10 contained within **Volume 5**.

Table 7 Zone 2 – SH18 Upper Harbour Highway (SH1 to Albany Highway)

Activity	Description
Caribbean Drive Intersection Widening	Widening of Caribbean Drive to meet requirements of the revised configuration of Caribbean Drive intersection.
Paul Matthews Road Bridge	New multi-span bridge over the SH18. Connecting the existing Paul Matthews Road to Caribbean Drive intersection and Upper Harbour Highway.
Reconfiguration of SH18 between Paul Matthews Road and Albany Highway	240m Bored pile wall (cut) max height 7.5m. 270m Two tier wall; bored pile cut wall (bottom), L-shape gravity fill wall (top) max height 7.0m. 50m Steel UC wall with concrete panels (cut) max height 1.6m. 50m L-shape gravity wall (fill) max height 3.0m. 40m Steel UC wall with concrete panels (cut) max height 1.1m. 350m Combined TL5 concrete barrier/ retaining wall (cut) max height 1.1m. Closure of existing off-ramp to Z petrol station. Closure of existing off-ramp to Unsworth Drive.
SH18 to Albany Highway westbound off-ramp	Shoulder widening to increase sight lines on the off-ramp.
Alexandra Creek Pedestrian Underpass	Lengthening of the pedestrian underpass beneath SH18 and construction of new retaining (head) walls on the southern side.
Bluebird Reserve or Rook Reserve Wetland	Proposed new wetland to manage SH18 runoff. To be located in either Bluebird or Rook Reserve (subject to AC Parks department preference).
Stormwater Culverts	Existing stormwater culvert 13 to be abandoned and replaced by culverts 13A and 13B.
New SUP including Constellation Station link	New SUP along SH18 with a reduction of lane widths on Constellation Drive beneath SH1 to maximise the width of the existing footpath for the proposed SUP. Connection to existing walking and cycling facilities on Albany Highway. Ramp connection from SUP to William Pickering Drive. Connection to existing path network beside Alexandra Creek. Ramp connection to Paul Matthews Road.
Utility diversions	Diversion of all affected services

5.4 Zone 3 – SH1 Northbound Widening

The key construction activities within Zone 3 are as summarised in the table below. For further detail of these works reference should be made to General Arrangement drawing sheets 1 to 6 contained within **Volume 5**.

Table 8 Zone 3 – SH1 Northbound Widening

Activity	Description
SH1 to Constellation Drive northbound off-ramp	Reconfiguration of SH1 to Constellation Drive northbound off-ramp.
Northbound widening of Constellation Dr Bridge	Widening of Constellation Dr Bridge to the west carrying the SH1.
SH18 northbound on-ramp	New SH18 northbound on-ramp onto SH1.
Widening from 3 lanes to 5 lanes of SH1 between Constellation Drive and Greville Road	Causeway extension (1V:3H earthworks slope with rip rap armour). 120m Steel UC wall (cut) max height 2.4m. 200m MSE block wall (fill) max height 4.6m. 220m MSE block wall (fill) max height 5.1m. 90m MSE block wall (fill) max height 2.8m. Removal of existing enforcement bay just north of causeway. 3 no. new enforcement bays. 1 no. new maintenance bay. Realignment of existing Greville Road northbound off-ramp. Northbound widening of Rosedale Rd Bridge to the west carrying the SH1.
Constellation to SH1 northbound on-ramp	Reconfiguration of the existing Constellation to SH1 northbound on-ramp.
Greville Road northbound off-ramp	Reconfiguration of Greville Road northbound off-ramp.
Greville northbound climbing lane	Realignment of Greville Road northbound on-ramp. 70m MSE block wall (fill) max height 3.2m. 260m Steel UC wall with concrete panels (cut) max height 2.7m. 220m MSE block wall (fill) max height 3.0m. Northbound widening of Greville Rd Bridge to the west carrying the SHN New maintenance bay. Widening of SH1 under McClymonts Road Bridge Removal of existing bus off-ramp to Albany Station.
Oteha Valley Road northbound off-ramp	Reconfiguration of Oteha Valley Road northbound off-ramp.
Greville Road Ponds	2 No. existing ponds in vicinity of Greville off-ramp to be retained and outlets modified.
Greville Road Southern Dry Basin	Proposed new Greville NB off-ramp dry basin.
Greville Road Northern Wetland	Proposed new wetland north of Greville Road to manage stormwater run-off.
McClymonts Road wetland	New proposed McClymonts Road wetland to replace existing pond at CH12730.

Activity	Description
Oteha West Wetland	New proposed Oteha Valley West Wetland.
Pondlink	New upgraded hydraulic link between WSL Ponds 1 and 2.
Lowering of Rosedale Road	Lowering of Rosedale Road to maintain a clear height of 4.9m beneath the SH1 bridge. May result in modification to the Rosedale Rd Bridge abutment walls and foundations.
Utility diversions	Diversion of all affected services
McClymonts Rd Bridge Replacement	The existing McClymonts Rd Bridge will be demolished after the construction of a new two span bridge along a new alignment just south of the existing bridge. The new bridge will carry McClymonts Road over the SH1, SUP and busway.
McClymonts Road bus on-ramp	Existing McClymonts Road bus on-ramp removed.

5.5 Zone 4 - SH1 Southbound Widening

The key construction activities within Zone 4 are as summarised in the table below. For further detail of these works reference should be made to General Arrangement drawing sheets 1 to 6 contained within **Volume 5**.

Table 9 Zone 4 – SH1 southbound widening

Activity	Description
SH1 Widening from 2 lanes to 4 lanes between Greville Road and Constellation Drive	Temporary batter slope. Pavement widening.
SH1 Shoulder Widening between Oteha Valley Road and Greville Road	Shoulder widening between Oteha Valley Road and Greville Road.
Maintenance Bays	7 No. new maintenance bays.
Enforcement Bays	Removal of existing enforcement bay on causeway.
SH1 southbound off-ramp	New SH1 southbound off-ramp to SH18.
Constellation Drive southbound off-ramp	Realignment of existing Constellation Drive southbound off-ramp.
Southbound widening of Constellation Dr Bridge	Widening of Constellation Dr Bridge to the east carrying the SH1.
Southbound widening of Rosedale Rd Bridge	Widening of Rosedale Rd Bridge to the east carrying the SH1.
Southbound widening of Greville Rd Bridge	Widening of Greville Rd Bridge to the east carrying the SH1
Oteha Valley East Wetland	New proposed wetland to offset loss of existing NZTA pond at CH12460 and to manage new impervious surfaces
Lucas Creek Culvert	New 1500dia. culvert to convey flow from the cut-off drain behind the shared use path to Lucas Creek.
Greville Road attenuation	New dry Greville southbound on-ramp dry attenuation basin.
Auckland Council Moro Pond	Existing Auckland Council Moro Pond to be removed with new culvert connection made.
Moro Wetland	New proposed wetland at location of existing Moro Pond to manage motorway stormwater runoff.

Activity	Description
ARC Refuse Pond	Existing ARC refuse pond to be removed and new pond created on the western side of SH1
Utility diversions	Diversion of all affected services

5.6 Zone 5 - SH1 Median Works

The key construction activities within Zone 5 are as summarised in the table below. For further detail of these works reference should be made to General Arrangement drawing sheets 1 to 7 contained within **Volume 5**.

Table 10 Zone 5 – SH1 median works

Element	Description
Median	Reconfiguration of the median with TL5 F-shaped concrete barriers (double sided) and 12-14m high central lighting columns between CH12300 and CH16520.

5.7 Zone 6 - Albany Station Busway Bridge

The key construction activities within Zone 6 are as summarised in the table below. For further detail of these works reference should be made to General Arrangement drawing sheet 1 contained within **Volume 5.**

Table 11 Zone 6 – Albany Station busway bridge

Element	Description
Albany Station Busway Bridge	New multi-span Albany Station Busway Bridge over SH1 to Albany Park & Ride. MSE block wall (fill)
Albany Bus Station	Albany bus station and adjacent intersection reconfiguration to allow for operation with new busway connection.

5.8 Zone 7 - Busway North (Albany Station to Greville Rd)

The key construction activities within Zone 7 are as summarised in the table below. For further detail of these works reference should be made to General Arrangement drawing sheets 1 to 3 contained within **Volume 5**.

Table 12 Zone 7 – Busway North (Albany Station to Greville Road)

Element	Description
Busway	New busway between Albany Station and Greville Road
Retaining Walls	20m MSE block wall (fill) max height 10.0m. 110m MSE block wall (fill) max height 3.0m. 170m Steel UC wall with concrete panels (cut) max height 1.5m. 590m MSE block wall (fill) max height 9.7m. 60m MSE block wall (fill) max height 7.0m. 90m Bored pile wall (cut) max height 4.2m. 80m Anchored bored pile wall (cut) max height 8.31m. 40m MSE block wall (fill) max height 3.2m.

Element	Description
	160m Anchored bored pile wall (cut) max height 8.6m. 60m Bored pile wall (cut) max height 5.6m.
SUP between Albany & Greville Road	New path to connect existing path on McClymonts Road to SUP and McClymonts Road bridge. New proposed pedestrian crossing from new path on McClymonts Road to existing path on Elliot Rose Avenue. SUP ramp connection to Oteha Valley Road. SUP connection to Medallion Drive. New proposed pedestrian crossing from existing path on McClymonts Road to proposed shared use path ramp connection. SUP ramp connection to McClymonts Road. SUP stairs connection to Spencer Road.
Existing Ponds	Removal of 3 No. existing ponds (Alpurt A1 ponds 31, 32 & 33)
McClymonts Road bus ramp	Existing McClymonts Road bus ramp removed.
Utility diversions	Diversion of all affected services

5.9 Zone 8 Busway South (Greville Road to Constellation Station)

The key construction activities within Zone 8 are as summarised in the table below. For further detail of these works reference should be made to General Arrangement drawing sheets 4 to 6 contained within **Volume 5**.

Table 13 Zone 8 – Busway South (Greville Road to Constellation Station)

Element	Description
Busway	New busway between Greville Road and Constellation Station.
Greville Rd Busway Bridge	New multi-span busway and SUP bridge over Greville Road.
Rosedale Rd Busway Bridge	New single span busway and SUP bridge over Rosedale Road.
Constellation Dr Busway Bridge	New multi-span busway and SUP bridge over Constellation Drive.
Retaining Walls	20m MSE block wall (fill) max height 7.0m. 60m MSE block wall (fill) max height 5.7m. 180m Bored pile wall (cut) max height 4.7m. 160m Anchored bored pile wall (cut) max height 6.8m. 260m MSE block wall (fill) max height 13.3m. 240m MSE block wall (fill) max height 6.4m. 70m L-shape gravity wall (fill) max height 2.0m. 60m MSE block wall (fill) max height 2.4m. 130m Steel UC wall with concrete panels (cut) max height 2.8m. 480m Steel UC wall with concrete panels (cut & fill) max height 1.8m. 60m Bored pile wall (cut) max height 6.5m. 140m Anchored bored pile wall (cut) max height 8.3m.

Element	Description
	120m Bored pile wall (cut) max height 5.4m. 70m MSE block wall (fill) max height 5.7m. 50m Steel UC wall with concrete panels max height 4.5m. 285m MSE block wall (fill) max height 8.2m. 240m MSE block wall (fill) max height 6.6m. 40m MSE block wall (fill) max height 4.9m. 40m MSE block wall (fill) max height 5.5m.
SUP between Greville Road & Constellation Park & Ride	Ramp connection to Greville Road. Ramp connection to Rosedale Road. New proposed pedestrian crossing on Rosedale Road. Ramp connection to Arrenway Drive. Ramp connection to reserve beside Pond 2.
Greville Road Southbound On-ramp	Realignment of Greville Road Southbound On-ramp. Proposed new transit lane.
Constellation Drive On and Off-ramps	Removal of existing bus lane.
Constellation Station Configuration	Reconfiguration of existing platforms and busway, including: ■ Extension of existing platform 2 (southbound platform) including the cantilevered canopy structure; ■ Widening of the busway carriageway to the east along with a new median traffic island to create 2 southbound lanes and 2 northbound lanes; ■ Creation of a new northbound platform (platform 1) partly on retained fill, including a cantilevered canopy structure; ■ Creation of a lift and stair tower between platform 2 and 3 and a lift and stair tower adjacent to platform 1, supporting a new pedestrian overpass structure across the busway; and ■ Reconfiguring the internal layout of the concourse between existing platforms 2 and 3 requiring the relocate the electrical and communications rooms.
Lowering of Rosedale Road	Lowering of Rosedale Road to maintain a clear height of 4.9m beneath the SH1 bridge. May result in modification to the Rosedale Rd Bridge abutment walls and foundations.
Utility diversions	Diversion of affected services as a result of road lowering works.

6 Construction Duration and Staging

6.1 General

An indicative construction methodology has been prepared for the purposes of identifying and assessing the environmental effects of the Project associated with construction. The Project is anticipated to take approximately 45 months (3.75 years) including an initial 5 months of mobilisation and detailed design, assuming the land required for the Project is acquired within the necessary timeframes. Assuming a contract award date of January 2018, completion of the Project is scheduled in September 2021. The construction of this Project will be undertaken on a number of fronts, such that many elements in multiple zones will be undertaken at the same time.

Appendix C shows an indicative programme for construction of the proposed works and how the different work fronts may progress over and within the 45 month timeframe. It is noted that while there are some dependencies between these proposed construction stages, the specific staging and phasing of the work will be dependent on the methods of procurement and the availability of contractors and other resources (such as land, materials and construction equipment).

6.2 Description of Construction Stages & Indicative Works

6.2.1 Stage 0 (5 months)

- Project mobilisation (site establishment).
- Detailed design.

6.2.2 Stage 1A (3 months)

- Commence and complete early works for Paul Matthews Road diversion including widening on Upper Harbour Highway westbound carriageway to accommodate temporary traffic management requirements.
- Commence busway construction.
- Commence Rosedale Road lowering (needs to begin prior to SH1 bridge widening above to ensure that the sub-standard existing vertical clearance is not further reduced during construction).
- Commence McClymonts Road bridge replacement offline in order to maintain bus operations on the existing bridge.

6.2.3 Stage 1B (14 months)

- Commence construction of the Albany station busway bridge
- Continue busway construction.
- Commence north facing ramps and Paul Matthews overbridge construction (following early works in Stage 1A).
- Commence and complete SH1 southbound widening (following early works in Stage 1A).
- Complete Rosedale Road lowering.
- Complete McClymonts Road bridge replacement.

6.2.4 Stage 1C (3 months)

- Continue busway construction.

- Continue north facing ramps and Paul Matthews overbridge construction.
- Commence SH1 northbound widening (following construction of SH1 southbound to balance level of construction activity during Stages 1B and 1C).

6.2.5 Stage 1D (6 months)

- Continue busway construction.
- Continue north facing ramps and Paul Matthews overbridge construction.
- Complete SH1 northbound widening.
- Commence and complete Upper Harbour Highway eastbound lowering which allows the connection of eastbound lanes to northbound ramp in a temporary arrangement, i.e. northbound north facing ramp live.

6.2.6 Stage 2A (3 months)

- Continue busway construction.
- Complete Paul Matthews overbridge construction, i.e. connection live.
- Commence and complete Upper Harbour Highway median lowering which allows the connection of westbound lanes to the southbound ramp in a temporary arrangement, i.e. southbound north facing ramp connection live.

6.2.7 Stage 2B (6 months)

- Continue busway construction.
- Commence and complete Upper Harbour Highway westbound lowering which allows the north facing ramps to be connected in their final form.
- Commence and complete SH1 median works (following connections to northbound and southbound ramps).
- Complete Albany Station busway bridge.

7 Construction Methodology

7.1 General

This section provides a description of the anticipated construction methodology for the Project. It provides a broad overview of anticipated construction across the Project, and industry typical methodologies for key elements of the Project. It is intended to be indicative and does not represent a definitive methodology which will be developed by the contractor once appointed at a later stage of design development.

The construction methodology described in this section is a realistic and feasible methodology from which the anticipated effects on the environment of these activities can be identified. The purpose of this description is to provide sufficient detail on the proposed construction activities to assess their potential environmental effects and subsequently to identify any necessary measures to avoid, remedy or mitigate these effects where appropriate (e.g. to assist the specialists and ultimately the consenting authority to identify a suitable suite of conditions for the consents and designations to effectively manage the effects of the construction activity).

Once the Project has been awarded and a contractor (or contractors) are in place, the methodology will be further refined and developed. This will be done within the scope of the conditions which will be in place to manage the environmental effects of the construction activities.

7.2 Working hours

Construction will generally occur within daylight hours. However, in order to minimise disruption to traffic, it is envisaged that night works may be undertaken on the existing motorway and local roads.

For example, this may include (but is not limited to) the following major construction activities:

- General traffic switching along SH1 and SH18.
- Albany Station busway bridge construction over SH1.
- McClymonts Road bridge replacement and demolition of the existing bridge over SH1.
- Watercare Pond Link bridge construction beneath SH1.
- SH1 southbound to SH18 westbound ramp construction over SH1.
- Paul Matthews Rd bridge construction over SH18.
- Construction of busway bridges over local roads.
- Existing SH1 bridge widening over local roads.
- Rosedale Road lowering.
- SH18 lowering.

7.3 Construction Support Areas

Construction Support Areas will be required for the provision of contractor office and welfare facilities, plant/material storage and earthworks stockpiling as required.

A description of each Construction Support Area (CSA) and the activities that will be undertaken is set out below.

It is envisaged 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.
- All CSAs are likely to be provided with water, telecommunications and power connections, and where required sewer connections. In most cases, these services are able to be connected directly to the existing adjacent networks. Where there is no existing network adjacent to the CSA, a temporary connection will be made. These connections will be removed after the completion of the Project.
- All CSAs are likely to be established on compacted hard-fill, (i.e. not impervious), unless impervious areas exist such as at the CSAs 1 & 5 on Paul Matthews Road and Rosedale Road which are likely to be retained.
- All CSAs are likely to be used for stockpiling of earthworks, including contaminated material. CSA 2 at the north facing ramps is the most likely location for specifically stockpiling contaminated material.
- All CSAs are likely to be used as structures compounds (incl. laydown for bridge/ retaining wall construction materials).

The contractor will need to provide a suitable methodology to prevent dirt tracking from the CSAs onto the road.

7.3.1 Likely Amenities

CSAs 1 to 6 as identified on the General Arrangement Drawings are likely to require some or all of the following amenities:

- Project offices;
- Welfare facilities including:
  - Toilets;
  - Dining areas;
  - First Aid equipment.
- Worker car parking;
- Weighbridge;
- Steel shipping containers for small tools/equipment storage;
- Aggregate crusher

7.3.2 Likely Storage & Site Activities

Activities likely to occur within the CSAs include:

- Site offices and construction personnel amenities, including car parking.
- Construction vehicle and machinery parking and maintenance.
- Loading and unloading of construction materials.
- Storage of construction materials.
- Fabrication, reinforcement cutting and bending.
- Storage of plant and equipment, and building materials.
- Storage of ground improvement plant and materials.
- Storage of hazardous construction materials (if any).

- Construction vehicle wheel washing areas (where necessary).
- Stormwater and groundwater treatment facilities where required.
- Waste storage and collection.
- Spoil handling and storage
- Storage of supplanted trees / shrubs
- Aggregate crushing

7.3.3 Access

Access to the CSAs will be from local roads wherever practicable both for safety and to minimise any potential traffic disruption. Access may be subject to specific temporary traffic management where appropriate.

7.3.4 Satellite Welfare Facilities

Satellite welfare facilities are likely to also be required in addition to any welfare facilities provided within the CSAs. These will typically include provision of the following temporary facilities for workers in closer proximity to their immediate working area:

- Toilets
- First aid
- Break out / dining area

7.3.5 Temporary parking south of Albany Station

The construction of the busway bridge into Albany Station will have an effect on the availability of car parking spaces within the existing car park. As this car park is already at capacity, the Transport Agency is working with Auckland Transport to provide potential temporary parking on Transport Agency owned land adjacent to SH1 immediately to the south of the existing park & ride station.

7.4 Construction Noise & Vibration

For an overview of the assessment of the noise and vibration effects associated with the construction phase of the Project reference should be made to the Construction Noise & Vibration Effects, Technical Assessment 3 in **Volume 3**.

7.5 Earthworks

Earthworks cut and fill volumes are shown in the drawing in Appendix D and further summarised in the tables below. These volumes represent the full volume to finished surface level and do not account for the following:

- Top soil
- Cut to waste
- Compaction
- Bulking Factors

As indicated the design shows a current fill deficit. Fill material will need to be imported for the Project in accordance with the resource consent conditions. For further information regarding sampling and classification of imported fill to site reference should be made to the Draft Contaminated Soil Management Plan, NCI-3PRE-2ENV-RPT-0158 which forms Appendix B of the Assessment of Land Contamination Effects NCI-3PRE-2ENV-RPT-0025.

Table 14 Construction Zone indicative cut & fill volumes

Construction Zone	Volume (m^3)			Area (m^2)		
	Cut	Fill	Balance	Cut	Fill	Total
1	149,000	212,000	63,000	58,000	54,000	112,000
2	71,000	3,000	-67,000	105,000	37,000	142,000
3	49,000	45,000	-4,000	86,000	52,000	138,000
4	48,000	39,000	-9,000	84,000	36,000	121,000
5	-	-	-	-	-	-
6	0	2,000	2,000	0	1,000	1,000
7	48,000	56,000	7,000	22,000	21,000	44,000
8	49,000	119,000	70,000	24,000	31,000	55,000
Totals	**414,000**	**476,000**	**62,000**	**379,000**	**232,000**	**613,000**

7.6 Contaminated Ground Management

For an overview of the areas of potential environmental concern identified in the Preliminary Site Investigation which may present a risk to environment and/or public health, both during and post construction reference should be made to the Assessment of Land Contamination Effects, Technical Assessment 6 in **Volume 3**.

7.7 Construction Water Management

For an overview of the erosion and sediment management techniques and measures that will be used within the Project, including outline methodologies and management techniques that will apply and will achieve the necessary environmental objectives reference should be made to the Assessment of Construction Water Management, Technical Assessment 4 in **Volume 3**

7.8 Stormwater Wetland Construction

Stormwater wetlands will be constructed in accordance with the Auckland Council compliance and construction process described in Auckland Council TP10 (Chapter 5) relating to the installation of stormwater treatment / detention areas. These treatment devices will be established early in the construction programme so they can act as temporary sediment retention ponds during the construction period.

A typical construction methodology in accordance with these processes would involve:

- A pre-construction meeting with Auckland Council;
- Installation of perimeter erosion and sediment controls. This includes installing sediment controls at the downstream perimeter wherever sediment may leave the site during the clearing and grubbing for the wetland;
- Installation of temporary, stabilised channel diversion if necessary to divert clean water flow away from the wetland construction area;
- Removal of topsoil from the wetland area and stockpiling the soil in an approved location;
- Stabilisation of the stockpile area as per the erosion and sediment control plan;
- Setting out the centreline of embankment, outside and inside toe of slopes;

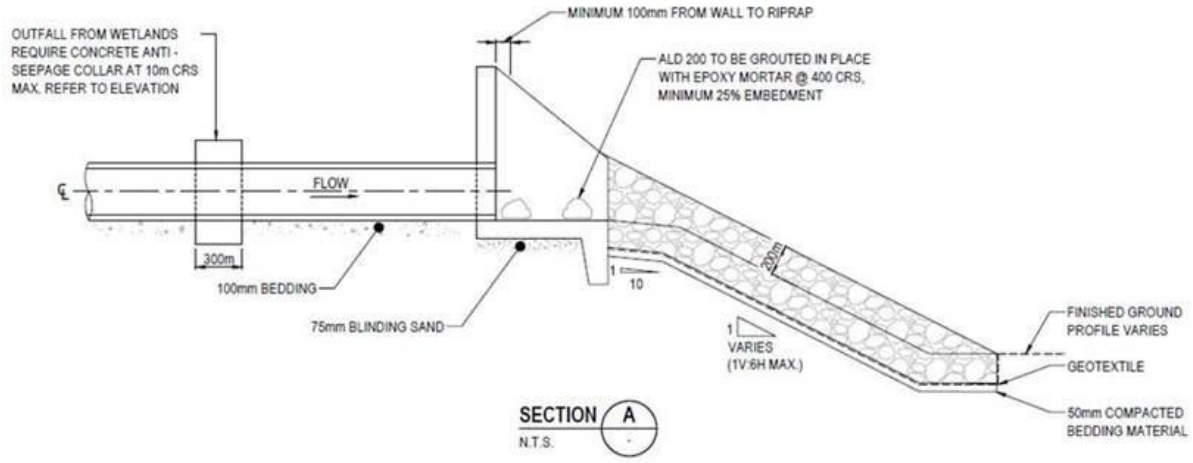
- Installation of the outfall pipe;
- Completion of bulk earthworks for the wetland, including:
  - Placing impervious material in core of embankment and in forebay in accordance with construction drawings;
  - Compacting the embankment according to the earthworks specification; and
  - Stabilising the embankment.
- Diversion of flows into pipe system and construction of an emergency spillway;
- Stabilisation of all disturbed areas in and around the wetland and planting as per the landscape specification; and
- Completion of pond approvals including:
  - Obtaining the approval of the Auckland Council compliance office to convert the wetland/pond from a sediment pond to stormwater control (if used as a sediment pond during construction);
  - Properly de-watering the pond in an approved manner as per TP90;
  - Removing accumulated sediment and restoration of the pond to design grade;
  - Completion of final stabilisation;
  - Making any structural modifications to the riser for permanent function; and
  - Undertaking as built documentation for submission to Auckland Council / AMA for approval.

7.9 Outfalls to Streams

Outfalls to streams will generally be constructed as follows:

1. Install erosion and sediment control measures
2. Vegetation clearance
3. Strip top soil and undercut to required levels
4. Lay blinding sand, bedding and compact in accordance with stormwater specification
5. Install geotextile
6. Install pre-cast headwall unit
7. Install rip-rap protection rocks as per stormwater detail drawings
8. Contour surrounding ground profile to tie-in with headwall and rip-rap protection
9. Construct upstream pipe network
10. Lay top soil and provide landscape as per landscape drawings

Figure 2 Outfall to streams – typical detail



7.10 Works in or adjacent to Overland Flow Paths / Floodplains

All works associated with the Project (permanent and temporary) will be kept clear of existing overland flow paths or floodplain areas during construction, unless otherwise described in the Assessment of Stormwater Management Report, Technical Assessment 11 in **Volume 3**. The effects of works associated with overland flow path and flood plain modifications are also addressed in the report.

Where diversion of overland flow paths or flood compensation works are proposed, these will be carried out in accordance with the Project erosion and sediment control plan and TP90 guidelines.

No existing overland flow path or floodplain area will be decommissioned until the new flow path or an equivalent compensatory storage area has been installed and is fully operational.

7.11 Abandonment and diversion of existing manmade open channels

There are two key areas within the Project extents where diversion of stormwater flows through existing manmade channels will be required to allow completion of the works. These are:

- Within Rosedale Park South in the vicinity of the existing Constellation Pond for flows from Caribbean Drive; and
- Within Watercare's land to the west of SH1 to divert flows from the existing ARC refuse pond.

In both cases the following construction methodology is assumed:

- Construct proposed new culvert and piping to divert flows
- Connect to existing manhole
- Divert flows
- Abandon existing culvert and channels

7.12 Pavements and Impervious Areas

Pavements and impervious areas will generally be constructed as follows:

- Earthworks and subgrade preparation and improvement, including;
  - Undercut unsuitable material and subgrade; and
  - Backfill and compact with approved filling material.
- Construction of pavement and subsoil drainage systems
- Construction of kerbs, channels, traffic islands and medians
- Construction of granular layers as necessary, including:
  - ground improvement/capping layers
  - sub-base course
  - base course
- Placing of geogrids/geotextiles
- Milling and planning of existing pavements and surfacings
- Construction of asphaltic concrete binder and surface/wearing course pavement layers including membrane seals and tack coats where necessary

7.13 Rosedale Road Lowering

Widening of SH1 over Rosedale Road results in the reduction of the clear headroom due to the requirement to maintain cross-falls on SH1. As such, localised lowering of Rosedale Road will be required to maintain a minimum clearance of 4.9m beneath the bridge, resulting in lowering the road level by approximately 0.5m. These works will likely necessitate the temporary restriction of Rosedale Road to 1 lane with temporary signals for a period of several months, dependent on the detailed construction methodology to be developed by the contractor.

As a result of the necessity of lowering the vertical alignment of Rosedale Road, it will also be necessary to lower the existing utilities in this area in order to maintain the required minimum covers for protection. The extent of the utilities affected is likely to be greater than that of the road due to the need to relocate the utilities between manholes, and junction boxes.

7.14 Constellation Station

Reconfiguration of Constellation Station from a terminus station to a through station is likely to include:

- Temporary diversion of existing bus operations;
- Minor earthworks;
- Diversion of utilities; and
- Night works in order to minimise bus disruptions.

The contractor's construction methodology will need to allow for the retention of the existing station functionality and amenities whilst the reconfiguration is being undertaken.

7.15 Utility Diversions

Where possible it is anticipated that diversion of existing utilities will occur before construction of the main works for the Project. It is intended to relocate services only once due to the high cost and time associated with movement and disruption effects.

It is anticipated that services will be:

- relocated to the relevant provider's standards;
- where possible located within dedicated service corridors; and
- will be constructed and tested in the realigned position to enable a short switch-over timeframe with minimal disruption to users.

7.16 Causeway Works

7.16.1 General

The methodology described below relates to the causeway works between WSL ponds 1 and 2 to accommodate the widening of SH1 and the addition of the busway and SUP. It should be read in conjunction with the sketches included in Appendix A. This methodology represents one feasible option for the proposed modifications to the existing causeway. The contractor may choose to develop an alternative methodology within the requirements of the consent conditions for agreement with the Transport Agency and Watercare. A detailed method statement will be developed by the contractor for their chosen methodology prior to construction.

7.16.2 Indicative construction sequence

An indicative construction sequence is outlined below.

1. Install rock revetment/sheet piles and groynes.
2. Remove existing Rip Rap material and stockpile adjacent to the works within the catchment of a Super Silt Fence device.
3. De-water construction area between existing causeway and rock revetment/sheet piles.
4. Construct bunded area beside the existing carriageway to temporarily stockpile contaminated excavated material from the wastewater pond for removal off site.
5. Excavate toe in a sequenced manner as follows:
   - Monitor groundwater elevation, flow and quality;
   - Install trench stops to control groundwater flow;
   - Remove groundwater from excavations by pumping and discharging it into appropriate storage or into the Rosedale oxidation ponds subject to WSL permission; and
   - Monitor excavation for presence of methane gas. If concentrations are greater than 2% v/v then the works at this location should cease and the gas allowed to vent passively. Work should only recommence at this location once methane concentrations is below 2% v/v for a period of 15 minutes.
6. Conduct testing on the bottom of the toe excavation. Engineer to review Scalar test results prior to filling.
7. Stockpile excavated contaminated material in bund area.
8. Conduct testing to establish if stock piled material is contaminated.
9. Remove excavated material off site to an approved allocated site.
10. Line bottom of the toe excavation with approved geotextile.
11. Fill excavated area with approved GAP100 and line external batter face with rock lining (this can be sourced from the outer groyne feature). All other materials shall be cleanfill.
12. Continue with Items 3-11 in that sequence until the full length of the fill embankment has been extended.
13. Restoration of the area used for dewatering pond sludge to be inspected by Watercare prior to the replacement of topsoil.

7.16.3 Potential Effects on WSL Ponds 1 & 2

The proposed works on the causeway between WSL ponds 1 & 2 will result in the following effects:

- The capacity of both ponds will be reduced by a very small (insignificant) margin.
- Extension of the causeway will likely require the removal of existing sediment/sludge. Works at the toe will require excavation (as described in the section above). Depending on the detailed design by the contractor, the sludge / soft foundations soils will need to be removed or displaced.
- The use of sheet piles will penetrate the lake bed. A temporary revetment if required will also require new material to be placed temporarily on the lake bed.

7.17 Closed Landfill

For an overview of the refuse, leachate and landfill gas management techniques and measures that will be used within the Project, including outline methodologies and management techniques that will apply and will achieve the necessary environmental objectives reference should be made to the Assessment of Effects – Corridor Encroachment on Rosedale Landfill, Technical Assessment 7 in **Volume 3**.

7.18 Transport Disruption

The NCI Project requires works on and around live transport corridors including SH1, SH18 and the surrounding local road network. As a result, construction of the Project will result in disruption to the existing transport network including Public Transport (PT) operations.

7.18.1 Assessment of Traffic Effects

For an overview of the assessment of traffic effects during construction, including how the proposed construction works will affect AT Metro busway, frequent, connector, local and peak period services within their North Shore network reference should be made to the Assessment of Transport Effects, Technical Assessment 14 in **Volume 3**.

7.18.2 Temporary Traffic Management

7.18.2.1 SH1 & SH18

In order to provide adequate space for construction, lane widths on SH1 & SH18 will require temporary lane width reduction. These restrictions are expected to be in place throughout the full length of the construction programme from mid-2018 to late 2021.

7.18.2.2 Rosedale Road Contra-flow

The lowering of the vertical alignment of Rosedale Road beneath SH1 will require restrictions to the existing traffic operations for approximately 6 months to allow construction access. It is understood that traffic movement is already constrained at this location at peak times and modelling suggests that eastbound operation is critical in the morning peak, while evening peak operation is more balanced. Traffic signal controlled one way working allowing alternating movement in both directions (one direction at a time) is predicted to result in lesser effects than one way operation which would allow movement in one direction only (either from west to east or east to west but not both).

Restrictions on Rosedale Road result in traffic migrating to McClymonts Road and Constellation Drive to north and south.

7.18.2.3 McClymonts Bridge

In order to move the horizontal alignment of the busway/SUP against SH1 the existing eastern abutment of McClymonts Road Bridge must be removed. The existing southbound span and the existing median pier and substructure must be removed and replaced. In addition, the western abutment of the current McClymonts Road bridge restricts sight distance to the Oteha Valley northbound off-ramp to 90km/h due to a substandard 1.9m edge shoulder. Therefore, construction of an off-line bridge is proposed.

Traffic counts show that McClymonts Road is very tidal, with dominant westbound morning flows and eastbound evening flows. Construction of the bridge off-line results in minimal disruption to the existing McClymonts Road Bridge during construction and allows both lanes on the existing bridge to remain open maintaining pedestrian, bus and car access at this location across the existing bridge until such time as the new bridge is completed

7.18.2.4 Paul Matthews Road

Construction of the proposed new Paul Matthews Bridge over SH18 will necessitate the temporary relocation of the Paul Matthews Road and Upper Harbour Highway intersection. This diversion is likely to be required from mid-2018 until early 2021. As a result of the requirement to lower the vertical alignment of SH18 to tie in to the new ramp connections to SH1 right turn restrictions into and out of

Paul Matthews Road will likely be required for a period of 3 to 6 months. This is predicted to result in travel time increases.

7.19 Structures

Table 15 shows a grouping of structures based on typical expected construction methodologies. For each structure type (group) a tabulated methodology is presented for new structures (Table 16) and for existing structure improvement (Table 17). These structures and methodologies are feasible and likely solutions, but the appointed contractor may develop alternative structures and methodologies.

Table 15 Types of structure

Structure Type (Group)	Relevant Structures
Multi-span precast concrete girder bridges	Albany Station Busway Bridge
	Greville Rd Busway Bridge
	SH1 - SH18 Westbound Ramp
	Constellation Dr Busway Bridge
	McClymonts Rd Bridge (Replacement)
Single span precast concrete girder bridges	Rosedale Rd Busway Bridge
	Caribbean Dr Intersection Bridge
	Watercare Pond Link Bridge
Composite steel girder and concrete slab bridges	Paul Mathews Rd Bridge
Precast concrete box culvert lengthening	Watercare Pond Link (Lengthening)
Armco steel pipe culvert lengthening	Alexandra Creek Pedestrian Underpass (Lengthening)
Bridge widening (U-beams)	Greville Rd Bridge (Widening)
Bridge widening (Double Hollow Cores)	Rosedale Rd Bridge (Widening)
	Constellation Dr Bridge (Widening)

7.19.1 New Bridge Construction

Table 16 New bridges – Construction methodologies

Activity	Temporary / Permanent works	Description
TTM	Temporary	As required pre and during construction to provide safe working areas and traffic thoroughfare. Also to allow for lifting girders and for in-situ concrete pours when necessary. **Rosedale Rd Busway Bridge –** TTM will be required on Rosedale Rd predominantly due to the adjacent Rosedale Rd Bridge Widening. **Caribbean Dr Intersection Bridge –** TTM is unlikely to be necessary due to the off-line nature of the works. **Watercare Pond Link Bridge –** TTM will be required to phase the construction of the bridge beneath the motorway, multiple traffic switches are expected.
Night works	Temporary	Heavy crane lifts will be required during construction of all bridge types. Night works will be required during construction, particularly during above motorway and local road works. For example girder launching, in-situ deck pours and placement of sundry bridge items. Busway bridges are constructed offline with less TTM impacts. **Caribbean Dr Intersection Bridge –** Night works are not likely to be required at this site due to the off-line nature of the construction **Watercare Pond Link Bridge –** Large scale TTM and motorway deviations will be required to allow offline construction.
Earthworks	Temporary & Permanent	Earthworks as required to provide safe working areas, particularly at the abutments (typically fill) **Watercare Pond Link Bridge –** Cut depths of approximately 2-5m may be required. Deeper excavation will only be required once sheet piles are in place. Excavation to be filled once the structure is constructed.
Piling	Permanent	Bored piles for bridge pier and abutment foundations, including steel works, vibration if required, concrete works. Heavy piling rigs are likely required given reference design pile sizes. Driven steel piles, particularly at the abutments may be considered during detailed design. **Rosedale Rd Busway Bridge –** Medium sized piling rigs are likely required given reference design pile sizes **Caribbean Dr Intersection Bridge –** Contiguous bored pile walls with shotcreting for abutment foundations and walls. Medium sized piling rigs are likely required given reference design pile sizes. **Watercare Pond Link Bridge –** Sheet piling for abutments. Alternative wall systems should not be precluded
Ground Improvements	Permanent	Not identified as a requirement at this stage for any bridge type. Potentially required at the SH1-SH18 Westbound Ramp.
Retaining Walls	Permanent	MSE block retaining walls particularly on the approach walls and where spill through abutments cannot be used. Urban design proposed concrete finish on walls and abutments, alternative wall types should not be precluded. **Watercare Pond Link Bridge –** Sheet piling of the abutment walls, with soil nails to tie sheet piles back prior to deeper excavation.
Temporary Falsework	Temporary	Potentially required around the longer spans and in relation to retaining walls, dependent on design and construction sequence. Otherwise as would be typical for safety purposes in regular precast girder, composite steel girder, and slab bridge construction. Cantilever slab sections, due to curved road geometry, will require clip-on falsework on outer girders. **Watercare Pond Link Bridge –** As above, but with the requirement to retain the live motorway dependent on TTM.
Abutments	Permanent	Steel fixing, formwork / falsework, in-situ concrete works for all bridge types
Piers	Permanent	Steel fixing, formwork / falsework, in-situ concrete works using a pre-fabricated steel mould or pre-fabricated concrete elements lifted and concreted in place.
Bridge Deck	Permanent	**Precast Concrete Girder Bridges** Pre-stressed, precast concrete girders transported to site and lifted in place. In-situ concrete slab cast over girders and likely integral with piers. Multiple heavy crane lifts will be required, though a self-launching girder gantry may be utilized on the longer multi-span bridges. **Watercare Pond Link Bridge –** As above, but with DHC units, transverse stressing and grouting may also be considered as replacement to an in-situ deck slab. **Composite Steel Girder And Concrete Slab Bridges** Prefabricated, structural steel girders transported to site in sections, spliced and connected in pairs or three's as required and lifted in place. In-situ concrete slab cast over girders. Multiple heavy crane lifts will be required. Precast deck slab sections may be considered during detailed design. Protective coatings should be applied prior to delivery to site, though painting of steel sections may be carried out on site. Touch-ups will be required once constructed. Likely deck will be integral with piers, not abutments.
Bearings, Joints	Permanent	**Multi-Span Precast Concrete Girder Bridges and Composite Steel Girder and Concrete Slab Bridges** Elastomeric or pot bearings are required at simply supported abutments. Expansion joints at abutments are required, though the type may vary dependent on the final design and in order to minimize long term maintenance (strip seal is likely for Paul Matthews Rd Bridge). **Single Span Precast Concrete Girder Bridges** Likely use of an integral abutment means that bearings and joints should not be required. Possibly an asphaltic plug joint or bitumen seal if required.
Sundry Items	Permanent	**Precast Concrete Girder Bridges** Bridge lighting, settlement slabs, traffic barriers, drainage catch-pits and pipe works. Typically these items will be pre-fabricated solutions, either bolted in place or connected to the bridge via a small in-situ concrete / grout pour (such as in the case of precast traffic barriers). In-situ concrete elements may be required. **Composite steel girder and concrete slab bridges** As above but with the inclusion of kerbing and cycle rails. The kerbs will be cast together with the concrete deck slab.
Demolition	Permanent	**McClymonts Rd Bridge Replacement –** Demolition of the existing bridge including abutment retaining structures and the bridge super and sub-structure.

7.19.2 Existing Structure Improvements

Table 17 Existing bridge/culvert improvement - Construction methodologies

Activity	Temporary / Permanent works	Description
TTM	Temporary	As required pre and during construction to provide safe working areas and traffic thoroughfare. **Bridge Widening Operations –** TTM of the motorway above will be required during the Project construction. Limited TTM of the local road is expected, particularly for modification to the piers, lifting girders and in-situ concrete pours.
Night works	Temporary	Heavy crane lifts will be required during bridge widening operations, some crane lifts will be required for culvert lengthening. **Culvert Lengthening Operations –** Night works are not likely to be required due to the off-line nature of the construction. **Bridge Widening Operations –** Night works will be required during construction, particularly above local the road and adjacent to motorway girder placement, localized demolition, potential steel destressing and stressing activities and placement of sundry bridge items.
Earthworks	Temporary & Permanent	**Culvert Lengthening Operations –** Earth works as required to provide safe working areas, including fill over the lengthened portions of the culvert and compaction works to create a foundation layer for the culvert segments. Cement stabilized fill may be used. **Bridge Widening Operations –** Earthworks as required to provide safe working areas, particularly at the extension of the abutments (typically fill). For Rosedale Rd Bridge, large deep cuts may be required for construction of the retaining walls immediately adjacent to the motorway.
Piling	Permanent	**Culvert Lengthening Operations –** Not required **Bridge Widening Operations –** Bored piles for bridge pier and abutment foundations or soldier pile and panel abutment walls, including steel works, vibration if required, concrete works. Medium sized piling rigs are likely required given existing pile sizes. **Constellation Dr Bridge Widening –** Additional pier and abutment piles should not be required due the existing structure's future proofing.
Ground Improvements	Permanent	Not identified as a requirement for any bridge/culvert improvement at this stage.
Retaining Walls	Permanent	**Precast Concrete Box Culvert Lengthening –** Construction is intended to be completed using precast concrete box sections extending far enough that wingwalls / retaining walls are not required. **Armco Steel Pipe Culvert Lengthening –** Demolition of the southern crib retaining wall. Construction of replacement in-situ L-shape gravity retaining wall. Alternatives may involve sheet piling or MSE retaining walls. **Greville Rd Bridge Widening –** Consideration is to be given to the existing SUP, low height retaining walls. Otherwise spill through abutments are used without retaining walls. **Rosedale Rd Bridge Widening –** Widening of the MSE small block retaining walls at both abutments. Temporary shoring or sheet piling will be required in order to widen these walls, due to the depth of cut and fill required to construct a matching wall. **Constellation Dr Bridge Widening –** Additional retaining walls should not be required due to the existing structure's future proofing.
Temporary Falsework	Temporary	**Culvert Lengthening Operations –** Potentially required, dependent on design and construction sequence and motorway TTM above. Otherwise as would be typical for safety purposes in regular culvert lengthening or repair methodologies. Potentially required to prop the existing culvert during construction. **Armco Steel Pipe Culvert Lengthening –** Further shoring of retaining walls may be required. **Bridge Widening Operations –** As would be typical for safety purposes in regular bridge widening. Temporary shoring may also be required to support the live motorway during earthworks and demolition. For double hollow core construction, may be required in relation to retaining walls, cut and fill as required by the construction sequence.
Inlet & Outlet Structure	Permanent	**Culvert Lengthening Operations –** No typical drainage inlet and outlet structure, though the headwalls and "wingwalls" will need to be demolished and rebuilt to the south.
Culvert Lengthening	Permanent	**Precast Concrete Box Culvert Lengthening –** Construction joints will need to be prepared and sealed between old and new precast sections. New foundation material will need to provide similar stiffness to the existing culvert length. **Armco Steel Pipe Culvert Lengthening –** Existing Armco culvert sections will need to be trimmed back square and prepared for adjoining new length of Armco culvert. The existing culvert is understood to have two steel skins filled in with lightly reinforced concrete all around. A similar finish will need to be obtained, with the outer and inner steel sections being used primarily as a permanent shutter. The end culvert sections of Armco pipe will need to be shaped to fit the realigned pathway. Headwalls and retaining walls as above will need to be reconstructed. Finally painting as required.
Abutments	Permanent	**Bridge Widening Operations –** Localized demolition of existing abutment to accommodate tying into the existing structure. Steel fixing, formwork / falsework, in-situ concrete works. For double hollow core construction, drill and dowel may be necessary and strengthening works could be required, but are not expected.
Piers	Permanent	**Bridge Widening Operations –** Localized demolition of existing pier to accommodate tying into the existing structure. Steel fixing, formwork / falsework, in-situ concrete works. For double hollow core construction, drill and dowel may be necessary and strengthening works could be required, but are not expected. Not applicable to Rosedale Rd Bridge.
Bridge Deck	Permanent	**Bridge Widening Operations –** Pre-stressed, precast concrete girders transported to site and lifted in place. For U-beam construction, in-situ concrete slab cast over girders. For double hollow core construction, transverse post-tension destressing and stressing activities on site, grouting, access restricted welding will be necessary. Both bridge types will require multiple heavy crane lifts
Bearings, Joints	Permanent	To match existing for all bridge widening operations
Sundry Items	Permanent	**Precast concrete box culvert lengthening –** Lighting may be added due to the considerable length of structure. Otherwise drainage and pipe works, concrete floor slabs with typical construction methodology is to be applied. **Armco steel pipe culvert lengthening –** Lighting, drainage catchpits and pipe works, concrete floor slabs. Typical construction methodology is to be applied. It is evident that the floor slab of the pedestrian underpass is constructed using permeable concrete and a suitable matching product should be used.

		Bridge Widening Operations – Bridge lighting, settlement slabs, traffic barriers, drainage catchpits and pipe works to match existing. Typically these items will be pre-fabricated solutions, either bolted in place or connected to the bridge via a small in-situ concrete / grout pour (such as in the case of precast traffic barriers). In-situ concrete elements may be required.
Strengthening and Repairs	Permanent	**Precast Concrete Box Culvert Lengthening –** Crack injection, localized demolition, steel plate or FRP repairs / strengthening may be required on the existing portion of the subway.

7.19.3 Retaining Walls

Proposed retaining walls including four bridge abutment walls are to be constructed along the Project alignment with a mix of wall types including:

1. Gravity type retaining structures, either concrete L-shaped cantilever or TL-5 barrier walls,
2. Mechanically Stabilised Earth (MSE) block walls,
3. Bored pile walls and anchored bored pile walls,
4. Steel post walls, and
5. Timber pole walls

The tables below present the likely construction activities required during the construction of aforementioned types of wall.

Table 18 Construction Activities for Gravity Type Retaining Walls

Activity	Temporary / Permanent works	Description
Earthworks	Temporary & Permanent	Earthworks as required to provide safe working areas and space for installation of footing (L shape) and drainage at the back of retaining walls.
Piling	Permanent	N/A
Ground Improvements	Permanent	Not identified as a requirement at this stage.
Temporary Staging	Temporary	Potentially required in relation to the safe temporary back slopes required behind the walls.
Construction Sequence	Permanent	1. Excavate to the wall foundation grade and prepare the foundation subgrade with stable temporary back slopes provided, if necessary. For fill walls, stable temporary back slopes need to bench into existing embankment. Foundation preparation might include removal of unsuitable materials (undercut). 2. The footing outline is formed, and the reinforcement steel for the footings is placed and extended into the stem. The footing concrete is then poured. 3. The wall stem is formed, and the concrete is poured. In general, concrete is poured in sections between vertical construction joints and wherever possible, it is poured for the full height to eliminate the cold joints. 4. Drainage systems are then constructed behind the walls. 5. Backfill is placed behind the retaining walls.

Table 19 Construction Activities for MSE Walls

Activity	Temporary / Permanent works	Description
Earthworks	Temporary & Permanent	Earthworks as required to provide safe working areas and space for installation of geogrid reinforcement and drainage systems.
Piling	Permanent	N/A
Ground Improvements	Permanent	Not identified as a requirement at this stage. Ground improvement might be necessary for MSE walls of H>10m dependent on the ground conditions.
Temporary Staging	Temporary	Required in relation to the safe temporary back excavation required behind the walls.
Construction Sequence	Permanent	1. Prepare subgrade including removal of unsuitable materials (undercut) from the area to be occupied by the retaining structure. 2. Place a levelling pad for the erection of the facing blocks. 3. Erect the first row of facing blocks on the prepared levelling pad. 4. Install the subsoil drains and drainage mat behind the walls. 5. Place and compact backfill on the subgrade to the level of the first layer of reinforcement and its compaction. 6. Place the first layer of reinforcing elements on the wall fill. 7. Place the backfill over the reinforcing elements to the level of the next reinforcement layer and compaction of the backfill. 8. Repeat steps 3 and 5 to 7 for each successive layer till the design level is reached. 9. Construct traffic barriers and copings.

Table 20 Construction Activities for Steel Post Walls / Timber Pole Walls

Activity	Temporary / Permanent works	Description
Earthworks	Temporary & Permanent	Earthworks as required in front of the wall and in the temporary back slopes to provide safe working areas for the installation of drainage systems behind the walls.
Piling	Permanent	Piling work is required to install the steel posts or timber poles.
Ground Improvements	Permanent	Typically not required
Temporary Staging	Temporary	Potentially required in relation to the temporary work platform for installation of steel post or timber poles.
Construction Sequence	Permanent	1. Drill the holes from the front (facing) side of the walls. 2. Install the steel post or timber pole sections by concreting them within the pre-drilled holes. 3. Excavate between the steel post or timber pole sections from the top down for installation of lagging and drainage behind the walls with a safe temporary excavation subject to the ground conditions and the contractor's discretion. 4. Continue step 3 until the bottom of excavation is reached and the drainage facilities behind the walls are installed. 5. Install the lagging. 6. Backfill the temporary excavation with specified materials to the top of retaining walls.

Table 21 Construction Activities for Bored Pile Walls and Anchored Bored Pile Walls

Activity	Temporary / Permanent works	Description
Earthworks	Temporary & Permanent	Earthworks as required in front of the wall and potentially required in the temporary work platform for installation of bored piles.
Piling	Permanent	Required to install the bored piles.
Ground Improvements	Permanent	Typically not required for bored pile walls and anchored bored pile walls.
Temporary Staging	Temporary	Required in relation to the safe temporary work platform and stage excavation for installation of bored piles and anchors, respectively.
Construction Sequence	Permanent	1. Install the piles with auger type drill rigs. Temporary casing might be required. 2. Excavate between the bored piles from the top down for installation of capping beams and reinforced shotcrete. 3. Install the capping beam. 4. Continue excavation and apply the reinforced shotcrete. A drainage gallery/mat is provided behind the shotcrete to intercept and channel any seepage that might penetrate the walls. 5. Install the anchors, if required. 6. Conduct testing on the anchors, if required. 7. Excavation will go down in stages. Anchors will be installed following the stage excavation, if required. 8. Install the facing panels.

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Appendices

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Appendix A
Causeway Works Sketches

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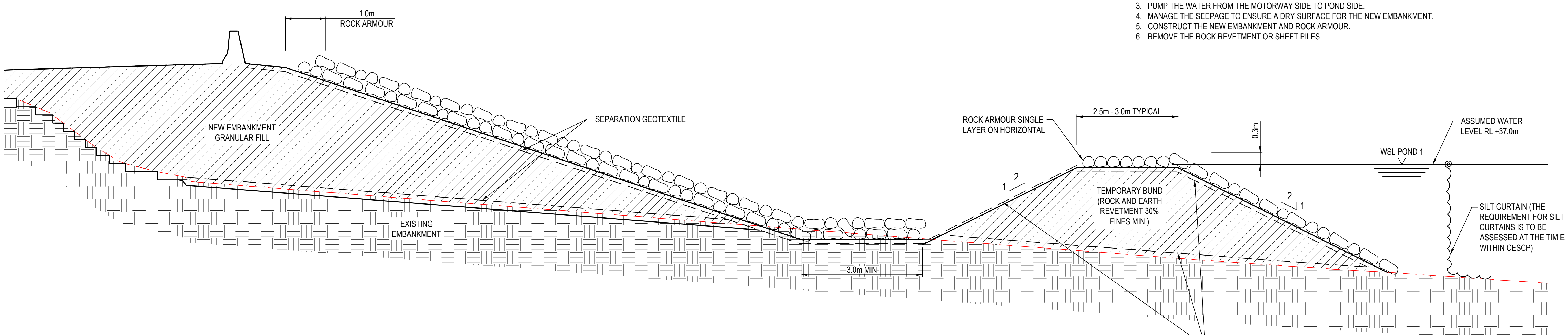
CONSTRUCTION SEQUENCES:

1. INSTALL THE SILT CURTAIN.
2. CONSTRUCT THE ROCK REVETMENT / GROYNE OR INSTALL THE SHEET PILES.
3. PUMP THE WATER FROM THE MOTORWAY SIDE TO POND SIDE.
4. MANAGE THE SEEPAGE TO ENSURE A DRY SURFACE FOR THE NEW EMBANKMENT.
5. CONSTRUCT THE NEW EMBANKMENT AND ROCK ARMOUR.
6. REMOVE THE ROCK REVETMENT OR SHEET PILES.



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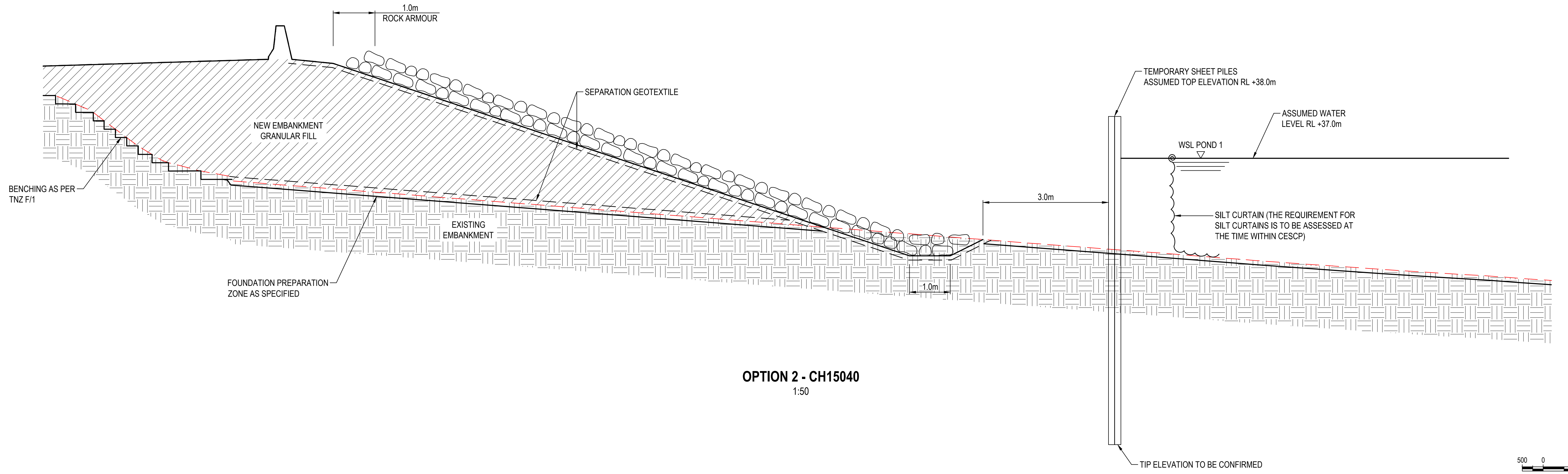

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DESIGNED: C. CHEN
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DATE

PROJECT: NORTHERN CORRIDOR IMPROVEMENTS

TITLE: CONSTRUCTION METHODOLOGY TEMPORARY WORKING PLATFORM & PROTECTION - SHEET 1 OF 2

DRAWING No.	PROJECT No.	STAGE	WP	TYPE	NUMBER	REV
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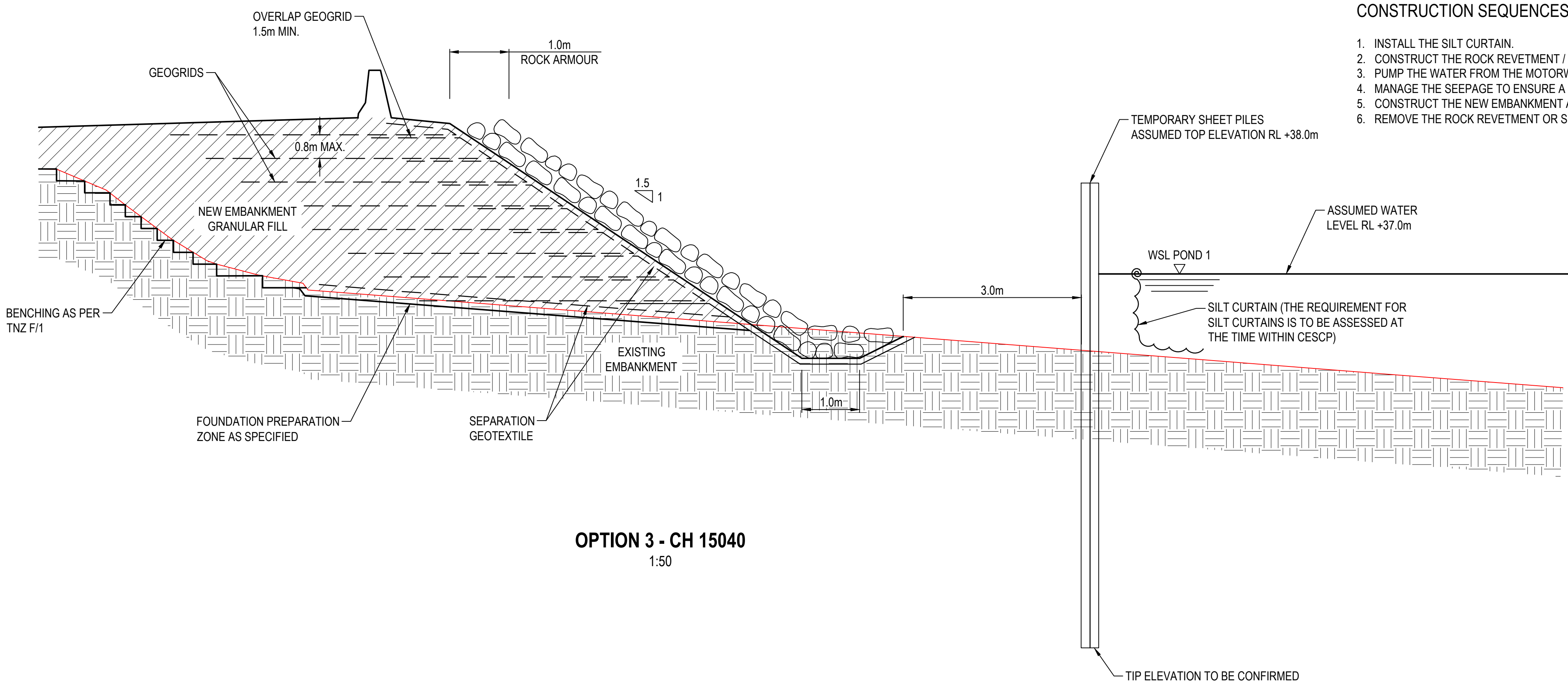
CONSTRUCTION SEQUENCES:

1. INSTALL THE SILT CURTAIN.
2. CONSTRUCT THE ROCK REVETMENT / GROYNE OR INSTALL THE SHEET PILES.
3. PUMP THE WATER FROM THE MOTORWAY SIDE TO POND SIDE.
4. MANAGE THE SEEPAGE TO ENSURE A DRY SURFACE FOR THE NEW EMBANKMENT.
5. CONSTRUCT THE NEW EMBANKMENT AND ROCK ARMOUR.
6. REMOVE THE ROCK REVETMENT OR SHEET PILES.



OPTION 3 - CH 15040

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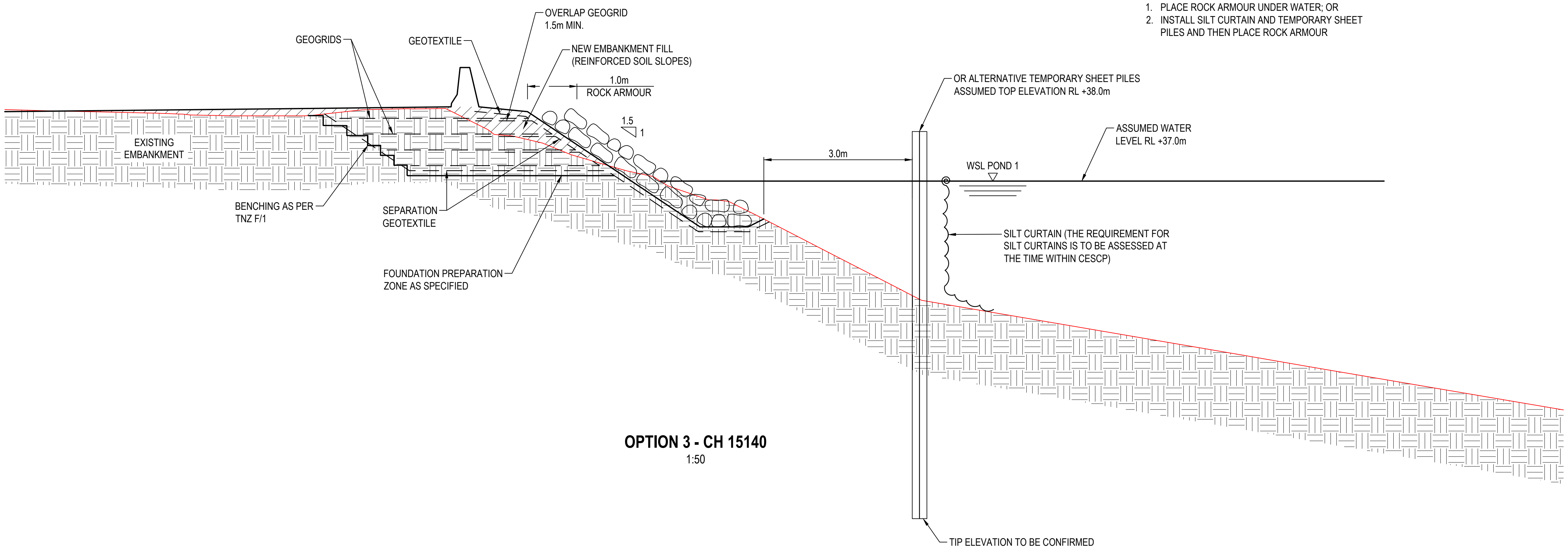
CH 15140 TWO OPTIONS:
1. PLACE ROCK ARMOUR UNDER WATER; OR
2. INSTALL SILT CURTAIN AND TEMPORARY SHEET PILES AND THEN PLACE ROCK ARMOUR



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PROJECT: NORTHERN CORRIDOR IMPROVEMENTS

TITLE: CONSTRUCTION METHODOLOGY TEMPORARY WORKING PLATFORM & PROTECTION - SHEET 2 OF 2

DRAWING No.	PROJECT No.	STAGE	WP	TYPE	NUMBER	REV
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Appendix B
Proposed Construction Zones

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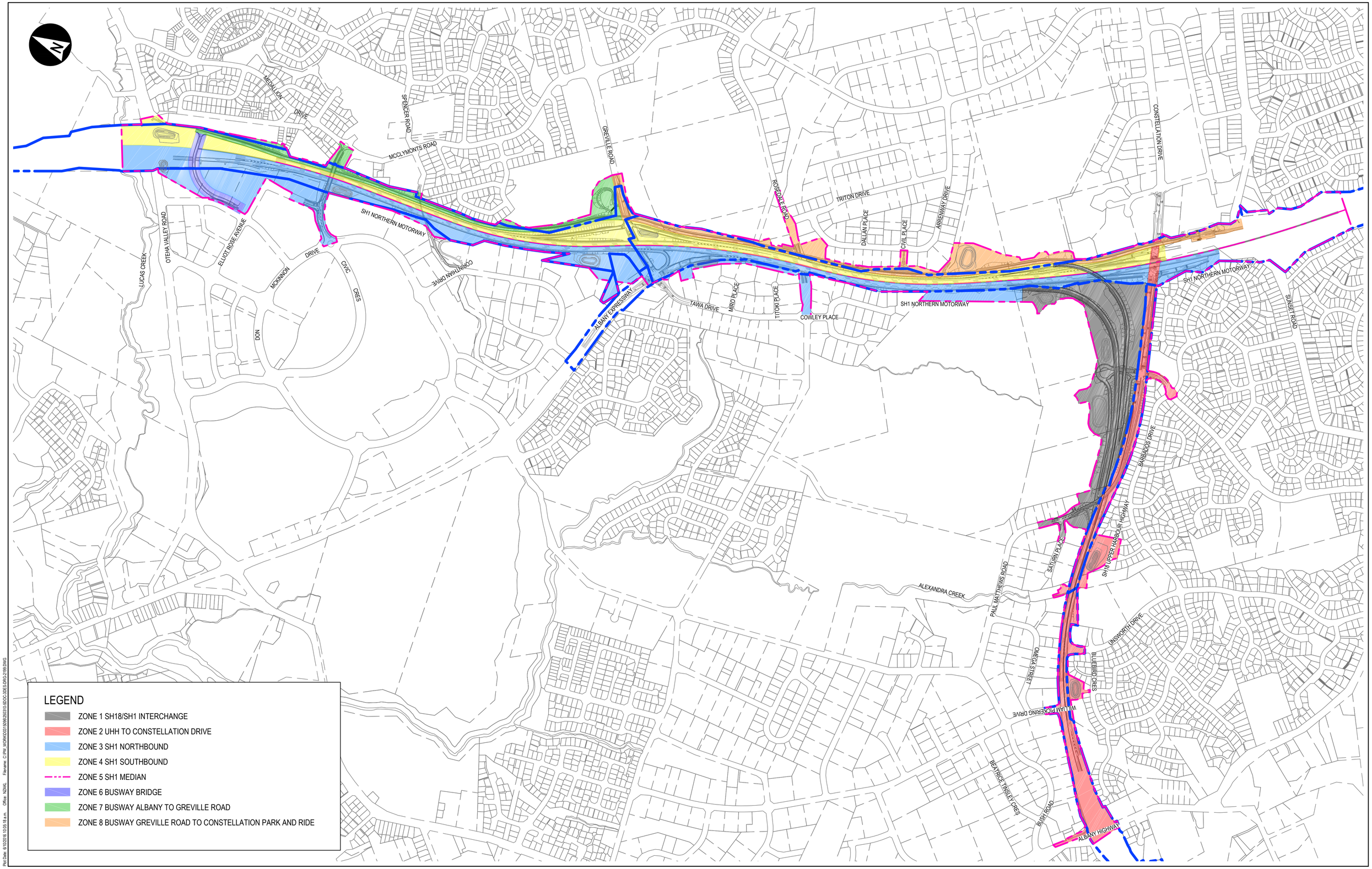

LEGEND

- ZONE 1 SH18/SH1 INTERCHANGE
- ZONE 2 UHH TO CONSTELLATION DRIVE
- ZONE 3 SH1 NORTHBOUND
- ZONE 4 SH1 SOUTHBOUND
- ZONE 5 SH1 MEDIAN
- ZONE 6 BUSWAY BRIDGE
- ZONE 7 BUSWAY ALBANY TO GREVILLE ROAD
- ZONE 8 BUSWAY GREVILLE ROAD TO CONSTELLATION PARK AND PARK AND RIDE

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DESIGNED: K. DE SILVA
CHECKED: A. DOUGLAS

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DATE

PROJECT: NORTHERN CORRIDOR IMPROVEMENTS

TITLE: CONSTRUCTION ZONES OVERALL PLAN

DRAWING No.	PROJECT No.	STAGE	WP	TYPE	NUMBER	REV
	250310	5DOC	3DES	DRG	2199	A

Appendix C
Indicative Construction Programme

Zone	Activities	2018: Year 1												2019: Year 2												2020: Year 3												2021: Year 4						
		J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45
		Stage 0					Stage 1a			Stage 1b																Stage 1c							Stage 1d						Stage 2a			Stage 2b					
	Project Mobilisation and Detailed Design																																												
Zone 1	SH18/SH1 Motorway to Motorway connection and SH18 offline works																																											
Zone 2	SH18 Upper Harbour Highway (SH1 to Albany Highway)																																											
Zone 3	SH1 northbound widening																																											
Zone 4	SH1 southbound widening																																											
Zone 5	SH1 median works																																											
Zone 6	Albany Station Busway Bridge																																											
Zone 7	Busway North (Albany Station to Greville Road)																																											
Zone 8	Busway South (Greville Road to Constellation Station)																																											

Rosedale Road contraflow restrictions begin

SH1 speed restrictions begin (80km/h)

Rosedale Road Lowering completed. Full operations resume.

McClymonts Road bridge placement completed and traffic diverted.

Eastbound to Northbound ramp opens

Southbound to westbound ramp opens

SH1 speed restrictions end

Appendix D
Indicative Cut & Fill Volumes by Construction Zone

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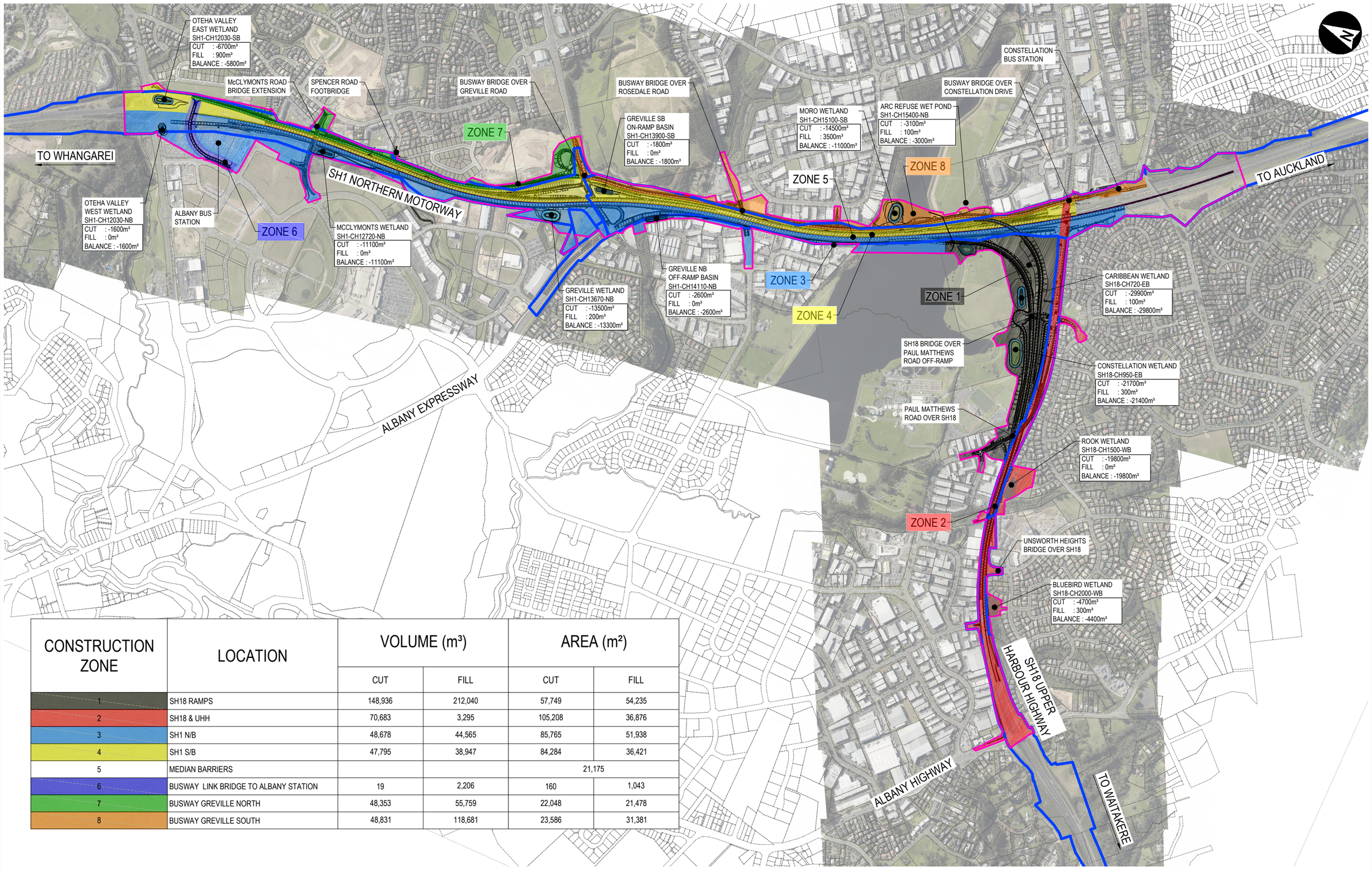

CONSTRUCTION ZONE	LOCATION	VOLUME (m³)		AREA (m²)	
		CUT	FILL	CUT	FILL
1	SH18 RAMPS	148,936	212,040	57,749	54,235
2	SH18 & UHH	70,683	3,295	105,208	36,876
3	SH1 N/B	48,678	44,565	85,765	51,938
4	SH1 S/B	47,795	38,947	84,284	36,421
5	MEDIAN BARRIERS			21,175	
6	BUSWAY LINK BRIDGE TO ALBANY STATION	19	2,206	160	1,043
7	BUSWAY GREVILLE NORTH	48,353	55,759	22,048	21,478
8	BUSWAY GREVILLE SOUTH	48,831	118,681	23,586	31,381

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DESIGNED: M. FAN
CHECKED:

PRELIMINARY
NOT FOR CONSTRUCTION

APPROVED
DATE

PROJECT: NORTHERN CORRIDOR IMPROVEMENTS

TITLE: GENERAL ARRANGEMENT
OVERALL KEY PLAN
INDICATIVE CUT AND FILL VOLUMES

DRAWING No.: PROJECT No. 250310 – STAGE 3PRE – WP 3DES – TYPE SKT – NUMBER 0201 – REV B

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